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

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***Abstract*—For interactions to be natural, virtual agents should understand humans' emotions, and humans should have emotional reactions towards them. In human-to-human interaction, this is achieved through empathic processes between individuals. So, improving empathic responses towards virtual agents represents a crucial step in improving human-virtual agent interactions. This study aims to identify whether the presence of a personification story and individual differences in the ability to empathize predict the empathic response towards a virtual agent. Furthermore, it investigates the effect of previous experience with virtual agents and gender on empathy towards the virtual agent. In an experiment, participants witnessed a virtual reality scene in which a virtual agent experienced sadness. Half of the participants were previously presented with a personification story about the virtual agent, and all completed a self-report questionnaire about empathy and a post-experiment survey about their empathic response towards the virtual agent. Results showed that individual differences in empathy significantly predict the ability to empathize with the virtual agent: people who are naturally predisposed to feel more empathy towards others tend to be more empathic towards the virtual agent. The personification story, previous experience and participants' gender did not affect the empathic response. Implications and future direction for the design of virtual agents are discussed.**

***Index Terms*—Virtual reality, Social agents, Emotional rapport, empathy and resonance, Emotion in human-computer interaction**

I. Introduction

Technologies are increasingly embedded in our lives. Our social environment has become more complex: not only do we need to interact with machines, but the interactions should also be as natural and effortless as possible. Technology must be able to *socially* interact with humans, equipped with the capability to understand humans' needs, motivations and feelings [1]. It is known that humans tend to treat computers as social agents, and apply social schemas to communication towards them [2], [3]. This phenomenon is also valid when communicating with Embodied Virtual Agents (EVAs), computational agent interfaces provided with facial expressions, body gestures, and emotional expression [4]. One of the most crucial social skills for these social processes is empathy. Empathy allows humans to engage with one another, understand each other, build emotional connections and create meaningful relationships [5]. Given its importance in shaping human communication, empathy has been a central point in Human-Computer Interaction studies. The creation of interfaces that would elicit empathy soon became a crucial objective.

It is well-known that a human-like appearance of the agent increases the likelihood of an empathic response from the observer [6]. However, other factors need to be considered while designing empathic virtual agents. Individual factors, such as tendencies to empathy and gender, may also influence the felt empathy towards EVAs. [7] reported a link between an individual's propensity towards empathy and their ability to take an EVA's perspective, a skill associated with the perception of the EVA as a social agent. Furthermore, other studies suggest that a social response can be encouraged by providing more personal information about the EVA. In a study by [8] for training young doctors, personal information about the virtual agent positively impacted the empathic responses of the trainees.

While these studies show promising results for the design of EVAs, no study to date combined the individual tendencies of empathy and the presence of personal information about the agent as predictors of felt empathy. The study of [7] supports a link between empathy and EVAs' perspective-taking, but the question of whether this has a real impact on the felt empathy towards EVAs remains unsolved. Regarding the presence of a personification story, the study of [8] suggests that personal information about the agent facilitates empathy towards it. However, the experimental setup of [8] was specific to the scope of the simulation: it was created to train young doctors' interviewing skills, and the EVA was presented as a patient.

The present work aims to fill this research gap by studying to which extent the empathic response towards a virtual agent is predicted by the individual differences in empathic traits and by the presence of a personification story. This research aims to extend the work of [8] by providing personal information about the EVA in a generic virtual situation, where participants simply witness an EVA who is showing signs of distress. The aim is therefore to obtain a natural response, not influenced by the scope of the simulation itself. Furthermore, the study extends the work of [7] by testing the impact of general tendencies of empathy on the actual empathic response of participants, while [7] focused on the association between empathic traits and perspective-taking.

