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BACHELOR'S THESIS

Empathizing with virtual agents: the effect of personification and general empathic tendencies

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Abstract

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by Kim Kroes

Maintaining social relationships with people is considered crucial in the social environment. Technologies are slowly becoming part of people's social lives. However, for technologies to embed this social environment completely, humans' interaction with technologies should be as natural as with people. Technologies must be able to show emotions and understand human feelings. In other words, they must be empathic towards humans, and humans must be able to show empathy towards them. This study aims to identify the predictability of a personification story on the empathic response people show towards a specific type of technology, virtual agents. In addition to this factor, individual differences in the ability to empathize with other people and the predictability of this on the ability to show empathy to virtual agents are also studied. An experiment is designed where participants are asked to complete a self-report measurement of empathy, the "*Toronto Empathy Questionnaire*". Afterward, participants participate in a virtual reality experiment with a virtual agent showing signs of sadness. Half of the participants were presented with the personification story. Their ability to empathize with this agent is measured with a post-experiment survey. Results showed that individual differences in empathy significantly predict the ability to empathize with the virtual agent. This result implicated that when people are more empathic towards others, they tend to be more empathic towards virtual agents. The personification story did not show to predict this ability. This finding contradicted previous experience on the effect of personification stories on empathizing with virtual agents.

Keywords *– Empathy, virtual agents, Toronto Empathy Questionnaire, virtual reality, personification stories*

Preface

Before you lies the thesis "*Empathizing with virtual agents: the effect of personification and general empathetic tendencies.*". This thesis has been written in partial fulfillment of the Bachelor Information Sciences at Utrecht University. I was engaged in writing and researching this thesis from February to June 2022.

This subject of this thesis was established based on previous experience with modeling empathy in Artificial Intelligence, gathered during my Bachelor in Information Science. Together with my supervisor, Isabella Saccardi, a research question and research plan was formulated.

I want to acknowledge and express my gratitude to my supervisor, Isabella Saccardi, who guided me throughout my thesis. Her support and guidance helped me through all the stages of writing this thesis. Her support was always motivational and positive and helped me to a great extent to finish this thesis. I am also thankful to Judith Masthoff for taking the time to review my thesis.

Besides my supervisor and reviewer, I would like to thank Nabila Amadou for assisting me in setting up my virtual reality experiment. Her knowledge and support allowed me to learn more about the use of virtual reality, and she provided me with necessary technical suggestions. Her effort and time are very much appreciated and contributed to a well-ordered experiment.

I would also like to thank my family and friends for contributing to my research and providing me with helpful information. This allowed me to have diverse participants and much enjoyment during the experiments.

I hope you enjoy reading this thesis.

Kim Kroes

Utrecht, June 27th, 2022

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Chapter 1

Introduction

In the complex social environment that we live in today, understanding the people around us and their intentions, feelings, and motivations is essential in maintaining social relationships. This social environment has become even more complex with the rise of technologies that are deeply embedded into our lives. Think about autonomous cars, robots, and virtual agents; they are all becoming part of our reality. However, to allow these systems also to embed our social lives, we need to be able to interact with these technologies and vice versa. Not only do we need to be able to interact with technologies, but this interaction should also be natural and requires following the basic principles of human conversation. These basic principles include showing emotions and non-verbal and verbal behavior (Yalcin, 2020). Thus, this means that these technologies must be able to behave socially. Technologies are partially socially when they can understand human feelings (Yalcin, 2020). This is also referred to as the term empathy. This research defines empathy as "*the capacity of human beings to be in tune with another's emotions and to know and understand one another through reflection and shared experience*" (Titchener, 1915).

Empathy is considered an ability that leads to more trustful relationships, increases the length of interactions, and increases engagement (Yalcin, 2018). Therefore, it has also been a frequently studied phenomenon within the human-computer interaction (HCI) domain. Regarding empathy research within the field of HCI, a distinction can be made between modeling empathy within social agents and social agents as targets of empathy. The first regards creating computational models of empathy for virtual agents and robots to allow them to empathize with us humans. On the other hand, the latter applies more to the agent being the target that triggers empathy in the human interaction partner. Here, the agent itself does not necessarily need to have the ability to show empathic behavior (Paiva et al., 2017). In the scope of this research, the focus will be on the agent as a target of empathy. Agents as targets of empathy are also called empathic virtual agents.

Empathic virtual agents can be defined as "*agents that, by their design and behaviors, lead users to emotionally respond to a situation that is more congruent with the agent's situation than the user's*" (Paiva et al., 2017). Research with empathic virtual agents often relates to which elements in agents evoked empathic responses in humans or what characteristics of agents led to emotional responses. These studies have shown that we humans do not necessarily only show empathy toward other people but also toward fictional characters, game characters, or even robots (Paiva et al., 2017). However, research on HCI has shown that the interaction with technologies such as virtual agents is still very different from the usual human-to-human interaction (Moradinzehad & Solovey, 2021). This is because, for us to interact with virtual agents, an agent must be developed that allows both a natural experience and emotional relations. These relations are similar to those we can have with movie characters or characters from books or games. This means that several factors contribute to the extent to which the person can empathize with the virtual agent. Paiva et al. (2017) studied a few of these factors: the situation and context the agent is in, the features of the empathizer such as age, gender and culture, emotional cues or expressions, and the characteristics of the agent. These factors can change the

likelihood that a human observer can feel empathy toward the virtual agent (Paiva et al., 2017). The importance of the agent's characteristics has led to yet another research on empathy and HCI with the so-called embodied conversational agents (ECAs). ECAs are often also referred to as embodied virtual agents (EVAs). These types of virtual agents are used in empathy research as they are designed to look more human-like and show more human-like behavior. Numerous studies with ECAs and EVAs have shown that these developments in virtual agents trigger socially desirable behavior towards the embodied agent in people (Hoffmann et al., 2009).

Within the research performed with several types of virtual agents, including embodied agents, studying the factors that might evoke a feeling of empathy was a central study point. However, it is also essential to study whether individual differences in empathy influence the ability to empathize with the virtual agent. Individual differences in empathy mean the general differences in feeling empathy towards other people. After investigating individual differences, a better understanding of factors influencing the ability to empathize with a virtual agent can be established (Sinatra et al., 2021). Several studies, such as the one by Nass & Moon (2000) and Krämer (2008), have shown that humans' reactions toward virtual agents are significantly similar to the ones shown towards other humans. This is because virtual agents, especially embodied ones, elicit attention just like humans do. This allows us to percept them as real humans (Hoffmann et al., 2009). Exploring the effects and causes of an empathic response towards virtual agents will enable researchers and developers to improve the design and implementation of not only virtual technology but also robotic technology. Virtual agents and other technologies are used in diverse fields such as health, commerce, video games, military, and even education. Investigating how the interaction and relationships with these virtual agents can be improved can be of much value. This is because social components are essential in the fields where these virtual agents are deployed in. Allowing people to relate more to the virtual agent and understand its actions, motivations and feelings will increase engagement, attention, and improved relationships with the agent (Sinatra et al., 2021).

An even more recent development within the study of empathy and ECAs/EVAs is the use of Immersive Virtual Reality (IVR). This is a computer-generated environment that a user can view through a head-mounted display. By using IVR, users will have a feeling of actually being in the virtual environment. It will allow for more natural interactions with the virtual agents inside the environment. It is shown that virtual agents' presence in IVR increases users' engagement and the realism of the experience, which improves the interaction. This research was performed by Sbordone et al. (2021) and confirmed the importance of studying individual differences in empathic traits when studying the interaction with virtual agents (Sbordone et al., 2021). Darling et al. (2015) studied the effect of personification on the ability to empathize with robots. The personification allows people to relate more to the robot on an emotional level. This study has shown that personification stories indeed impact the empathic response from people to robots. In addition to Sbordone et al. (2021) and Hoffman et al. (2009), this study also confirmed that people with a higher trait of empathic concern, in addition to receiving a personification, showed more empathy towards the robot.

In this research, factors from previous studies are combined into one analysis. The predictability of a personification story on the ability to empathize with virtual agents will be studied. This effect will be measured by letting the research participants evaluate a situation with a virtual agent in Immersive Virtual Reality. Before measuring the predictability, the individual differences in the ability to empathize are measured using the Toronto Empathy Questionnaire (TEQ), designed by Spreng et al. (2009). This is a self-report measurement of empathy that emphasizes the emotional aspect of empathy. It consists of 16 statements where responses are measured using a five-point Likert Scale. The TEQ focuses on several aspects of empathy, including emotional contagion, emotion comprehension, sympathetic physiological arousal, and altruism (Spreng et al., 2009). The effect of the personification on the ability to empathize with the virtual agent in IVR is measured with a post-experiment survey. This consists of questions that relate to the same components of the TEQ with additional questions to evaluate the participants' experience. The research question that is designed for this research is the following question:

"Do the general tendencies towards empathy and the presence of a personification predict the empathy towards the character?"

The reasoning for this research question is that both the presence of a personification and the general tendencies of empathy leads to higher abilities to empathize with the character. Both factors will be evaluated individually to measure the effect of the specific factors on the ability to empathize with the character in the IVR environment.

First, an extensive literature review provides information on the concept of empathy, different measures of empathy, and virtual agents. The related work on virtual agents, personification stories, and IVR are examined in the following sections. The next section covers the methodology for the research and explains the self-report measurement of empathy used, the experiment itself, and the evaluation of the experience. The results are followed up with which qualitative and quantitative analysis is performed. The research will be concluded with a discussion and conclusion of the results.

Chapter 2

Empathy

2.1 The research history of empathy

The concept of empathy has been a subject of interest for psychologists, neuroscientists, and other scientists outside of these fields (Duan & Hill, 1996). It is a crucial concept for considering humans as social beings. It allows them to understand and know the thoughts and feelings of others. This is needed to engage with one another and create meaningful relationships (Karsten, 2019). Since the beginning of the eighteenth century, philosophers David Hume and Adam Smith have extensively studied the psychological basis of the human's social and moral nature. From around 1739-1740, David Hume documented this in his book '*A Treatise of Human Nature.*' In this book, he attempted to introduce the experimental method of reasoning to the moral subject (Hume, 2018). However, even after all types of studies that have been performed regarding the concept of empathy and its role in our social and moral nature, the definition and mechanism of empathy remain unclear (Duan & Hill, 1996).

During David Hume's era, sympathy was commonly used to refer to empathy-related phenomena. Hume stated that "*the minds of men are mirrors to one another*" (Hume, 2018). He described that humans could resonate with and recreate the thoughts and feelings of other people (Karsten, 2019). The actual origin of the concept of empathy dates back to the 1880s. During this time, German psychologist Theodore Lipps described the emotional appreciation of the feelings of others like the term '*Einfühlung*.' When translated; this means '*in-feeling*' (Hardee, 2003). Lipps described Einfühlung as the spontaneous projection of oneself into another body in the environment. This means understanding what it feels like to be in that other person's body or environment. This refers to some imaginary perspective-taking of the other person to understand the feelings or situation of another person. It can be considered imaginary because the other body or the environment that a person is trying to understand does not have to be physically present. A person could, for example, try to understand the experience or feelings they could have when looking at a painted landscape. Thus, the body or environment does not have to be human but could be anything from animals to even inanimate objects (Ganczarek et al., 2018). David Hume's phenomena of sympathy constitute the concept of Einfühlung expressed by Lipps (Karsten, 2019). Lipps did not only use the word Einfühlung to define how people experience other humans or the environment. He also used it to describe how they can understand the mental state and feelings of others. This distinguishes Lipps from his predecessors (Montag et al., 2008).

The current concept of empathy is a product of modernity. It was first used by British psychologist Edward Titchener who in the 1900s translated the word Einfühlung to empathy. Titchener used empathy in his work '*Elementary Psychology of the Thought Process*' (Titchener, 1909). Titchener's notion of empathy does find its origin within the earlier works of Lipps and other psychologists who used the concept of Einfühlung. This is because Titchener also wanted to preserve the idea of projecting oneself into a perceived object. He mentioned that someone could not

know the feelings or emotions of another person by just observing his behaviors. His theory was that this was only possible by some imitation, as he wrote in several of his works.