In order to do so, the following research question is explored: ***(RQ1)*** *Do general tendencies towards empathy and*

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the presence of a personification story predict the empathy towards the virtual character? Given that the experience with virtual agents may also affect the users' expectations and reactions, the following research question is also explored: ***(RQ2)*** *Does the experience with virtual agents affect the empathy towards the virtual character?* Lastly, gender differences in feeling empathy have been reported in several studies [9], [10]. Therefore, a third research question has been formulated: ***(RQ3)*** *Are there gender differences in the empathy felt towards the virtual character?*

II. Previous work

A. Modeling empathy

The study of empathy dates back to the eighteenth century, when David Hume described how humans resonate with one another and recreate others' thoughts and feelings in their own minds [11]. The current concept of empathy was born only a century later, when the psychologist Theodore Lipps described the emotional appreciation of the feelings of others with the term "Einfühlung", later translated as "empathy" by Edward Titchener [12], [13]. Over the years, several definitions have been proposed: some focused on the mental aspects of being able to understand and imagine someone's emotions [11], [14], while others focused on the emotional aspects of living someone's feelings [15]. In modern years, these two components have been unified into a definition of empathy as a multidimensional construct, comprising both an emotional and a cognitive response to others' emotional states [16]–[19].

Affective empathy refers to the emotional reaction of the observer when perceiving that someone else is experiencing an emotion [18], [20]. *Cognitive empathy* refers to the ability to understand others' emotional experiences by actively trying to step outside of oneself and step into someone else's experiences [20]. This distinction has been used to distinguish between *categorical* models of empathy, focusing on the differences between cognitive and affective empathy, and *dimensional* models of empathy, suggesting that cognitive and affective empathy are deeply interconnected [21].

Empathy is indeed a complex process, involving a variety of skills whose interaction with one another is yet to be defined [20]. Dimensional models of empathy attempt to recreate such complex interactions by proposing dynamic multidimensional systems. A good example is the model by [22] shown in Fig. 1, comprised of three levels, each one embedding a set of skills necessary for empathy [22]. *Communication competence* includes emotion recognition, expression and mimicry. Emotion recognition can be defined as the ability to recognize and interpret the emotional state of others [23]. Since affective empathy includes mimicking others' behavior and emotions [24], the capabilities of imitating others (mimicry) and expressing emotions are also included in this level, considered the basis of empathic behavior. The second level is *emotion regulation*. It can be defined as an attempt to influence emotions in ourselves or others [25]. It is essential to show an appropriate emotion to the situation, and it can encourage re-interpretation of the distressing situation, if needed. It is known to be influenced by the relationship between the empathizer and the target [22]. The third and final level contains *cognitive mechanisms*. High-level empathic behavior requires cognitive capabilities, such as appraisal and re-appraisal of a situation, theory of mind [26], perspective-taking and targeted helping.

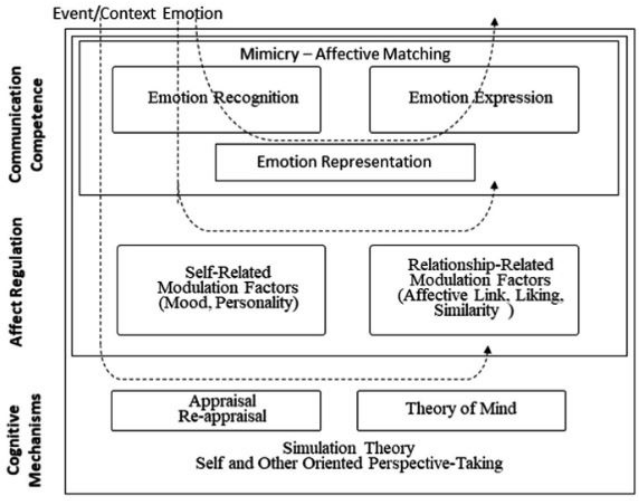


Fig. 1: Model of empathy proposed by [21].

B. Inter-individual differences in empathy: contributors and developmental factors

Several psychologists tried to establish whether empathy is a skill that simply develops over time [27], or whether it is something that can be learned [15]. The challenge of this query lies in the variety of factors that contribute to the development of empathy. Figure 2 shows an overview of such factors [28], divided into within-child factors and socialization factors. Each of these plays a role in the development of empathy as a child, and can ultimately determine interpersonal differences in empathy.

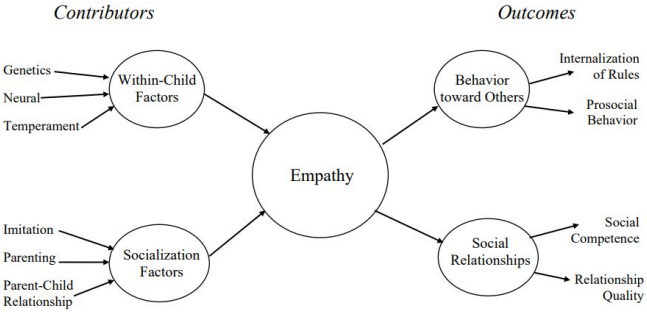


Fig. 2: Contributors of empathy development [28].

Within-child factors include genetics, neurodevelopment and temperament. Empathic concerns are known to be inheritable in twins and children studies, and these heritability effects tend to increase with age [29], [30]. Furthermore, several brain areas are implicated in empathic behavior. An example is the

neuron mirror system, known to be implicated in mirroring someone else's emotional state [31]. Mirroring is crucial to empathy, and corresponds to the base component according to the model of [21]. Dysfunctions of the mirror neuron system in early childhood can negatively impact 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 a lower ability to empathize with others [32]. Lastly, one's temperament is the personality's aspects related to emotional reactions and their speed and intensity [28]. Individual differences in temperament may therefore influence the degree of empathic response.

Socialization factors are related to the social environment, and they comprise imitation and parenting. The capability of imitating others' emotions and behaviors depends on the possibility of moving facial muscles. Factors that might prevent the ability to imitate facial expressions as a child, or other factors impeding mimicry, can affect the capability of feeling empathy [33]. Finally, parenting and a child's attachment style may influence empathy development in many ways [28], [34]–[37].

C. Gender differences in empathy

Several studies raised the question of whether gender influences empathic tendencies. One of the first systematic reviews in that regard was performed by [9]: after reviewing 29 papers, they concluded that there were no differences between genders. However, the studies cited in the review comprised also a variety of other behaviors such as social sensitivity or affective role-taking, broadening the definition of empathic behavior. A different attempt was made by [10], who reviewed nine articles distinguishing between empathy and indices of role-taking and social behavior; in their review, women scored higher in empathy in all studies. Therefore, [10] concluded that women are more empathic than men.

A subsequent review and meta-analysis by [38] suggested that gender differences were reported especially in studies using self-report, but less common in studies examining alternative measures of empathy, such as empathic behavior or physiological arousal. [38] argued that the gender differences depend on the methods used and for self-presentation preferences: when compiling a self-report, women may aim to appear especially empathic and nurturing, as they are part of the stereotypical feminine role [39]. However, the validity of this explanation relies on the internalization of social values and as such is strongly dependent on society and culture. Further research is needed to investigate eventual self-presentation bias in self-reports about empathy.

A new perspective was brought by the study of [40], reporting a correlation between prenatal testosterone levels and children's empathic behaviors. Differences between genders in brain activation following unfair games were also reported by [41] and by [42].

In conclusion, the question regarding gender differences in empathy remains unclear. Some studies suggest that gender differences are simply a product of presentation bias in self-reports, since measures that do not rely on self-report (behavioral observation, arousal) do not present such biases. However, more recent studies relying on physiological methods report a biological basis for differences in empathy between genders.

D. Empathic concern from humans to virtual agents

[2], [3] defined the *"Computer as Social Actors"* (CASA) framework, describing the social reactions observed during human-computer interaction. The belief that humans react socially to computers, displaying social behaviors such as politeness or criticism, suggested that efficient communication between humans and machines should be as human-like as possible. Technological interfaces soon started to be populated by embodied virtual agents (EVAs). EVAs are computational agents provided with facial expressions and body gestures, with the idea that they would facilitate effortless, natural conversation [43], [44]. The CASA framework was shown to apply to EVAs as well [4]. Therefore, researchers focused on how the EVAs' appearance and attitude should be modified to affect how humans treat them. The use of immersive virtual reality soon allowed to simulate social interactions with them. In immersive virtual reality (IVR) users can enter a computer-generated environment through a head-mounted display [45]. IVR represents a great way to simulate social interactions: users are immersed in an unreal environment, but they typically respond and react as if it was real [7] and they tend to treat virtual agents (VAs) as if they were humans rather than objects [46].