In his work '*A beginner's psychology'* (Titchener, 1915), Titchener stated that empathic ideas are the converse of perception. According to Titchener, perception of the environment through the human senses is the only effective way to get to know reality. Titchener believed that things are real only if they can be perceived by human senses or imagined through them. However, in his work '*A beginner's psychology',* he mentioned, "*Their core (empathic ideas) is imaginal, and their context is made up of sensations that carry the empathic meaning*" (Titchener, 1915, p.198). This means that empathy does not differ much from perception because it is also made up of sensations. In addition to perception, empathy is also imagination of another person's emotions. Based on this work, a new definition of empathy was derived. This definition was "*a person's awareness in the imagination of the thoughts and feelings of another person*" (Wispé, 1986). However, as the concept of Einfühlung had a somewhat ambiguous definition, the question arises to what extent the meaning of Einfühlung is translated into the modern concept of empathy as expressed by Titchener. These so-called multiple translations, which are translations between concepts, form the base of the ambiguous definition of empathy as it is currently known (Lux & Weigel., 2021). Titchener's new meaning of empathy emphasized the ambiguous definition of empathy itself (Wispé, 1986). Nevertheless, his definition was still widely used among clinical and social psychologists.

Psychotherapist and psychologist Rogers used the concepts of the definition of Titchener to define a new definition of empathy. This definition was "*the ability to live the attitudes of others*" (Rogers, 1951). A difference between Roger's and Titchener's definition is that Titchener tried to look more at the nature of empathy. Roger simply tried to find a universally accepted term (Wispé, 1986).

After several definitions of empathy had been established, a distinction between cognitive and affective empathy was made. This distinction formed the base of the direction toward emotional empathy (Mehrabian & Epstein, 1972). Here, empathy was more concerned with the emotional response to the emotions of others. Davis (1983) defined this as an empathic concern. By this time, all kinds of psychotherapists and psychologists were familiar with the term empathy, which was widely used in research (Wispé, 1986).

2.2 Affective and cognitive empathy

Cognitive empathy
According to Mehrabian and Epstein (1972), empathy can be distinguished between cognitive empathy and affective empathy (Thompson et al., 2021). Cognitive empathy refers to the ability to understand others' emotional experiences. For cognitive empathy, the observer must have attention to the target. An example is when you see a family member crying and understand that they are feeling sad. This attention is necessary to retrieve important information on the state of the target, such as signals or situational context cues. This information is used to understand the reactions and responses of the target. Referring to the example mentioned above, if a person does not look at a family member, they will not notice tears or sad facial

expressions. Moreover, to respond to these cues and signals, the observer must have experience with or knowledge about emotional expressions or situations. If you do not have experience with sad expressions, you will not interpret these expressions as a sad signal.
This knowledge can be created by having experiences with detecting and identifying the internal emotions of the observer itself. Knowing which internal response is triggered by which external stimuli form the basis of all empathic understanding. It is because the observer experiences sadness, allowing them to recognize the emotion in another person.

The ability to distinguish between yourself and a specific target is essential for empathy. Cognitive empathy is closely connected to the theory of mind (ToM) (Zoll & Enz, 2010). The ToM, also called mentalizing, is the ability of a person to understand and predict the behavior of another person and to react to this accordingly. Even though the ability to understand the feelings of others is crucial in being able to have social interactions, it is not sufficient. The ToM is considered only a part of a person's ability to empathize. This is because having empathy also considers the aspect of interfering with and sharing the emotional experiences of others, not just recognizing and understanding them (Dvash & Shamay-Tsoory, 2014).

To conclude the statements about cognitive empathy, it is considered the situation in which an observer actively tries to step outside of itself and step into someone else's experiences. This process involves a cognitive recognition of the people's emotions in the environment. Therefore, cognitive empathy is a multifaceted ability. It consists of various skills, ranging from emotion recognition, perspective-taking, and ToM to memory (Dvash & Shamay-Tsoory, 2014).

Affective empathy
Other studies have highlighted a different aspect of empathy which concerns the affective aspects of it. These studies have referred to affective empathy (Dvash & Shamay-Tsoory, 2014). Affective empathy refers to the ability to share others' emotions. It relates to the emergence of emotions in the observer due to the perception of the internal states of others. The internal state is any emotion or attitude a person might express (Zoll & Enz, 2010). Affective empathy is seen as an emotional reaction of the observer when perceiving that someone else in the environment is about to experience an emotion. An example is when you see your friend being sad because her grandma just passed away. You mention that you feel very sorry for her and that you will be there for your friend. As a result of this definition of affective empathy, it is also sometimes referred to as emotional empathy (Dvash & Shamay-Tsoory, 2014).

Affective empathy is often a result of cognitive empathy after a person has observed and understood another person's emotion. However, affective empathy can also occur due to the perception of expressive behavior where another immediately perceives a person's mental state. This is also called emotional contagion, where a person shows similar facial, vocal, or other behavioral aspects as a reaction to someone else's emotion. As a result of emotional contagion, people show synchrony regarding behavior, attention, and emotions (Herrando & Constantinides, 2021). To conclude, a difference between cognitive and affective empathy is that cognitive

empathy involves understanding another person's emotion, while affective empathy consists of synchronizing these emotions (Dvash & Shamay-Tsoory, 2014).

2.3 Models of empathy

As stated in section 2.1. '*The research history of empathy,'* many definitions of empathy have been used and formulated. Several behaviors have been used to define the concept of empathy, and these can be listed as:

- *Motor mirroring (mimicry)*, is the action or skill of imitating someone (Chartrand & van Baaren, 2009).
- *Emotional contagion,* is the perception of expressive behavior where the mental state of a person is immediately perceived by another (Herrando & Constantinides, 2021).
- *Concern about another's emotional state (empathic concern)*
- *Consolidation behavior (altruistic helping),* is the unselfish behavior to benefit others (Waters, 2021)
- *Understanding another's emotional state and thoughts*
- *Imagining other's thoughts (perspective taking)*
- *Projection of oneself into another's situation*

Some researchers tend to study empathy based on one of these phenomena individually. However, others believe that empathy is related to each of these phenomena, where each layer is built on top of the other (Yalcin & DiPaola, 2019).

Yalcin and DiPaola (2019) performed research regarding the models of empathy. These models of empathy can be divided into categorical and dimensional models. The categorical model focuses on the distinction between cognitive and affective empathy, covered in section 2.2, '*Affective and cognitive empathy'*. The dimensional model is a multidimensional system that integrates these so-called layers of empathy. They suggest that cognitive and affective empathy are interconnected. Yalcin and DiPaola tried to model empathy based on a set of cognitive and behavioral capabilities required to be empathic, which they call components. They attempted to understand the main components of empathy to try to model empathy in Artificial Intelligence (AI). The components that have been defined are:

- Communication competence
- Emotion regulation
- Cognitive mechanisms

Based on the capabilities of empathy, a model is composed of three levels, each linked to form empathic behavior (figure 1) (Yalcin & DiPaola, 2019).

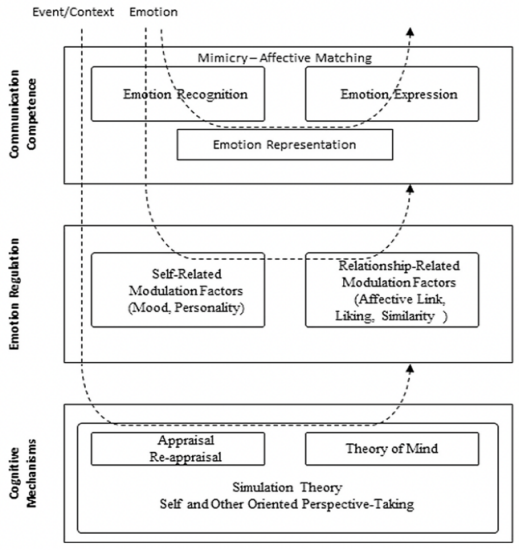

Figure 1: Empathic capabilities (Yalcin & DiPaola, 2019).

Communication competence
Emotion recognition and expression are crucial in showing any empathic response towards others. This is because a person, for example, must recognize that a friend is being sad to respond empathically to this. A lack of empathy is often positively correlated with a deficit in expressing or

recognizing emotions (Preston & de Waal, 2002). Other researchers claim that the intensity of an empathic response is also based on the level of emotion recognition and expression. The model's lowest level of the hierarchy is called affective communication competence and includes emotion recognition, expression, and representation. Emotion recognition can be defined as the ability to recognize and interpret the emotional state of others (Nalbant et al., 2019). As explained, affective empathy includes mimicking/imitating other people's behavior or emotions. This arises from affective communication competencies. The mirroring of behaviors such as yawn contagion and emotional contagion is considered low-level empathic behavior. Yawn contagion means that an individual yawns in response to someone else's yawn (Norscia et al., 2020). Emotional contagion and mimicry form the base of empathic behavior (Besel & Yuille, 2010).

Emotion regulation
Emotion regulation is another component of empathy. It relates to several psychological, social, and cultural factors (Yalcin & DiPaola, 2019). Emotion regulation can be defined as an attempt to influence emotions in ourselves or others (McRae & Gross, 2020). An example is when your child is crying, and you might feel angry, but instead of yelling, you regulate your emotions and calm your child. Emotion regulation consists of empathy modulation factors. These factors can be distinguished between self-related modulation factors and relationship-related modulation factors. The self-related modulation factors include characteristics of the empathizer, such as the mood of the empathizer and the personality. These characteristics influence the emotion that is expressed but also the representation of emotions, attention towards the situation of another, and the interpretation of the observed situation. On the other hand, relationship-related regulation factors depend on the relationship between the empathizer and the target. These factors include a social link, familiarity, liking, and similarity. These factors might influence the expression of emotional behavior (Yalcin & DiPaola, 2019). Preston & de Waal (2002) mention that more complex forms of empathy require these factors.

Cognitive mechanisms
Higher-level empathic behavior requires cognitive capabilities such as appraisal and re-appraisal of situations and the theory of mind. Examples of higher-level empathic behavior are behaviors such as perspective-taking and targeted helping. An example of perspective-taking is imagining what it feels like for your friend who just lost a family member. With targeted helping, you make sure your friend feels comfortable, and you are at the funeral to support them. Moreover, appraisal means evaluating things happening in the environment based on the impact of these events. The evaluations are made based on the emotions and social values but also plans and goals of the empathizer. An event is more likely to influence an emotional response if it affects a person's goals. Re-appraisal, on the other hand, is essential to be able to reason about the mental state of others and to understand their perspective (Yalcin & DiPaola, 2019).

2.4 Development of empathy

Carl Rogers, a humanistic psychologist, developed a theory and process of training that identified empathy as a skill. He developed several counselor-training programs to train people to improve their empathy skills. This view was not shared by Davis

(1990), who believed that Roger was not teaching empathy but rather self-transposal. This means putting yourself in someone else's shoes. Davis (1990) stated that empathy is something that cannot be taught. He believes it is a communication process that develops along with cognition and emotions during puberty and improves when we mature.

Neurologist Freud believed that young children were not self-conscious enough to experience empathy or empathize (Freud, 1958). However, the study by McDonald & Messinger showed that young children could show empathy-related behavior (McDonald & Messinger, 2009). The problem is that children have limited verbal expressiveness. This makes measuring empathy even more difficult than it already was. McDonald & Messinger (2009) defined a measure of empathy for young children by studying their reactions to other people's distress. The response to the distress depends on the stage of the empathy development that the child is in. This study revealed that children show impressive improvements in empathy development while growing up (McDonald & Messinger, 2009). This indicates that empathy is indeed something that can be developed. However, the question arises of whether some people might develop more empathy than others. To answer this question, it is essential to look at which factors might facilitate empathy development. Figure 2 shows the contributors and outcomes of empathy development. The following section will describe each of these factors that might influence the development of empathy in a young child. The factors are distinguished between within-child factors and socialization factors.

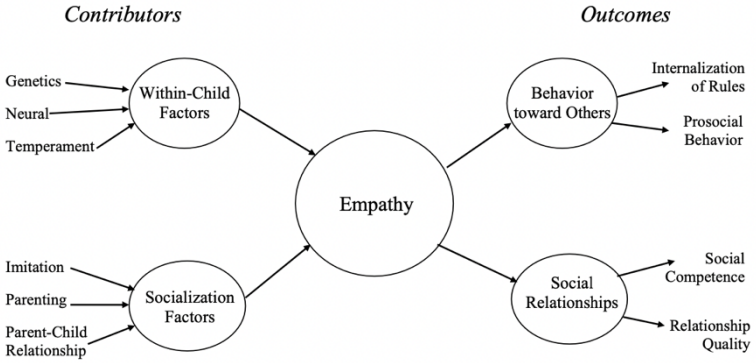

Figure 2: Contributors and outcomes of empathy development (McDonald & Messinger, 2009).

2.4.1 Within-child factors

Genetics

In a study by Zahn-Waxler et al. (1992), both genetic and environmental components showed to be implicated in the development of empathy. In this study, the responses of both identical and fraternal twins (twins from two separate eggs) to simulated distress were studied. The study aimed to indicate whether the correlation in empathy levels was more significant for identical or fraternal twins. This might reflect the impact of heredity on empathy. The results showed significant heritability estimates for prosocial behavior and empathic concern. This showed that a proportion of the individual differences in the ability to empathize is likely to be associated with genetic differences. The results also showed that significant heritability estimates are more stable for empathic concern than other sub-concepts of empathy. A study by Knafo (2008) expanded on this and studied 24 and 36 months old children. This study showed that the heritability effects increased with age. In conclusion, these studies support the idea that empathy is inheritable to a certain extent, especially for empathic concern. Moreover, these heritability effects also tend to increase with age.

Neurodevelopmental factors
Several brain areas are shown to be implicated in empathic behavior and development. A study by Iacoboni (2008) showed that mirror neurons provide a neural basis for connecting our own experiences with those of others. Mirror neurons are put into action when observing somebody else performing the same or a similar activity that a person performs (Iacoboni, 2008). However, these mirror neurons are not responsible for the ability to have empathic feelings. Preston & de Waal proposed the Perception-Action Model of empathy (2002) which explains the importance of the mirror neurons in empathy development. Their theory suggests that viewing the emotional state of others automatically and unconsciously activates a person's associations with that state. This causes a person to react to someone else's experience as if it were their own (Preston & de Waal, 2002). De Waal (2008) stated that this matching of emotional states is the basis of higher levels of empathy (section 2.3 '*Model of empathy*'). Mirror neurons communicate with other areas of the brain to induce empathy. These brain areas, for example, process emotional aspects of empathy-inducing situations or are involved in experiencing emotions. To experience empathy, neural mechanisms involved in emotion regulation must be activated (McDonald & Messinger, 2009). Dysfunctions of the mirror neuron system in early childhood development are potential reasons for individual differences in empathic abilities. For example, children with autism spectrum disorders (ASD) experience deficits in the ability to imitate, theory of mind, and social communication. This could lead to lower abilities to empathize with other people (Dapretto et al., 2006). There has been much research on the role of neural mechanisms in empathy. However, there is still much to be studied.

Temperament
Temperament is an aspect of someone's personality concerned with emotional reactions and their speed and intensity (McDonald & Messinger, 2009). It is comprised of several attributes, and they form the early basis for personality development. It is thought to be present from birth; therefore, individual differences based on temperament may also reflect genetic influences on empathy development. In a study by Rohtbart (1994), shy infants were rated more empathic by their parents than other children. However, they were less likely to engage in empathic and helping behaviors with strangers. Thus, these shy infants show higher levels of empathic behavior in familiar contexts. Other temperamental factors such as speed and intensity have been associated with empathy. Young et al. (1999) showed that infants with low motor and affective responses to environmental stimuli responded less empathically to the distress of people in the environment.

2.4.2 Socialization factors

Imitation
An essential mechanism for learning about experiences is mimicry, especially the imitation of the facial expressions of others. When interacting with other people, we tend to unconsciously imitate the behavior of the people we are communicating with. A study by Oberman (2007) showed that a person unable to move facial muscles might show less emotional contagion (imitating other people's emotions and behavior). This study prevented participants from showing facial expressions by holding a pen sideways in their mouth (Oberman, 2007).

People who show high levels of empathy have been able to engage more in facial imitating than others. Thus, imitation, or mimicry, is essential in empathy development. Imitating facial expressions and the behavior of other people starts in early childhood. An example of this is when infants smile in response to a smile of their parent, meaning that they share the emotion of the other. This experience of sharing an emotion becomes an automatic process when maturing and allows a person to be emotionally empathic. Imitation of other people's actions leads a person to understand what other people are experiencing (McDonald & Messinger, 2009). To conclude, factors that might prevent the ability to imitate facial expressions as a child, or other factors impeding mimicry, can affect the felt empathy.

Parenting
Parenting can also influence the development of empathy in children. What is essential to study is the synchrony of behavior between the parent and the child. Feldman (2007) showed that high mother-infant behavioral synchrony in the first year of life positively correlated with the level of empathy between the ages of 6 and 13. Maternal warmth is also a factor that influences empathy development. Examples of maternal warmth are admiration and affection toward the child and interest and love. Children whose parents showed more warmth towards them at home showed to be more empathic in their later years (Feldman, 2007). The extent to which parents talk about emotions with their children may also affect empathy development. This is because children tend to show more emotional concern for others when they learn how to label emotions. If, in addition to this, the children are also taught to know the causes and consequences of specific emotions, then they can also understand other people's emotions better (McDonald & Messinger, 2009).

The parent-child relationship quality discusses attachment security between parent and child. The attachment theory, developed by psychologist John Bowlby, explains that humans are born with a need to have emotional connections with their parents. This bond should be formed within the first six months of life (Wiley, 1963). This has been tested by Trairatvorakul (2016), where children were separated and reunited with their parents. Children who were securely attached to their parents showed behaviors of trusting and loving relationships with their parents. For example, they showed upset for missing the parent or even feelings of comfort because they knew the parent was coming back. Insecurely attached children showed behavior like ignoring the parent or being extremely clingy toward the parent. Research by Kestenbaum (1989) showed that securely attached children responded more empathically than those who were not.

2.5 Differences in empathy between men and women

In the previous section, the development of empathy is discussed and possible factors that might explain individual empathic differences between people. Besides these factors, several studies suggested that there are also differences between genders. A study performed by Eisenberg & Lennon (1983) showed that women might be more empathic than men. This study was built upon the stereotypic perception that people believe that females are more nurturing and interpersonally oriented than males. Sociologists like Parsons & Bales (1955) suggested that women must have an expressive role in facilitating harmony within the family.

Conversely, males form an instrumental role, serving a relationship between family and society. To fulfill the roles of a woman, they must be socialized to be nurturing, sympathetic, and empathic. While the study of Eisenberg & Lennon (1983) was based on stereotyping, the study of Maccoby & Jacklin (1974) tried to find scientific evidence for empathic differences between genders. They reviewed 29 papers related to empathy and concluded that there was no evidence of empathic differences between the genders.

Following this study, this line of research shifted toward studying behavior related to empathy, such as social sensitivity and affective role-taking. Social sensitivity means understanding and perceiving the feelings and thoughts of others (Bender et al., 2012). Affective role-taking means being aware of how another person feels (Kagan & Knudson, 1982). Hoffman (1977) studied empathy and signs of affective role-taking and social sensitivity. He reviewed nine articles, and the results showed that females scored higher on empathy in all reviewed studies. Results were significant for 3 out of 16 samples that were gathered for the research. He concluded that females are more empathic than males (Hoffman, 1977).

A study performed by Rueckert & Naybar (2008) used both the Mehrabian and Epstein Empathy Questionnaire (MEEQ) (Mehrabian & Epstein, 1972) and the Levy Chimeric Faces Task (LFCFT) (Levy et al., 1983). These behavioral tasks can be used to evaluate empathy among genders. The results showed that women scored higher on the MEEQ than men. This is in line with previous studies that have found that women tend to score higher on behavioral questionnaires like the MEEQ than men (Eisenberg & Lennon, 1983). Even though many studies have suggested that women are more empathic than men, the nature of these gender differences is a topic that needs further research. It has great potential to benefit from social neuroscience (Rueckert & Naybar, 2008).

2.6 Emotion recognition

As defined in section 2.3, '*Model of empathy,'* emotion recognition is considered a component of communication competence and part of the lower level empathic behavior. A collection of studies have identified six basic emotions that are universally recognized. These emotions are anger, disgust, fear, happiness, sadness, and surprise (Mancini et al., 2018). Mancini et al. (2018) investigated the accuracy of emotion recognition among preadolescents. The result of this study concluded that happiness expressions are considered best recognized, followed by anger, disgust, and neutral expressions. Sadness and fear were less recognized compared to all other emotions. A study by Vicari et al. (2000) has shown similar results. This study also showed that happiness is the most recognized emotion. For the least recognized emotion, results tend to differ. For example, Herba et al. (2006) have shown that anger is the least recognized emotion. However, a study by Chronaki et al. (2013) showed that sadness is the least recognized emotion (Mancini et al., 2018).

The role of emotion recognition in empathy was further studied by Kuypers (2017). This study used the Multifaceted Empathy Test (MET) and Multidimensional Movie Empathy Test to assess behavioral, cognitive, and emotional empathy. Findings showed that the empathic responses were higher when participants were confronted with negative emotional stimuli than positive emotional stimuli (Kuypers, 2017).

Similar results were found by Reed & DeScioli (2017), who showed that humans are more willing to help people showing sad expressions than neutral expressions. A possible interpretation could be that those sad expressions automatically evoke empathy and help. This shows that sadness is one of the emotions that affect viewers' behavior, such as showing greater cooperation (Reed & DeScioli, 2017).

2.7 Measures of empathy

The measurement of empathy can be seen as a challenge for researchers in disciplines such as psychology and neuroscience. This challenge mainly stems from the lack of a unified and precise definition of the concept of empathy. Empathy is considered an essential part of forming social relationships, leading to researchers' extensive interest in measuring empathy.

The first attempts at measuring empathy with instruments date back to the 1940s. During this time, several emotion-based measures, such as the Emotional Empathic Tendency Scale (Mehrabian & Epstein, 1972), were created. Throughout the 1980s to the 1990s, psychological measurements such as skin conductance and heart rate were more and more included in measuring empathy. During this period, the assessment of empathy was influenced by social and developmental psychologists who emphasized the multiplicity of empathy, such as cognitive processing, self-awareness of feelings, and emotion regulation. From the 1990s to the present day, measuring empathy has been influenced by the development of social-cognitive neuroscience. However, the self-report scales of measuring empathy are still extensively used and are continued to be developed. A brief analysis will give an overview of several measures of empathy that have been developed throughout the years. These measures are all considered self-report measures (Neumann et al., 2015).

2.7.1 The Balanced Emotional Empathy Scale

The Balanced Emotional Empathy Scale (BEES) was developed by Mehrabian (1996) and focused on measuring affective empathy. The focus of this measurement scale was to assess the ability to show empathic emotional responses to other people. The BEES consisted of 33 items that could be rated on a nine-point Likert response scale. High scores on the scale relate to greater levels of affective empathy (Mehrabian, 1996). The BEES is a scale that researchers extensively use to assess the level of empathic concern a person can show. However, because the BEES is only limited to affective empathy, it might not be suitable to measure empathy as a whole, including cognitive empathy. Examples of statements in the BEES are '*I cannot feel much sorrow for those who are responsible for their own misery*' and '*Unhappy movie endings haunt me for hours afterward*' (Neumann et al., 2015). Affective empathy was divided into several subscales in the BEES:

- Susceptibility to emotional contagion
- Appreciation of the feelings of unfamiliar and distant others
- Tendency to be moved by others
- Negative/positive emotional experiences
- Sympathetic tendency
- Willingness to be in contact with others who have problems

The negative items are changed to compute a participant's eventual total empathy score, and then an algebraic sum of all responses to the scale is obtained (Mehrabian, 1996).

2.7.2 The Toronto Empathy Questionnaire

The Toronto Empathy Questionnaire (TEQ) is a more recent self-report measurement of empathy (Spreng et al., 2009). The TEQ did not begin with a definition of empathy, but they considered empathy as a broad concept. Spreng et al. (2009) derived the TEQ based on existing scales. The TEQ items emphasized empathy's emotional/affective component (Spreng et al., 2009). The final measurement scale consists of 16 items where responses are made using the five-point Likert Scale. Examples of statements in this self-report measurement scale are '*I enjoy making other people feel better*' and '*I find it silly for people to cry out of happiness*'. An essential aspect of the statements in the TEQ is that there is an equal number of positively and negatively worded items (Neumann et al., 2015). In the TEQ, affective empathy is divided into:

- Emotional contagion
- Emotion understanding
- Sensitivity
- Sympathetic physiological arousal
- Altruism
- Higher-order empathic behavior

2.7.3 The Multidimensional Emotional Empathy Scale

Caruso & Mayer (1998) developed the Multidimensional Emotional Empathy Scale (MDEES). The purpose of the study of Caruso & Mayor (1998) was to create a measure of empathy that was explicitly suitable for adolescents and adults. The focus of this measure was, just like the BEES and the TEQ, on affective empathy. The final scale consisted of 30 statements where examples are: '*The suffering of others disturbs me*' or '*I rarely take notice when other people treat each other warmly*'. The latter statement reduces response bias by changing the statement to a negatively-worded sentence. Moreover, Caruso & Mayer (1998) also included positive and negative emotional sentences such as '*Being around happy people makes me feel happy, too*'. A five-point response scale was used for this scale, ranging from 'strongly disagree' to 'strongly agree' (Caruso & Mayer, 1998).