Based on these premises, several studies explored how the appearance of virtual agents may influence the emotional response of users. [47] concluded that the appearance should be similar to humans to elicit automatic social responses from users, possibly showing a similar range of emotional expression. A great deal of research therefore focused on how to elicit empathy in the human observer. In this line of research, [48], [49] identified several characteristics of VAs to be targets of empathy, ranging from the characteristics of the agent (physical appearance, emotional expression) to the situation and context of the interaction and, lastly, to the features of the empathizer.

However, to be capable to elicit empathy, the mere appearance and emotional expression may not be enough [50]. Additional factors are the presence and quality of information about the VA. In a longitudinal study by [51], VA counsellors relating personal stories to their users were found more enjoyable, and participants interacted with them more. Similarly, a robot study showed that the presence of a personification story allowed humans to relate more to the robot, increasing their emotional responses towards it [52]. Personification stories include personification attributes, such as name, age, job, or even favorite colors. Similar results were found in a study with virtual agents for training young doctors, supporting the idea that the presence of a personification story may evoke more

empathy and facilitate greater empathic responses from people [8].

Lastly, the individual characteristics of the user may also impact the way the agent is perceived [6]. The mood and personality of the empathizer have already been mentioned by [53] as an influential factor in building an empathic response towards an EVA. A study by [7] explored the correlation between individual empathic traits and social interactions with agents. They compared the propensity towards empathic traits and the ability to take the perspective of a virtual agent. They found that some components of empathy were positively correlated with the capability of taking the agent's perspective, suggesting that individual differences in empathy play a crucial role in interactions with VAs.

III. Method

A. Design

A between-subject design was used, with two conditions. In the personification condition, participants received a personification story about the virtual agent they were about to see. In the control condition, no such story was provided.

B. Procedure

After signing the informed consent, participants were asked whether they had any previous experience with intelligent agents and, if yes, to explain which kind of experience. Then, participants filled out the Toronto Empathy Questionnaire (further explained in section III-D). Participants in the personification condition were given the following personification story: *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 centre. Sophie recently got a new job and will start her job as a veterinarian in about a week.* This story was based on the study performed by [52].

Next, participants entered the virtual reality (VR) environment and observed a situation for 1.5 minutes. They found themselves at a bus stop, where a virtual character (VC) approached them, increasingly showing signs of sadness: at first, it displayed a sad posture while walking, and once arrived at the bus stop it started crying. Sadness was chosen among other emotions because it affects users' behavior: humans are more willing to help people showing a sad expression compared to a neutral expression, possibly because sad expressions automatically evoke empathy and willingness to help [54]. Participants were not able to directly interact with the character, they could only observe the VR situation. The virtual reality environment was created with Unity 3D [55], a cross-platform designed to develop video games and simulations, and the virtual character with Adobe Mixamo [56].

Afterwards, participants filled in a survey which evaluated their experience with the virtual agent and their ability to empathize with it.

C. Participants

28 participants (18 female, 10 male) were recruited via convenience sampling. The age range was between 18-65 years old ($\mu = 23.89$, $sd = 14.39$). 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.

D. Measures

Toronto Empathy Questionnaire. The Toronto Empathy Questionnaire (TEQ) is a 5-point Likert scale developed by [57]. It measures empathy as a multi-component construct, but it emphasizes the affective/emotional component. Therefore, it was deemed suitable to identify the participants' ability to share the virtual agent's emotion in the experiment. The TEQ consists of six components, namely emotional contagion (EmCon), emotion understanding (EmUnd), sensitivity (Sens), sympathetic physiological arousal (SympPhy), altruism and higher-order empathic behavior (AltEmp). The TEQ results in a TEQ score (maximum 64 points), where higher scores indicate higher empathic abilities [57].

Post-experiment survey. After the virtual reality experiment, participants were asked to fill in the post-experiment survey, consisting of questions assessing the felt empathy towards the virtual character. First, participants were asked to write down the emotion the virtual character was showing, to assess which emotion they perceived. Then, they were asked to answer to five 5-point Likert scale statements, related to the components of the TEQ. Participants were then asked to explain their answers. An overview of the statements and the corresponding components can be seen in Table I. A total of 20 points could be achieved, where a higher score indicates more empathy felt towards the VC. They were then asked the extent to which the personification story, if received, influenced the way they felt towards the VC. Lastly, they were asked whether the fact that the character in the virtual environment cannot feel emotions like humans did affect their feelings towards the character. The last two questions were created to explore participants' attitudes towards the VC's emotion, and whether the personification story influenced it.