2.7.4 The Questionnaire of Cognitive and Affective Empathy

The Questionnaire of Cognitive and Affective Empathy (QCAE) is developed by Reniers et al. (2011). This questionnaire builds upon previously developed measures of empathy. Reniers et al. (2011) believed these previous questionnaires were too narrow, inaccurate, or inconsistently defined. An essential difference between the QCAE and, amongst others, the BEES is that the QCAE considers both cognitive and affective components of empathy. The QCAE defined cognitive empathy as '*the ability to construct a working model of the emotional states of others*' (Reniers et al., 2011). Affective empathy was defined as '*the ability to be sensitive to and*

vicariously experience the feelings of others'(Reniers et al., 2011). The affective empathy dimension is divided into several subcategories, which are:

- Emotion contagion
- Proximal responsivity
- Peripheral responsivity

The cognitive dimension of the questionnaire is divided into:

- Perspective-taking
- Online simulation

2.8 Virtual environment and empathy

Immersive virtual reality (IVR) is an innovative technology that is new and emerging. Within IVR, users can use head-mounted displays and hand controllers such as the Oculus Rift and HTC Vive. These can be used to, for example, play games but also to use in learning environments (Parong & Mayer, 2018). Over the years, VR systems have become more affordable, resulting in VR becoming an often used technology in various areas of daily life and scientific fields. IVR aims to allow users to have the feeling of actually being in the virtual environment and allowing them to interact with virtual agents.
An important concept here is "*presence*", which describes the quality of subjective experience in IVR. Here, the people know that what they see in the virtual environment is not real, but they still react and respond as if it were real (Sbordone et al., 2021).

Within IVR, researchers are interested in the extent to which users of IVR respond similarly to the virtual agents in the environment as to other humans (Sbordone et al., 2021). Technological developments make virtual agents similar in appearance and behavior to real humans. However, looking at other factors associated with the users' perception of virtual agents is still essential. One factor that has not been studied frequently is the role of individual differences in empathic traits on the users' perception of virtual humans (Sbordone et al., 2021).

The role of the IVR system is to simulate social interactions. There are simulated in such a way as to enable researchers to control the appearance and behavior of the virtual agents within the environment. Research by Morganti et al. (2006) has shown that there is an awareness that users using IVR are in a fictional virtual environment. However, they do tend to attribute a human-like reality to virtual humans. A study by Ianchini (2016) showed that virtual agents tend to be treated the same as humans and different from objects. Moreover, virtual agents that are showing emotions can cause emotional responses. Several studies studied how the appearance of virtual agents might influence this emotional response. They concluded that this appearance should be similar to humans (Nowak & Biocca, 2003). Thus, if the virtual agents have enough human and natural characteristics, humans would be more likely to have feelings and thoughts towards them.

Aside from the fact that the appearance of the virtual agent influences emotional responses towards them, there is little understanding of how general individual differences in empathy influence the social interaction with virtual agents. Sbordone et al. (2021) studied this, exploring a correlation between individual empathic traits and social interaction with virtual agents. An assessment was made to investigate

whether these individual differences in empathic traits were associated with the ability to take a virtual agent's perspective. Taking the perspective of the virtual agent means understanding its situation from the point of view of the virtual agent. This is important to study because it could give a better understanding of whether individual differences might affect the ability to take the virtual agents' perspective. Perspective-taking is an essential aspect of social interaction (Sbordone et al., 2021). In this study, participants were placed in an IVR scenario where they had to locate a glass according to the virtual agent's perspective. They sat behind a table, and the virtual agent was placed in different positions from the participant with a glass placed in front of him. The participants had to put themselves into the shoes of the virtual agent (Sbordone et al., 2021). The participants' empathic traits were measured by using the Interpersonal Reactivity Index, developed by Davis (1983).

Results have shown that the presence of virtual agents in IVR environments helps improve the participant's engagement and the experience's realism. It also helps to facilitate interaction between the participant and the virtual agent. The point of view of the virtual agent was also associated with individual empathic traits, as was expected by Sbordone et al. (2021). This shows that individual differences play an essential role in the ability to interact with virtual agents. Therefore, if the efficacy and engagement of virtual interactions are measured, the individual differences in the ability to empathize must also be taken into account (Sbordone et al., 2021).

Chapter 3

Virtual agents

3.1 Virtual agents as social actors

Figure 3: Amazon Alexa

Virtual agents have obtained an essential role in our professional and private lives. An example of a virtual agent is Amazon Alexa (figure 3). This is a virtual assistant that can understand and help its users by making use of voice recognition and natural language. This device is already widely adopted by people to, for example, play music at home or switch on lights by just telling Alexa to do so (Realinteract, 2021). Virtual agents are also used to converse with or guide you to your doctor visits. The most common virtual agents that most people have had experience with are the customer service virtual agents. Websites are widely using virtual agents to answer questions and help customers with issues. According to Vosinakis & Panayiotopoulos (2005), virtual agents are autonomous entities in an environment that should behave like a living organism. You should be able to interact with it (Vosinakis & Panayiotopoulos, 2005)

Figure 4: Embodied virtual agent (Utami et al., 2017)

Besides the virtual agents like the one in figure 3, there are also the embodied virtual agents (EVAs). EVAs are computational agents like virtual agents. However, they look like humans and can show facial expressions and body gestures. Moreover, they can even facilitate more natural conversations and interactions with people (Moradinezhad & Solovey, 2021). An example of an EVA is shown in figure 4. These two types of virtual agents are used often and interact with people more often. This is why more insight into humans' reactions and relationships toward these agents is needed to improve and develop EVAs (Moradinezhad & Solovey, 2021).

A human-computer interaction study performed by Nass et al. (1997) defined the so-called "*Media Equation*". This phenomenon can be described as the social reaction people mindlessly show computers. The Computer as Social Actors research group (CASA-group) further defined this. They demonstrated in their studies that social effects that occur in interpersonal interaction, such as criticism or politeness, can be observed in human-computer interaction. Their studies showed three essential results of people's responses toward computers. First, people responded more socially to computers by evaluating a computer better if another computer praised it than by itself. Moreover, they also showed to be more social toward a computer that has helped the person before than one who has not (Nass et al., 1997).

The studies performed by both Nass et al. (1997) and the CASA-group applied to computers. However, the media equation is also shown to apply to virtual agents (Hoffman et al., 2009). Technological developments about embodied conversational agents (ECAs), a virtual agent, aim to improve the intuitiveness of conversations between these ECAs and humans. These types of virtual agents are designed to look

like humans and be capable of using human-like communication such as verbal and non-verbal behavior. It is important to carry over these basic principles of human-human interaction to human-agent interaction. This is because the ECAs appearances and attitudes can affect how humans treat these agents (Holz et al., 2008). These new developments emphasize whether humans can show social reactions to virtual agents. As they are more human-like, this might lead to the same or even more pronounced social responses from humans towards agents (Hoffman et al., 2009). However, treating these virtual agents like humans treat other people is still a big challenge within the field of Human-Computer Interaction (Holz et al., 2008).

3.2 Examples of ECAs

One of the first ECAs was developed by Marsella et al. (2000), which is called "*Carmen Bright IDEAS*". It was developed at the University of Southern California and aimed at improving the problem-solving skills of mothers with children who are pediatric cancer patients. There was an interaction between a virtual mother (Carmen) and a virtual counselor (Gina). The goal of showing this interaction was to address the user's stress by interacting with the characters. Carmen and Gina discussed different situations and how to deal with them. Empathy was modulated through the identification with Carmen and the situation that Carmen is in. The user of this system was going through the same situation as Carmen, which allowed the user to establish a relationship with her (Marsella et al., 2000).

Another ECA was developed by Rosis et al. (2005) to create a therapist that promotes healthy eating. This ECA was a head-only character driven by a model of dialogue. The goal of this ECA was to lead the users to respond to the therapist's message and change their eating habits by eating healthier. In the study by Rosis et al. (2005), 30 participants were advised by the virtual therapist about what to eat and what not. Results have shown that the number of social responses the users gave was positively correlated with the participant's involvement in the scenario. In this study, signs of social reactions were, for example, humor and irony. An example of a humorous conversation between the ECA and participant was:
"ECA: 'Do you like sweets? Do you ever stop in front of the display window of a beautiful bakery?"
"Participant: 'I don't only stop: I go in!"
However, it was impossible to conclude that the ECA affected evoking empathy within the participants (Rosis et al., 2005). However, this study did open up possibilities for other researchers in a way in which it is essential to investigate how ECAs can evoke empathy within the users (Paiva et al., 2017).

More recent work in the area of Human-Computer Interaction and the role of empathy is in the area of cultural sensitivity. Mascarenhas et al. (2013) focused on triggering intercultural empathy in humans to train intercultural awareness. In this study, the "*Traveller*" was designed as a serious game that follows an interactive storytelling approach. The user plays an active role in stories that take place in different fictional countries. The user solves practical problems in every country, such as finding a hotel. This requires the user to interact with characters that behave culturally distinctly, such as how they treat users and respond to actions. An example of this culturally distinct matter is a scene where a participant is looking for the

supervisor of a wild park. The user has to encounter the supervisor's assistant, whom he has met before. The assistant tells the user that the supervisor is looking at one of the museum exhibitions. The user must ask the supervisor whether they can visit the wild park. The supervisor might respond in two different ways. One response was, "*Sure, it is always nice to have new visitors.*" The other response was, "*I am busy right now, can't you see that. Wait a moment.*". The aim is to raise intercultural awareness and empathy by exploring these different cultures. Results have shown that users' responses indeed depended on the culture of the agent in the game and the user's culture (Mascarenhas et al., 2013).

3.3 Empathic concern from humans to virtual agents

As is stated in section 3.1, '*Virtual agents as social actors*', it is a challenge to allow the interaction with virtual agents to be as natural as possible and similarly to human-human interaction. It is not only crucial that the agent can act socially, but they must also be capable of understanding others and their intentions, motivations, and feelings. Being social is defined as being reactive and proactive and having social capabilities when interacting with humans (Wooldridge, 2002). The ability to understand others and their feelings is defined as empathy.

Empathy is crucial in human social relationships and, therefore, a central point of study in Human-Computer Interaction (Paiva et al., 2017). It has been shown that people not only show empathy to other people but also, potentially, to fictional characters, game characters, or even robots (Paiva et al., 2017). There are two ways of observing empathy in virtual agents. One way is where the human is the empathizer, and the virtual agent is the target who triggers the empathy in the human interaction partner. The other aspect of this human-agent interaction is to study the agent as the empathizer that empathizes with other agents, particularly humans (Paiva, 2011). In the scope of this research, the focus is on the first aspect, where the human is the empathizer.

In the research regarding agents as targets of empathy, it is important to study which processes of human empathy are relevant for these virtual agents to evoke empathy in human observers. Moreover, it is also essential to look at what characteristics the agent must have for that to happen (Paiva et al., 2017). Research has developed agents that can evoke empathic responses in human observers. The aim was often to study the attitude and behavior of people towards virtual agents (Paiva et al., 2017). However, for behavior changes to occur, people need to be immersed in engaging situations, connect to the events that happen in these situations, and, most of all, care about what is happening. Therefore, when designing agents to empathize with, care needs to be placed on the features of the agent. This is necessary for people to identify with the character and become immersed in the situation. Paiva et al. (2017) identified several characteristics of virtual agents that are needed for them to be targets of empathy. These characteristics may increase the likelihood of a person feeling empathy towards the virtual agents. These characteristics include:

- *The situation and context*; This refers to the situation that the virtual agent and empathizer are in. When this situation is shared, this might evoke empathic responses.
- *Features of the empathizer*; This includes characteristics such as age, gender, or culture that might influence the empathic response of the empathizer.

- *Characteristics of the agent*; This includes the physical appearance of the virtual agent. Moreover, the degree to which the virtual agent can express its emotional state is essential.