IV. Results

A. Post-experiment survey: descriptive results

In the post-experiment survey, participants gave their opinion on statements regarding their experience with the character and the effect of the virtual environment. First, they were asked which emotion was shown by the VC. All participants correctly identified the feeling of sadness. Secondly, they indicated their level of agreement with five statements, related to the TEQ components (an overview of the statements can be seen in Table I). Results can be seen in Fig.5. Most participants understood the emotion of the VC, and felt curious about why the character was showing such emotion (EmUnd and Sens). Results were divided for emotional contagion and sympathetic physiological arousal (EmCon and SymphPhy), showing high variability in the degree to which observing the VC elicited the

(a) (b)

Fig. 3: The virtual reality scenario. Participants were in a city, at a bus stop (3a). Then, a virtual character approached them (3b), increasingly showing signs of sadness (sad posture, crying).

TABLE I: Statements of the post-experiment survey and the corresponding TEQ components of [57]: emotional contagion (EmCon), emotion understanding (EmUnd), sensitivity (Sens), sympathetic physiological arousal (SympPhy), altruism and higher-order empathic behavior (AltEmp).

TEQ comp.	Definition	Post-Experiment Survey Statement
EmCon	Degree to which the perception of other's emotions stimulates the same emotion in oneself.	*When seeing the emotion of the character in the virtual environment, I felt the same emotion as she showed me.*
EmUnd	Comprehension of other people's emotions.	*When seeing the character in the virtual environment, I could easily tell what emotion she was showing me.*
Sens	Degree to which one is affected by others' emotions and wants to understand and explore them.	*I was curious why the character was showing the emotion she showed me.*
SympPhy	Degree to which the observer shares the physiological arousal elicited by others' emotions.	*When seeing the character in the virtual environment, her emotion affected me (e.g., it made me upset, concerned or irritated).*
AltEmp	Unselfish behaviors intended to benefit others [58].	*When seeing the character in the virtual environment, I felt the need to help her if I could.*

same emotion and physiological arousal in participants. Most participants expressed the desire to help the VC, if given the possibility (AltEmp).

Participants were then asked if the personification story, if received, influenced their empathy. Participants were almost equally divided between different levels of agreement, as can be seen in Fig.4. An overview of the post-experiment responses per group (no personification or personification) can be seen in Fig. 5b and Fig. 5c.

Lastly, they were asked whether the fact that the VC cannot feel emotions like humans affected their feelings towards it. Ten participants responded affirmatively. They explained that the VC was not a real person, and therefore the shown emotion was not perceived as real. Seven participants were slightly affected: the environment and the characters were realistic enough to elicit emotions towards the VC, but the felt emotions would probably have been more intense in the real world. Eleven participants were not affected, explaining that they feel emotions also towards movie and game characters.

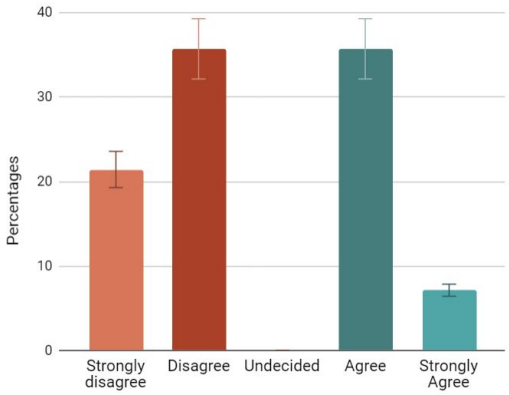
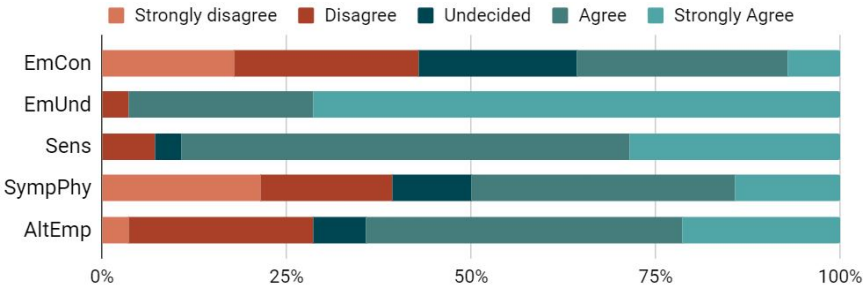