3.4 Personification stories

Paiva et al. (2017) identified that the physical appearance of virtual agents is often assumed to drive the ability to empathize with these virtual agents. Darling et al. (2015) studied a possible other factor that might engender empathy for virtual agents. This study explored whether personification stories might affect the ability to empathize with robots, specifically a robotic toy with the appearance of a machine-like insect.

Personification stories about robots may allow people to perceive the robot as more humanlike. This will enable humans to relate more to the robot, increasing their ability to empathize with them. Personification stories are possibly an additional factor that could influence the ability to empathize with robots (Darling et al., 2015). Personified stories include personification attributes. These attributes include a name, age, job, or even a favorite color. Given these personification attributes, robots or other robotic technologies may elicit more empathy than unassociated objects.

Darling et al. (2015) studied the role of these personification stories by examining how humans respond to this insect-like robot when asked to strike it. They evaluated the relationship between hesitation and people's empathy. They reasoned that if people feel empathy towards the robot, they will hesitate more to strike the robot than those who do not feel empathy. Moreover, they also reasoned that greater empathic concern and hesitation are more strongly related when the participants receive a personification story (Darling et al., 2015). Participants were exposed to a personification story about the robot via a piece of paper showing the following text: "*This is Frank. Frank is really friendly but he gets distracted easily. He's lived at the Lab for a few months now. He likes to play and run around. Sometimes he escapes, but he never gets far. Frank's favorite color is red. Last week, he played with some other bugs and he's been excited ever since.*"
The experiment was over once the participant followed the instructions and struck the robot "Frank" or when they did not comply. After the experiment, the participants were asked to fill out a survey that included an empathy test. The empathy test used for the experiment was the Interpersonal Reactivity Index to test the general ability to empathize with people (David, 1983).

In conclusion, results from the study by Darling et al. (2015) confirmed that personification stories could have an impact on the reaction that people show towards robots. This means that designing robots or other technologies that are personified could influence the perception of robots and increase emotional responses. The personification stories allowed people to relate more to the robot on an emotional level. This contributes to a better understanding of the role and importance of people's emotional responses when engaging with robotic technology.

The study by Cordar et al. (2014) raised the question of whether this effect of personification stories is also present in virtual agents. While Darling et al. (2015) mainly focused on robotic appearance, Cordar et al. (2014) focused on virtual agents

with a human-like appearance. In this study, young doctors are trained using a virtual patient suffering from depression. In this system, the doctors are taught how to interview people with depression. This study also explored the presence of a personification story for the virtual agent and the impact it can have on the empathic responses of the trainees interacting with the agent. One virtual agent was given a personification story and a second agent simply interacted with the trainees without providing details about its life. Results showed that participants who interacted with the virtual agent with the personification story provided more encouraging, supportive, and empathetic statements to the virtual agent. Thus, this result suggests that personification stories about virtual agents can evoke empathy. It is a possible way to facilitate greater empathic responses from people (Cordar et al., 2014).

Chapter 4

Method

4.1 Research question and hypothesis

The research question that will be studied in this research is the following:
"Do the general tendencies towards empathy and the presence of a personification predict the empathy towards the character?"
This research question tests whether the ability to empathize with people in real-life situations and the personification story, as studied by Darling et al. (2015), predicts the ability to empathize with the virtual agent in the virtual environment. A set of hypotheses is established. These hypotheses are formulated as the following:
H0: Neither of them predicts the empathy toward the character
H1: General tendencies of empathy lead to a higher empathy towards the character
H2: The presence of a personification story will lead to higher empathy
H3: Both the presence of a personification and the general tendencies of empathy leads to a higher empathy towards the character.

Given that experience with virtual agents might also affect the ability to empathize with the virtual character, a further sub-question will be explored. This sub-question is defined as:
"Does the experience with virtual agents affect the empathy towards the virtual character?"
A set of hypotheses has been established for this question. These hypotheses are formulated as the following:
H0: Experience with virtual agents does not affect the empathy towards the character.
H1: Experience with virtual agents affects the empathy towards the character.

Differences between genders might also be reflected in the empathy that is shown towards the character. The following sub-question tests whether there are gender differences in showing empathy towards the character:
"Are there gender differences in the empathy shown towards the character?"
A set of hypotheses has been established for this question. These hypotheses are formulated as the following:
H0: Gender differences in empathy are not reflected in the empathy shown towards the character.
H1: Gender differences in empathy are reflected in the empathy shown towards the character.

4.2 Participants

For this research, a group of n = 28 participants was gathered. Of the participants, 18 identified as female and ten as male. The age range was between 18 years old and 65 years and older. The average age of the participants was μ = 23,89 and *sd* = 14,39. Participants were randomly assigned to one of the two conditions, which was either a personification story or not. This resulted in 14 participants per condition.

4.3 Experiment setting and conditions

Participants entered the experiment room, where they were asked to sit in front of the VR headset, where they first completed an informed consent form. The participants were informed that they had to observe a particular situation in a virtual reality environment. Every participant was first asked to fill in the Toronto Empathy Questionnaire (further explained in section 4.4). The group with the personification condition was given the following text:

You are about to see Sophie. Sophie is a really friendly 28-year-old woman who loves cats. She has lived in Utrecht for 3 years now and has recently adopted two cats. She likes to go outside in her free time or meet with her friends in the city center. Sophie recently got a new job and will start her job as a veterinarian in about a week.

The personification story used in the experiment is based on the personification story used in the study performed by Darling et al. (2015).

The control and personification groups were then asked to participate in the virtual reality experiment. The virtual reality experiment was created by making use of Unity 3D. Unity is a cross-platform that is designed to develop video games and simulations. In the virtual environment, a city was made where a scenario was played at a bus stop in the city. The virtual agent was created by making use of Adobe Mixamo. Participants were asked to watch a situation in the virtual environment for 1.5 minutes. In this situation, the virtual character was showing signs of sadness. This emotion evokes a feeling of empathy, as explained in section 2.6, "*Emotion recognition*".

After completion of the experiment, a post-experiment survey was filled in. This survey evaluated the participants' experience with the character in the virtual environment. This was done to measure their ability to empathize with the virtual agent.

4.4 Toronto Empathy Questionnaire and post-experiment survey

For the scope of this research, the '*Toronto Empathy Questionnaire*'(TEQ), developed by Spreng et al. (2009), has been used to measure empathy. The TEQ is a self-report measurement focused on affective empathy, as defined in part 2.7.2, '*The Toronto Empathy Questionnaire'*. The TEQ was suitable for the research that was conducted because this research focused on identifying the participant's ability to share the virtual agent's emotion in the experiment. The purpose of the experiment was to determine whether the same emotion emerged in the participant as the virtual agent was showing—this related to the ability of affective empathy.

The score of the TEQ is based on a 5-point Likert scale, ranging from '*never'* to '*always'*. The answer '*never'* corresponds with 0 points while '*always'* corresponds with 4 points. Half of the items are negatively framed. The scores of all 16 items are summed to derive the total score of the TEQ. The maximum score of the TEQ is 64 points, where higher scores indicate higher empathic abilities (Spreng et al., 2009). The TEQ can be found in Appendix A. In addition to the TEQ, some questions about the participants' demographic data were added to the survey. The complete survey can be found in Appendix A.

After the virtual reality experiment, participants were asked to fill in the post-experiment survey (Appendix B) This survey consisted of questions related to their experience with the character in the virtual reality environment. It consisted of five statements, designed with a 5-point Likert scale ranging from '*Strongly disagree*' to '*Strongly agree*'. These statements related to the components of the TEQ, which were:

- Emotional contagion
- Emotion understanding
- Sensitivity
- Sympathetic physiological arousal
- Altruism
- Higher-order empathic behavior

Participants were asked to explain the answer to these five statements. This provided more helpful information because participants could provide more detail on why they felt the way they did. For the post-experiment survey, a total of 20 points could be achieved. Here, 20 points indicated high abilities to empathize with the virtual agent. In addition, a few other questions regarding their experience were added to the post-experiment survey. The components of both surveys are explained below.

Emotional contagion
Question 1 and 4 of the TEQ related to the perception of an emotional state of another person that stimulates the same emotion in oneself. This is also referred to as emotional contagion (Spreng et al., 2009). Emotional contagion can be further defined as '*The tendency to automatically mimic and synchronize expressions, vocalizations, postures, and movements with those of another person and, consequently, to converge emotionally*' (Hatfield et al., 1996). Based on these questions, statement 1 of the post-experiment survey was formulated. '*When seeing the emotion of the character in the virtual environment, I felt the same emotion as she showed me.*". This question tested whether the participant automatically adopted the emotional state of the virtual character.

Emotion understanding
Question 8 of the TEQ applied to the comprehension of other people's emotions. Statement 2 in the post-experiment survey was formulated as the following: '*When seeing the character in the virtual environment, I could easily tell what emotion she was showing me.*'. This question was also related to the concept of emotion understanding.

Sensitivity
Questions 2,7,10,12, and 15 of the TEQ related to the assessment of emotional states in others by indexing the frequency of behaviors demonstrating sensitivity. This means that a participant, for example, always prevents talking about the feelings and emotions of others (Spreng et al., 2009). In the post-experiment survey, statement 3 was formulated as: '*I was curious why the character was showing the emotion she showed me.*' to test the participant's sensitivity towards the virtual character.

Sympathetic physiological arousal
Questions 3,6,9, and 11 contained items that related to sympathetic physiological arousal. Researchers Levenson & Ruef (1992) studied the linkage between physiology and empathy. They hypothesized that empathy is associated with a state of shared

physiology. This meant that when one person was most empathically perceiving another person's feelings, the two would most likely be in a common physiological state. They found that there is indeed a physiological substrate for empathy. Physiological arousal could be defined as physiological responses such as increases in blood pressure. The sympathetic nervous system largely governs this. This system regulates blood pressure, breathing, and arousal in response to emotional cues (Levenson & Ruef, 1992). Statement 4 of the post-experiment survey also related to sympathetic physiological arousal. It was formulated as '*When seeing the character in the virtual environment, her emotion affected me (e.g., it made me upset, concerned or irritated)*'.

Altruism and higher-order empathic behavior
Questions 5,14, and 16 related to altruism. A common definition used to describe altruism is that it is unselfish behavior intended to benefit others (Waters, 2021). Altruism involves goal-directed actions that help to improve the welfare of someone else. This means that altruistic people do things out of kindness and a desire to help others (Waters, 2021). Finally, question 13 related to the frequency of behaviors engaging higher-order empathic responses such as prosocial helping behaviors (Spreng et al., 2009). Statement 5 of the post-experiment survey was '*When seeing the character in the virtual environment, I felt the need to help her if I could*.'. This statement related to both altruism and higher-order empathic responding. This is because both altruism and higher-order empathic responses relate to goal-directed actions that aim to improve someone's welfare.

Remaining questions in the post-experiment survey
Question 1 of the post-experiment survey, '*What emotion do you think the character in the virtual environment was showing to you?*' related to emotion recognition which is a crucial part of empathy. For this question, participants were allowed to write down their own answers. This reduced guessing and motivated the participant to give more helpful information. Another statement included in the survey was '*The information that I received about the character influenced the way in which I could empathize with her*.'. This statement was designed as a 6-point Likert scale with options ranging from '*Strongly disagree*' to '*Strongly agree*' with an extra option of '*Not applicable*'. When the participant did not receive a personification story, they were asked to fill in the '*Not applicable*' option. Participants were not given the option to explain their choice. The last question of the survey was, '*Does the fact that the character in the virtual environment cannot feel emotions like we humans do, affect your feelings towards the character? Please briefly explain your answer*'. This question gave some extra information about the reasons people might have for either being able to perceive the character as a social partner or not.

Chapter 5

Results

5.1 Quantitative results

5.1.1 The fit of the model for the TEQ and personification variables

The empathy towards the character in the virtual environment was measured across the personification story condition and the control condition. A linear multiple regression analysis was used to test the hypotheses (H1, H2, and H3). This regression was conducted to see if the Toronto Empathy Questionnaire scores (independent variable) and the personification (independent variable) predicted the score of the post-experiment survey (dependent variable).

The F-ratio in the ANOVA table (*table 2*) tests whether the overall regression model is a good fit for the data. A significant regression equation was found ($F(2,25) = 11.761$, $p < .001$), with an R^2 of .485 (*table 1*). This means that the independent variables explained 48.5% of the variability of the dependent variable.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.696	.485	.444	2.862

Table 1: Model summary

Model	Sum of Squares	df	Mean Square	F	Sig
Regression	192.665	2	96.332	11.761	<.001
Residual	204.764	25	8.191		
Total	397.429	27			

Table 2: ANOVA-table personification and TEQ

5.1.2 Predictability for TEQ and personification

The analysis shows that the Toronto Empathy Questionnaire score significantly predicted the post-experiment survey score with $p < 0.001$ (*table 3*). This means that higher TEQ scores indicate more empathy towards the character.

For the personification, the independent variable is insignificant, with $p > 0.05$ (*table 3*). This shows that the personification did not significantly predict higher empathy shown towards the character.

Model	Unstandardized B	Coefficients Std. Error	Standardized Coefficients Beta	t	Sig	95.0% Confidence Interval	Interval for B Upper Bound
(Constant)	-1.219	3.058		-.399	.694	-7.518	5.080
Personification	-.179	1.082	-.024	-.165	.870	-2.408	2.050
Score of TEQ	.313	.064	.697	4.850	<.001	.180	.445

Table 3: Coefficients

5.1.3 Experience variable

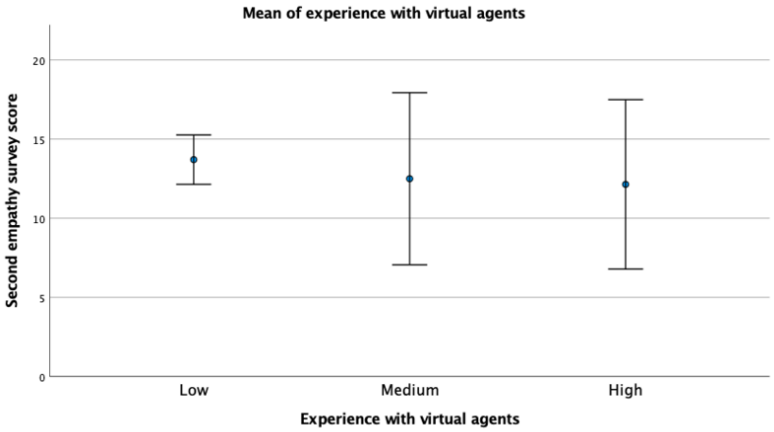

Figure 5: Means of experience groups

A one-way ANOVA was conducted to determine whether there is a difference between lower, medium, and higher experienced participants regarding the ability to empathize with the character. Low-experienced participants do not have experience with virtual agents, robots, avatars, or other AI applications. Medium experienced people, for example, have used a chatbot once. Higher experienced participants have experienced virtual reality, metahumans, or, for example, frequent gaming. No significant differences between the groups were found with ($F(2,25) = 0.458$, $p > 0.05$). This shows that experience with a virtual agent did not influence the empathy shown towards the character. Figure 5 shows the means of the scores on the post-experiment survey per experience group.

Model	Sum of Squares	df	Mean Square	F	Sig
Between Groups	14.042	2	7.021	.458	.638
Within Groups	383.387	25	15.335		
Total	397.429	27			

Table 4: ANOVA-table experience

5.1.4 Gender variable

An independent samples t-test was performed to compare the means of the results of the post-experiment survey between females and males (*figure 6*). The test variable of the independent samples t-test was the result of the post-experiment survey that measured the ability to empathize with the character. The grouping variable was the gender group variable. In total, 18 females participated in the experiment, and a total of 10 males—none of the participants filled in that they did not prefer to say their gender. The mean for the females was 13.94, and of the males, it was 11.70 out of 20 points. No significant differences between the genders were found with ($t = 1.519$, $p > 0.05$).

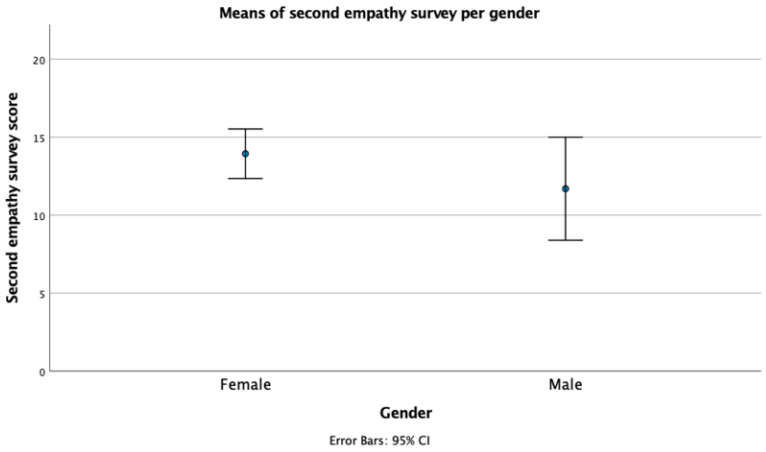

Figure 6: Means of genders

	F	Sig.	t	df	One-sided p	Two-sided p	Mean Difference	Std. Error Difference	Lower	Upper
Equal variances assumed	4.588	.042	1.519	26	.070	.141	2.244	1.478	-.793	5.282
Equal variances not assumed			1.366	13.882	.097	.194	2.244	1.643	-1.282	5.771

Table 5: Independent Sample Test genders

5.1.5 The influence of the personification compared to the post-experiment score

One statement in the post-experiment survey was formulated as "*Please express how much you agree with the following statement. - The information that I received about the character influenced the way in which I could empathize with her.*". Participants could fill in their opinion by making use of a 6-point Likert Scale ranging from "*strongly disagree*" to "*strongly agree*" with an additional option of "*not applicable*". Of the people who received the personification story, percentages per option are shown in figure 8. Figure 8 shows that most people agreed that the personification story influenced how they could empathize with the character. Given the small sample size of 28, a Shapiro-Wilk test was run to check whether the influence of the personification was equally distributed. The Shapiro-Wilk test did not show evidence of non-normality for this variable. A one-way ANOVA test was run and did not show that participants who said they were influences, also scored significantly higher on the post-experiment survey with ($F(4,23) = 1.090$, $p > 0.05$) (*table 6*).

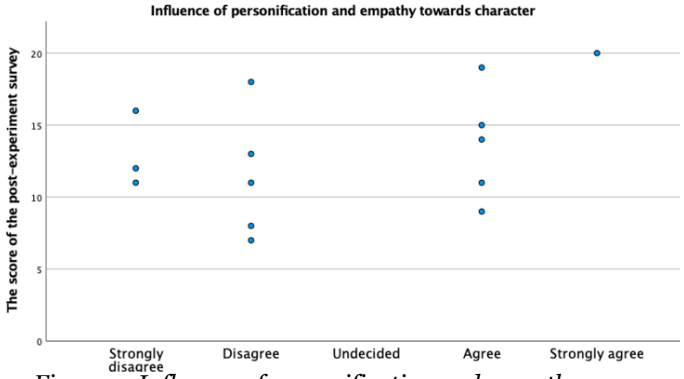

Figure 7: Influence of personification and empathy towards character.

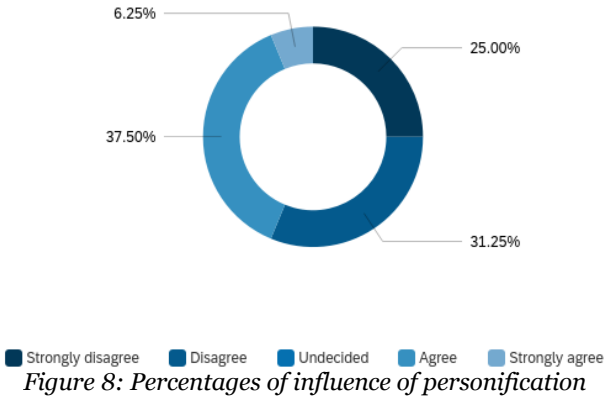

Figure 8: Percentages of influence of personification

Model	Sum of Squares	df	Mean Square	F	Sig
Between Groups	63.314	4	15.829	1.090	.385
Within Groups	334.114	23	14.527		
Total	397.429	27			

Table 6: ANOVA-table influence of personification

5.2 Qualitative results

This section will discuss several responses to statements from the post-experiment survey. In the post-experiment survey, participants were asked to give their opinion on certain statements that regarded their experience with the character. Moreover, one statement was provided to evaluate the effect of the character and environment being virtual. These are the only statements in the post-experiment survey for which the participants had to explain their choice.

5.2.1 The effect of the virtual character and environment on the ability to empathize

In the post-experiment survey, people were asked to explain their answer to the following question; "*Does the fact that the character in the virtual environment cannot feel emotions like we humans do, affect your feelings towards the character?*". The analysis is based on whether or not the participants were affected or slightly affected.

In total, ten participants mentioned that they were affected. They gave several arguments: "*Yes, the virtual environment for me, in this case, is not the same as I would feel in reality*" and, "*I think so, it does feel like it is not a real emotion that she shows but that it is programmed*". These comments applied to the fact that the virtual character was not considered a natural person. One other participant mentioned: "*Yes: due to being a programmer myself and interacting with, and programming, computers daily, I felt more curious about the mechanics of the simulation (as well as the research intent of the experiment) than about the person being simulated. As mentioned, this may be an over-correction due to not wanting to get overly attached to a simulation, for avoiding awkwardness*". Besides these arguments, one participant also mentioned: "*It is not real and I do not know her..*".

In total, seven participants mentioned that they were slightly affected and gave the following arguments: "*It is of course different from when it is a real person. But you are sort of in that world, and it is a realistic world*", "*Yes, even though you saw that she was sad and got the feeling that you wanted to help her, it did not make me sad. Maybe also because she shows sadness in a different way than a real person*" and "*No not really. The movement/attitude was exactly modelled like how a frustrated person would respond as well. Even though I am convinced that I would 'feel' more if this was real, I did get genuine emotions. It did have some effect, but not as much as I would initially think.*".

Eleven participants mentioned that they were not affected and said the following: "*No, I think just like animation and movie, the characters in the scene can also affect my emotions.*" and "*No, the fact that the character cannot experience real emotions makes my feelings towards her not very different. During gaming, I experience the emotions of the character as real as well*".

5.2.2 Emotional contagion

One statement in the post-experiment survey tested the ability to empathize with the character and applied to emotional contagion. The following statement was provided to the participants: "*When seeing the emotion of the character in the virtual environment, I felt the same emotion as she showed me.*". Participants could respond by using a 5-point Likert scale. Figure 9 shows the percentages per option for emotional contagion.

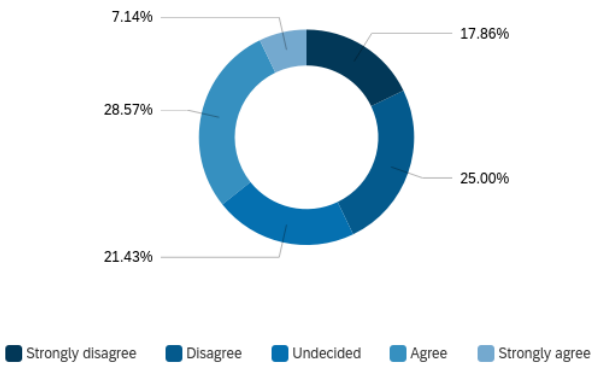

Figure 9: Percentages of emotional contagion

Participants who filled in that they strongly agreed with the statement, amongst others, mentioned: "*Because I am also that kind of person who tend to cry easily. I can understand how desperate she is and how shitty the thing she faces is, since she can't help crying in public; because I also had such experience before that I just couldn't help crying in public even though I don't want to.*".

One participant who agreed mentioned: "*The character came very close to me and she was crying and also angry. Because it happened so close to you, you feel someone suffering and you want to help.*". Some participants were undecided, and one of the reasons for this was: "*I saw that she was very sad, but in the back of my mind I knew that it was not real because it is a robot. So the image does not affect me, but the sound a little bit more because it sounds like a real person.*".

Participants who disagreed, amongst others, said: "*The VR context (limited focus due to me needing corrective glasses, black rings around the goggles, clearly 3D-rendered environment, imperfect and repetitive animation and sound) made it hard to me to connect emotionally to the scene. Alternatively, it made it _easy_ for me to _disconnect_ emotionally from the scene, which I have the tendency to do (especially in the case of films) because I don't want to feel uncomfortable in such a situation. "Plaatsvervangende schaamte" is also something that I feel, and that I hence consciously try to avoid in case the subject is not natural.*".

The participants who strongly disagreed mentioned, for instance: "*I saw that she was sad about something but because I did not have any context about why she was sad, I certainly did not feel sad myself.*".