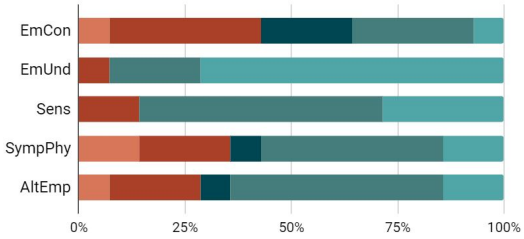
Fig. 4: Results of the post-experiment survey statement about the effect of the personification, showing the percentages of agreement within the personification story participants.

B. Fit of the model

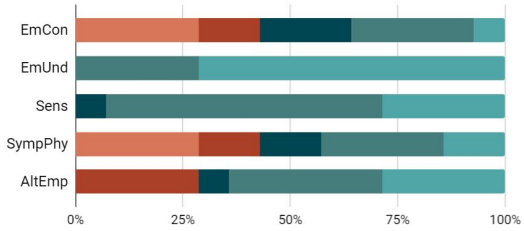
A linear multiple regression was conducted to see if the TEQ score and the personification story predicted the score of the post-experiment survey. A significant regression equation was found ($F(2, 25) = 11.761, p < .001$), with a R^2 of .485. The Toronto Empathy Questionnaire score significantly predicted the post-experiment survey score (Table II), while the personification did not significantly predict the same variable.



(a) General results.



(b) Control group.



(c) Personification group.

Fig. 5: Results of the post-experiment survey. All graphs show the percentages of responses per each level of agreement. 5a shows the overall results. Fig. 5b shows the results in the group without the personification story, and Fig. 5c shows the results in the group with the personification story.

TABLE II: Coefficients table.

	Unstandardized coef.		Standardized coef.			95.0% Confidence Interval for B	
Model	B	Std. Error	Beta	t	Sig	Lower Bound	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

C. *Effect of previous experience*

A one-way ANOVA was conducted to determine whether previous experience with intelligent agents affected the ability to empathize with the character. Participants were divided into low-experienced, medium-experienced and high-experienced based on their answers. Low-experienced participants reported no previous experience with virtual agents, robots, avatars or other AI applications. Medium-experienced referred some experience; for example, they used a chatbot once. High-experienced participants referred to having experienced virtual reality, metahumans or, for example, frequent gaming. No significant differences between groups were found with $F(2, 25) = 0.458$, $p = .638$.

D. *Effects of gender*

An independent samples t-test was performed to compare the means of the results of the post-experiment survey between females and males[1]. No significant differences between genders were found ($t = 1.519$, one-sided $p = 0.07$, Fig.6).

[1]We also considered whether there was a difference between males and females in the TEQ score and there was none ($t = 1.945, p = 0.063$).

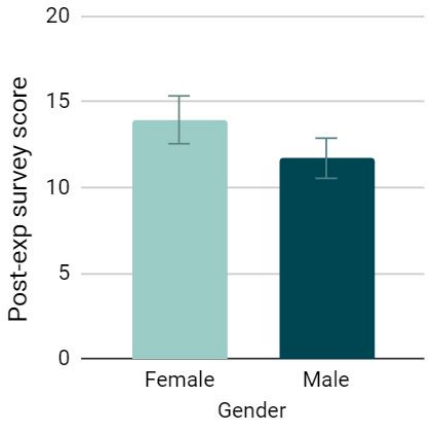


Fig. 6: Mean of the post-experiment survey score per gender.

V. Discussion

This study investigated whether the presence of a personification story and the general tendencies of empathy predict the empathy felt towards a virtual character in virtual reality.