5.2.3 Emotion understanding

The second statement in the post-experiment survey related to emotion understanding. The following statement was provided to the participants "*When seeing the character in the virtual environment, I could easily tell what emotion she was showing me.*". Here, participants could respond by using a 5-point Likert scale. Figure 10 shows the percentages per option for emotion understanding.

Participants that mentioned that they strongly agreed with the statement gave several arguments. One of these arguments was: "*Of course the crying, the way she walked and putting her hands in front of her face. She wiped her tears away.*". Participants who agreed with the statement gave similar arguments: "*Her body language and sounds she made easily gave away her emotion.*". A similar view was also provided by the person who disagreed: "*At first I think it's not obvious to see what the situation because it can either be a weird person approaching and doing weird movement. Later on I can tell she is crying because she let out loud and wipes her eyes.*". Thus, the majority of the participants were correctly able to identify the emotion of the character.

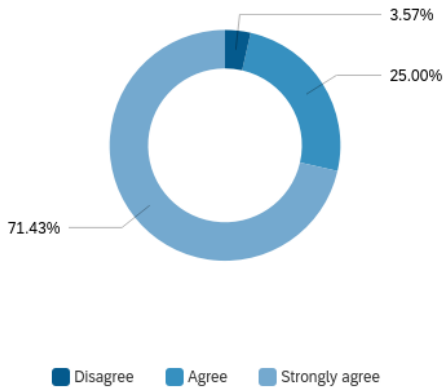

Figure 10: Percentages of emotion understanding

5.2.4 Sensitivity towards the character

The third question in the post-experiment survey related to the participants' sensitivity towards the virtual character. The following statement was provided to the participants "*I was curious why the character was showing the emotion she showed me*". Here, participants could respond by making use of a 5-point Likert scale. Figure 11 shows the percentages per option for sensitivity towards the character.

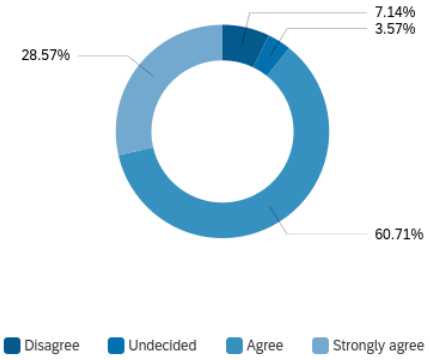

Figure 11: Percentages of sensitivity

Participants who strongly agreed with the statement mentioned that they wanted to ask what was wrong and were curious to know the cause of the emotion: "*You want to go and ask what is wrong.*" and "*I was tempted to ask if she was ok and if could be of help*". Participants who agreed said, amongst others: "*I am always very curious so I was wondering why she was sad but I would have never asked.*". One participant who agreed referred to the personification story: "*After reading the information paper, I wondered if something happened with her work or her cats (this is also because she wears a sweater with a cat on it)*". The undecided participant mentioned: "*I was not very curious to what was going on, I just felt bad that she was actually feeling these emotions. The reason to why, is not something I generally think about in such moments.*". Participants who disagreed mentioned either: "*I don't know her so it couldn't bother me.*" or "*Because it is in a virtual environment, I was not very interested to why the character was sad.*"

5.2.5 Sympathetic physiological arousal

The fourth statement in the post-experiment survey related to sympathetic physiological arousal. The following statement was provided to the participants "*When seeing the character in the virtual environment, her emotion affected me (e.g., it made me upset, concerned, or irritated)*". Here, participants could respond by making use of a 5-point Likert scale. Figure 12 shows the percentages per option for sympathetic physiological arousal.

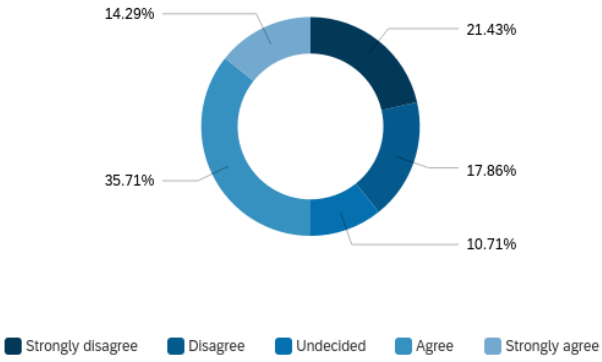

Figure 12: Percentages of sympathetic physiological arousal

Participants who strongly agreed gave explanations like: "*I felt very sorry for her.*" and "*I felt concerned and a little bit sad.*". People who agreed with the statement mentioned: "*Because you focus on the character, then of course you see the emotion, you feel it. You see it. It's real.*". However, other participants who agreed also said: "*It made me a bit uncomfortable and when she started crying, this annoyed me a little bit.*". The participants who were undecided mentioned, amongst others: "*I could not directly feel an 'emotional' connection with the character*" and "*One the one hand, I was because it was not nice to see and hear someone cry, but on the other hand I do know that it is not real. It felt bad to hear the sound.*". Participants that disagreed mentioned: "*It did not affect my state of mind.*" And "*I did not feel emotionally connected to her maybe also because of the unrealness of the situation.*" .The same applied for the people who strongly disagreed: "*I did not feel a strong emotion when seeing the character because there is no context and you have no personal relationship.*".

5.2.6 Altruism and higher-order empathic behavior

The fifth statement in the post-experiment survey related to altruism and higher-order empathic behavior. The following statement was provided to the participants "*When seeing the character in the virtual environment, I felt the need to help her if I could.*". Here, participants could respond by making use of a 5-point Likert scale. Figure 13 shows the percentages per option for altruism and higher-order empathic behavior.

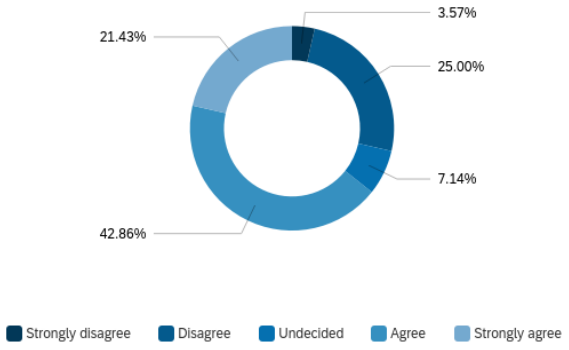

Figure 13: Percentages of altruism and higher order empathic behavior

All participants who mentioned that they strongly agreed provided statements such as: "*She looks like she needed help and if I could, I would have asked her what is*

going on." and "*Yes, in the real world I would have asked what was wrong*.". Similar statements were provided by the participants who agreed: "*If it was possible, I would have wanted to ask her what was wrong*." and "*I may give her tissues to wipe her tears or ask her what happened*.". However, one participant here also mentioned, "*It did give me the feeling of willing to help her. Knowing that it is fake, it affected me less*.". Some participants were undecided and mentioned: "*I would have wanted to help, but I do not know the person, so that seems weird to me. Some people also do not want you to help them and that is difficult to estimate*." and "*In my opinion, communicating with this virtual person is different because it is a device which results in the idea that I cannot really do anything to make her feel better. I also have the feeling that, because it is a device, she can simply switch to happiness. This made me not really feel the emotion of the virtual person*.". Participants who disagreed also gave similar statements like the latter: "*I accepted the fact that I could not interact with the world. Helping was not considered an option*." and "*Some feeling of wanting to help occurred, but lessened significantly because of the unrealness of the experience*.". The participant who strongly disagreed mentioned: "*I do not agree because I do not know her*."

Chapter 6

Discussion

6.1 Summary of the key findings

The present study aimed to explore the predictability of the presence of a personification and the general tendencies of empathy towards the ability to empathize with virtual agents. To test this predictability, a virtual reality experiment was conducted. In the present research, the addition of a virtual reality environment was made to increase the realness of the situation. This offers the possibility of an increase in user engagement (Sbordone et al., 2021). Moreover, it facilitates more social interaction between the person and the virtual agent. The general tendencies of empathy were measured using the Toronto Empathy Questionnaire (Spreng et al., 2009). The personification story was introduced during the experiment. Here, participants observed a situation where a virtual character showed signs of sadness. A post-experiment survey evaluated the ability to empathize with this virtual character. The results of this study have shown that the personification story does not significantly predict the empathy toward the character. On the contrary, general tendencies of empathy do predict the empathy towards the character. Together, these results suggest that personification stories might not contribute to a higher ability to empathize, but general empathy tendencies do.

6.2 Personification

The hypothesis of this research stated that both the presence of a personification and the general tendencies of empathy lead to more empathy towards the character (H3). The results reject this hypothesis because no significant results were found that the personification story predicts higher empathic abilities towards the character. This also leads to a rejection of H2, which stated that only the presence of a personification story would lead to higher empathy towards the character.

When comparing this result with previous studies, the finding is surprising. The study by Darling et al. (2015) has shown that a personification story allowed people to relate more to, in the case of their study, robots. The personification story impacted the reaction of participants towards the robot. It increased emotional responses and the ability to empathize with them. The study by Cordar et al. (2014) raised the question whether this effect is also present for virtual agents. This study has also shown that personification stories about virtual agents can evoke empathy towards them. They concluded that personification stories are a way to facilitate greater empathic responses from people.

The relatively small sample size can partly explain the results of the personification story. A sample size of 28 participants might have been too small to give significant results about the predictability of the personification story. The study by Darling et al. (2015) that showed significant results of the effect of a personification story on the empathy towards the character had a total of 101 participants. Cordar et al. (2014) conducted their research with the help of 35 first-year medical students. Moreover,

convenience sampling was used in this research which might have resulted in a sampling bias.

Another possible explanation for this result regards the character. One participant mentioned: "*The VR context (limited focus due to me needing corrective glasses, black rings around the goggles, clearly 3D-rendered environment, imperfect and repetitive animation and sound) made it hard to me to connect emotionally to the scene. Alternatively, it made it _easy_ for me to _disconnect_ emotionally from the scene, which I have the tendency to do (especially in the case of films) because I don't want to feel uncomfortable in such a situation. "Plaatsvervangende schaamte" is also something that I feel, and that I hence consciously try to avoid in case the subject is not natural.*". Another participant provided a similar statement: "*At first I think it's not obvious to see what the situation because it can either be a weird person approaching and doing weird movement. Later on I can tell she is crying because she let out loud and wipes her eyes.*". Both of these comments applied to the design and look of the character. These participants might have focused more on imperfections of the environment and character rather than focusing mainly on the emotion and situation. It is possible that people who looked at the defects of the character and the scene reacted differently than people who did not notice or paid attention to this.

Moreover, only one participant mentioned the personification story in their explanation for the statement, "*I was curious why the character was showing the emotion she showed me.*". He or she mentioned: "*After reading the information paper, I wondered if something happened with her work or her cats (this is also because she wears a sweater with a cat on it)*". A possible explanation for the results of the personification could have been that not everyone who received the personification story really had the story in mind when watching the situation in the environment. Participants were given the personification shortly before the virtual reality experiment started. Most participants read it very quickly and only once.

6.3 General tendencies of empathy

On the other hand, one hypothesis could be accepted, which stated that the general tendencies of empathy lead to higher empathy towards the character (H1). This could mean that the higher the ability of people to empathize with other people, the more empathy they will show towards the virtual agent. This is in line with previous research conducted by Sbordone et al. (2021). The present study showed additional importance of including individual differences in empathy when measuring the effect of certain factors on the ability to empathize with virtual characters. Moreover, in the study of Sbordone et al. (2021), a different self-report measurement scale for empathy was used. This scale was called the Interpersonal Reactivity Index (IRI). The IRI consisted of different sub-components of empathy than the TEQ. This contributes to existing research. This is because the results of this study potentially showed that when different components of empathy are measured, this could also lead to a higher ability to empathize with virtual agents.

6.4 Experience with virtual agents

The pre-experiment survey, including the Toronto Empathy Questionnaire, included a question about the experience with virtual agents. Participants were categorized as lower, medium, or higher experienced based on the answer. Results have shown no significant differences between the groups regarding their ability to empathize with the character in the environment. This rejects H1 for the sub-question about experience groups, which stated that experience with virtual agents affects the empathy towards the character. The relatively small sample size could partly explain this result. The group with low experience with virtual agents consisted of 17 participants, while the group of higher experienced participants only consisted of 7 people. A bigger sample size could show hidden results.

6.5 Gender differences

Besides studying the predictability of the personification and the general tendencies of empathy, gender differences have also been analyzed. Results have shown no significant difference between males and females and their ability to empathize with the character. This result rejects H1 for the sub-question about gender differences, which stated that gender differences in empathy are reflected in the empathy towards the character.

This result contradicts the results of studies performed by, amongst others, Eisenberg & Lennon (1983). Their research concluded that females might be more empathic than males. They reasoned that females tend to be more nurturing and interpersonally oriented. This was also confirmed by Parsons & Bales (1955), who mentioned that females facilitate harmony within the family, which requires them to be socialized. However, as most of these studies conclude, further research is needed. This is because the nature of gender differences in empathy is still unclear. Hoffmann (1977) stated in his study about gender differences that males rather solve problems than show empathic responses. This means that males tend to suggest alternative solutions to problems than women. This puts sex differences in empathy into a broader perspective (Hoffmann, 1977). The question arises whether empathy is not part of a larger pattern of behaviors and responses, such as problem-solving behavior.

6.6 Recommendations for future research

Even though the present study has shown contradicting results to previous results and has some limitations, there are several recommendations for future research.

First of all, the result of the personification and the experience with virtual agents could be explained by the small sample size. Future studies should investigate the predictability of the personification with a larger sample size, increasing accuracy. This could potentially also show different results for the experience with virtual agents. Moreover, some participants were more focused on the design and imperfections of the character than on the situation and emotion. This could be prevented in future research when movements, facial expressions and sounds are more human-like. In future research, meta-humans could, for example, be used. Computer graphics have developed to a point where photo-realistic characters can be

made. These meta-humans can be rendered even to the level of individual hair strands. The use of meta-humans might contribute even more to the realness of the character and the situation it is in (Siddiqui, 2022).

Moreover, in the present research, the personification story was presented on paper before the experiment. Most participants read it very quickly, and only one participant referred back to the personification story in the post-experiment survey. Personification stories presented in a video could contribute to the participants' understanding and their attention to the story (Arguel & Jamet, 2009). Here, the virtual character could introduce itself to the participants, possibly contributing to the realness.

The result of the general tendencies of empathy in the present study also has implications for future research. Based on the results of this study, a recommendation can be made that this factor should be included when researchers want to improve the engagement and efficacy of virtual social interactions. As these individual differences have not been included often in studies, the results of this study contribute to the findings of Sbordone et al. (2021).

Regarding differences in the ability to empathize between genders, problem-solving behavior as a construct of empathy could be included in future research (Hoffmann, 1977). This could potentially show that gender differences in empathy may not be as significant as is currently demonstrated by research. In addition, the stereotype of the female as the nurturing person in the family or relationship is no longer always reality.

Chapter 7

Conclusion

This study investigated the predictability of a personification story and general empathy tendencies on the ability to empathize with virtual characters. General tendencies of empathy have not been studied frequently in combination with other factors that might facilitate higher abilities to empathize with characters. Results were gathered by conducting an experiment consisting of the Toronto Empathy Questionnaire, a virtual-reality experiment, and a post-experiment survey. Several conclusions can be drawn from this study.

A multiple linear regression was run to test the predictability of the general tendencies of empathy on the ability to empathize with virtual agents. Results of the Toronto Empathy Questionnaire and the post-experiment survey have shown that general empathy tendencies predict higher abilities to empathize with virtual characters. Thus, when a person has a high capacity to empathize with people, this person also tends to show more empathy towards virtual agents.

Surprisingly, it was found that the personification story did not predict the ability to empathize with the virtual agent. A linear regression was run to test this factor's predictability and revealed a significance of $p = .870$. Even though previous research has shown that personification stories might elicit more empathy towards both robots and virtual agents, no significant results were found in this study.

In addition to the personification story and the general tendencies of empathy, two more factors were analyzed. These factors were gender differences and experience with virtual agents. Results of an independent samples t-test showed no significant differences between females and males and their ability to empathize with the virtual agent. An ANOVA test was run for the experience with virtual agents, but no significant differences were found between lower, medium, and higher experienced people.

In conclusion, one hypothesis could be accepted, which stated, "*General tendencies of empathy lead to a higher empathy towards the character"* (H2). The remaining hypotheses were rejected based on the results of the analysis. These results provided additional insight into the importance of including the general tendencies of empathy when studying which other factors evoke greater empathy towards virtual agents.

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Appendix A: Toronto Empathy Questionnaire

Data privacy & scope of the research
Dear participant, Thank you for taking the time to participate in this research. Before taking part in this study, please read the information below and click the "I Accept" button at the bottom of the page if you freely consent to participate in the research.

In this survey, you will be asked to provide several information about your demographic data, your experiences with the topic of the research, and your typical feelings and behaviors. The second part of the experiment consists of a virtual reality experiment in which you are asked to observe a certain situation in the environment. The last part of the experiment consists of a survey about your experience in the virtual reality experiment. The experiment will take approximately 15 minutes. This research is conducted by Kim Kroes in partial fulfilment of a Bachelor degree in Information Science at Utrecht University.

Please understand that your participation in this study is voluntary and you can decide at any time to terminate the survey early. Your identity and answers will remain confidential. Any personal information that is provided will only be used for the management of this research and will not be disclosed to third parties. Only the researchers will have access to the data of this research. Answers that are given to questions are completely anonymous and cannot be traced back to the respondent.

If you have any questions about this study or your rights as a participant, you may contact the principal researcher, Kim Kroes, by email:
k.m.d.kroes@students.uu.nl
In case of any other complaint or concern about the collected data, you may also contact MSc Isabella Saccardi:
i.saccardi@uu.nl

If you understand the statements above and freely consent to participate in this study, click on the "I Accept" button to begin the experiment. If not, thank you for your time.

- I accept
- I do not accept

Question 1:
How old are you?
- Under 18
- 18-24 years old
- 25-34 years old
- 35-44 years old
- 45-54 years old
- 55-64 years old
- 65+ years old

Question 2:

What is your gender?

- Female
- Male
- Prefer not to say

Question 3:
What is the highest degree or level of education you have completed?
If currently enrolled, select current education

- No education completed
- Elementary school (basisschool)
- High school (middelbare school)
- MBO
- HBO/University of Applied Sciences
- University Bachelor
- University Master
- PhD
- Other

Question 4:
What is your current employment status?

- Unemployed
- Student
- Self-employed
- Employed for wages
- Retired
- Other

Question 5:
Do you have any experience with working with virtual agents, robots, avatars or other Artificial Intelligence applications?
If yes, explain what experience you have.

Virtual agents are considered software programs that provide services to humans or to help humans such as chatbots, digital assistants and for example Amazon Alexa or Siri. Avatars are for example a player's representation in gaming worlds in games like the Sims.

- Yes, explain
- No

Below is a list of statements. Please read each statement carefully and rate how frequently you feel or act in the manner described. There are no right or wrong answers or trick questions. Please answer each question as honestly as you can. *Remember that the answers are completely anonymous. Responses to the questions cannot be traced back to the respondent.*

Statement 1:

	Never	Rarely	Sometimes	Often	Always

When someone else is feeling excited, I tend to get excited too.					

Statement 2:

	Never	Rarely	Sometimes	Often	Always
Other people's misfortunes do not disturb me a great deal.					

Statement 3:

	Never	Rarely	Sometimes	Often	Always
It upsets me to see someone being treated disrespectfully.					

Statement 4:

	Never	Rarely	Sometimes	Often	Always
I remain unaffected when someone close to me is happy.					

Statement 5:

	Never	Rarely	Sometimes	Often	Always
I enjoy making other people feel better.					

Statement 6:

	Never	Rarely	Sometimes	Often	Always
I have tender, concerned feelings for people less fortunate than me.					

Statement 7:

	Never	Rarely	Sometimes	Often	Always
When a friend starts to talk about his/her problems, I try to steer the conversation towards something else.					

Statement 8:

	Never	Rarely	Sometimes	Often	Always
I can tell when others are sad even when they do not say anything.					

Statement 9:

	Never	Rarely	Sometimes	Often	Always
I find that I am “in tune” with other people’s moods.					

Statement 10:

	Never	Rarely	Sometimes	Often	Always
I do not feel sympathy for people who cause their own serious illnesses.					

Statement 11:

	Never	Rarely	Sometimes	Often	Always
I become irritated when someone cries.					

Statement 12:

	Never	Rarely	Sometimes	Often	Always
I am not really interested in how other people feel.					

Statement 13:

	Never	Rarely	Sometimes	Often	Always
I get a strong urge to help when I see someone who is upset.					

Statement 14:

	Never	Rarely	Sometimes	Often	Always
When I see someone being treated unfairly, I do not feel very much pity for them.					

Statement 15:

	Never	Rarely	Sometimes	Often	Always
I find it silly for people to cry out of happiness.					

Statement 16:

	Never	Rarely	Sometimes	Often	Always
When I see someone being taken advantage of, I feel kind of protective towards him/her.					

Question 6:
Please state how much you agree with the following statement.

	Not at all	Slightly	Moderately	Very	Extremely
I consider myself an empathic person.					

Thank you for completing the first part of the experiment. You will now start the virtual reality experiment. Please leave the survey open to continue with the second part of the survey.

Appendix B: Post-experiment survey

In this part of the experiment, a few questions will be asked about your experience with the character in the virtual reality environment.

Question 1:
Below is a list of statements. Please read each statement carefully and answer each question as honestly as you can.
Remember that the answers are completely anonymous. Responses to the questions cannot be traced back to the respondent.

Statement 1:

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
When seeing the character in the virtual environment, I could easily tell what emotion she was showing me.					

Please explain your answer.

Statement 2:

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
I was curious why the character was showing the emotion she showed me.					

Please explain your answer.

Statement 3:

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
When seeing the character in the virtual environment, her emotion affected me (e.g. it made me upset, concerned or irritated).					

Please explain your answer.

Statement 4:

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree

When seeing the character in the virtual environment, I felt the need to help her if I could.					

Please explain your answer.

Question 2:
Please express how much you agree with the following statement.

	Strongly disagree	Disagree	Undecided	Agree	Strongly agree	Not applicable
The information that I received about the character influenced the way in which I could empathize with her.						

Question 3:
Does the fact that the character in the virtual environment cannot feel emotions like we humans do, affect your feelings towards the character? Please briefly explain your answer.

Thank you for participating in this experiment. Your response has been recorded.

Appendix C: TEQ results

PCP	**Emotional Contagion**	**Emotion Understanding**	**Assessment of Emotional States**	**Sympathetic Physiological Arousal**	**Altruism**	**Frequency of Behaviors**	**Score**
1	6	3	15	10	10	3	47
2	5	4	6	9	8	2	34
3	6	3	14	13	9	3	48
4	6	4	16	16	12	3	57
5	5	3	13	11	11	4	47
6	6	3	16	11	9	4	49
7	5	2	16	8	9	2	42
8	4	2	12	11	10	3	42
9	8	3	14	10	11	3	49
10	7	3	19	14	11	4	58
11	7	2	18	12	10	3	52
12	6	3	15	12	12	4	52
13	8	4	20	15	11	4	62
14	8	3	14	11	11	3	50
15	7	2	16	9	11	3	48
16	6	2	11	9	7	2	37
17	5	3	9	8	8	3	36
18	6	3	13	12	12	3	49
19	7	3	18	11	11	4	54
20	6	3	14	9	9	3	44
21	7	3	17	14	10	3	54
22	6	2	15	10	10	3	46
23	5	3	8	3	3	2	24
24	5	2	17	6	7	1	38
25	7	3	13	13	11	4	51
26	5	2	16	9	10	3	45
27	4	1	9	8	7	1	30
28	6	3	15	12	9	4	49
Max.	**8**	**4**	**20**	**16**	**12**	**4**	**64**

Demographic	Variables	N	Percent (%)
Age	Under 18	0	0,00%
	18-24 years old	23	82,14%
	24-34 years old	1	3,57%
	35-44 years old	0	0
	45-54 years old	1	3,57%
	55-64 years old	1	3,57%
	65+ years old	2	7,14%

Education	No education	0	0,00%
	Elementary school	0	0,00%
	High school	3	10,71%
	MBO	2	7,14%
	HBO	1	3,57%
	University bachelor	19	67,86%
	University master	2	7,14%
	PhD	0	0,00%
	Other	1	3,57%
Employment status	Unemployed	0	0,00%
	Student	21	75,00%
	Self-employed	2	7,14%
	Employed for wages	3	10,71%
	Retired	2	7,14%
	Other	0	0,00%

Appendix D: Virtual reality environment

Figure 14: Virtual environment of experiment

Figure 15: Character in virtual environment

Figure 16: Emotion of the character in the virtual environment

Figure 17: Design of character in the virtual environment