The presence of a personification story was not a significant predictor of higher empathy towards the virtual character. This

finding is surprising when comparing it to the ones of [52] and [8]. In the study of [52], the presence of a personification story increased the emotional response and empathic abilities of participants towards a robot. [8] conducted a similar study using a virtual agent: in this study, young doctors were trained using a virtual patient suffering from depression. The presence of a personification story positively impacted trainees' empathy, who showed more encouraging, empathic responses towards the virtual agent. Differences in the methodology may explain these contrasting results: in the study of [8], the personification stories were presented in the format of cutscenes, and participants interacted verbally with the virtual agent in a text-based interaction during the simulation. The possibility of interacting with the virtual agent may have increased its social presence, further facilitating feelings of empathy. Additionally, the specifics of the simulation, such as the fact that the EVA was presented as a virtual patient, could have positively influenced empathy towards it. Furthermore, cutscenes are heavily used in films and video games to facilitate narration. In a study of [59], 360-degree videos presented in VR were found as more effective in prompting an empathetic response compared to static photos and texts. Animated presentations are known to facilitate understanding and attention [60]. Using a diverse format when presenting the backstory may differently impact the felt empathy towards the virtual character.

Another possible explanation regards the virtual character's appearance. Some participants mentioned that they were focusing on the virtual environment imperfection and animations: it is possible that people who paid attention to the environment rather than focusing on the virtual character reacted differently than people who instead focused on the VC.

On the other hand, the general tendency of empathy as measured by the TEQ was reported as a significant predictor of empathy towards the character. This supports the idea that the higher the ability of people to empathize with other people, the more empathy they will show towards virtual agents. This is in line with previous research conducted by [7], who reported an association between general tendencies of empathy and the ability to take the perspective of the virtual agent. Perspective-taking is indeed a fundamental aspect of empathy. The present research was the first study testing the effect of general tendencies of empathy on the actual empathic response towards a virtual character, extending the results of [7].

Furthermore, this study investigated whether previous experience with virtual agents influenced the participants' empathy towards the virtual character. No differences between low, medium or high-experienced individuals were found. Given that experience with virtual agents was defined as any experience with chatbots, digital assistants and avatars, it may be that the virtual agents' definition was too broad to lead to more precise results. A stricter definition of what constitutes a virtual agent may lead to different results.

Lastly, no gender differences were found between men and women in their ability to empathize with the character. This result contradicts a previous study supporting the idea that women are more empathic than men [10], [38], [42], but supports the ones that suggest no differences between them [9]. However, as most of these studies conclude, the nature of gender differences in empathy is still unclear and needs further research.

VI. Conclusion

This study investigated whether the presence of a personification story and the general tendencies of empathy predict the empathy felt towards a virtual character. A virtual reality experiment was conducted, where participants witnessed a virtual character showing signs of sadness. Half of the participants were shown a personification story, providing personal details about the virtual character they saw. General tendencies of empathy were measured with the Toronto Empathy Questionnaire, while the participants' emotional reaction towards the virtual character was measured through a post-experiment survey, based on TEQ components. Results of the Toronto Empathy Questionnaire showed that general tendencies predict a higher empathy towards the virtual character. These results support the idea that a higher capability to empathize with people leads to higher empathy towards virtual agents.

Surprisingly, the personification story did not predict the ability to empathize with the virtual agent. The format of the story and the features of the virtual environment may explain the result. Lastly, two more factors were analyzed: the experience with virtual agents and gender differences. No significant differences were found between genders, or between differently experienced participants.

This study's results yield several implications for the design of empathic virtual agents. First, individual differences in empathy influence the ability to empathize with the virtual agents, and therefore need to be taken into consideration while designing and evaluating virtual interventions that rely on social processes. Secondly, the addition of a text-based personification story does not influence empathy towards the virtual character. Other formats may be more effective. Lastly, this study extends the results by [7] by showing the influence of general tendencies to empathy on the empathic response towards virtual agents.

The study has some limitations. First, the sample size was relatively small. Increasing the sample size may lead to greater accuracy and different results. Moreover, some participants mentioned they were more focused on the design and imperfection of the character than on the situation and emotion. This could be prevented in future research with a more accurate and human-like design of the virtual agent. Lastly, the created situation was specific to the simple observation of a sad virtual agent. Studying different agent appearances, interaction possibilities and personification stories may further extend the result and the generalizability of the study.

VII. Future works

When studying empathy in human-computer interaction, two different aspects can be explored. This study focused on humans empathizing with virtual agents. However, virtual

agents should also be able to display empathy. In this line, we are also studying how virtual agents can empathize with and support humans by means of algorithm-generated support messages (e.g. [61]–[63]).

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