The role of emotion in the study of humanoid social robots in the healthcare domain

Spekman, M.L.C.

2018

document version
Publisher's PDF, also known as Version of record

Chapter 5

General discussion

General discussion

The research reported in this dissertation aimed to study the effects of people's prior emotional states on how they perceive social robots in healthcare contexts. In this final chapter, we first present an overview of the results of our studies per chapter in light of different emotion theories (i.e., valence-based or appraisal-based emotional transfer theories as well as emotional coping theories). The summary of results is followed by an elaborate discussion of the theoretical implications of these results with regard to how people perceive social robots aimed to help them in healthcare situations. After discussing several methodological considerations based on our findings, suggestions for future research are presented. Finally, we turn to the practical and policy implications of our results in applying social robots in healthcare settings.

Summary of results

In the first study (*Chapter 2*), we performed an experiment in which we compared a valence-based approach with an appraisal-based approach toward emotions. The valence-based approach, based on the broaden-and-build framework (Fredrickson, 1998; 2001), assumes that the valence of an emotion leads to a widening or narrowing of one's worldview, which in turn leads to a more open or more closed focus of attention respectively. The appraisal-based approach, based on the appraisal-tendency framework (Lerner & Keltner, 2000; 2001), suggests that emotions are characterized by specific patterns of appraisals of the situation, which may transfer to future (unrelated) situations. Participants in the experiment were induced with one of multiple positive or negative emotional states, using a standard recall procedure from common emotion research. Subsequently, they read about a social healthcare robot in a newspaper article and completed a questionnaire thereafter. Participants' perceptions of the social healthcare robot were compared across conditions. The results showed that the valence-based approach did not directly fit the data, whereas the appraisal-based approach appeared to show a better fit to the data. Appraisals were different for various emotional states and affected perceptions of the robot as well. The appraisal of coping potential seemed to play the most important role among the tested appraisals. More specifically, results showed that the appraisal of

coping potential mediated between the manipulated valence of the emotional state and perceptions of the robot. Thus, when people had the feeling that they could deal with their emotion quite well, they were generally more positive about the robot as compared to people who felt that they would experience more difficulties coping with their emotion (regardless of what emotional state they were in or their actual ability to cope with the situation). Hence, emotions did not directly affect perceptions of robots but rather seemed to do so indirectly. An appraisal-based perspective thus seemed more promising than a valence-based approach in explaining how emotional states influence people's perceptions of social robots in healthcare contexts.

Chapter 3 presented a study in which we looked in more detail into specific appraisal tendencies and extended this with a detailed investigation of the role of coping. We performed an experiment with a common emotion recall procedure, in which we manipulated not only participants' emotional state, but also their level of ease-of-coping (i.e., by asking participants to recall either a situation that was very hard to cope with or one that was relatively easy to cope with). Instead of merely reading about a robot (cf. the study in *Chapter 2*), in this experiment, participants interacted with a robot via on-screen videos. We expected that the kind of coping strategies that people used in dealing with their emotions (i.e., emotion-focused vs. problem-focused) would be influenced by their specific emotional state (or, to be more precise, by the appraisals associated with their emotional state), and that these coping strategies in turn would affect the perceptions of the robot. Furthermore, we expected that appraisals related to an emotional state would also affect people's perceptions of the robot. Similar to the results of the study reported in *Chapter 2*, we found that the appraisal of coping potential indeed appeared to differ between emotional states (and also between manipulated ease-of-coping conditions). And again, results seemed to support the idea that the appraisal of coping potential affected participants' perceptions of the robot with which they interacted on-screen.

With regard to the coping strategies that were *actually* used, we found that participants applying a positive emotion-focused coping strategy generally appeared to have more positive perceptions of the robot, but this link was not found when participants applied any of the other coping strategies. However, we expected that the manipulated emotional states and ease-of-coping influenced which coping strategies participants would use, but the results showed that this was not the case. Thus, as in the previous study, we

appeared to have found an indirect effect of emotional state via the appraisal of coping potential on perceptions of the robot, but no effects of emotional state via *actual* use of coping strategies on those perceptions. Hence, the results again seemed to support the appraisal tendency framework as a promising approach in explaining how (prior) emotions may influence people's perceptions of social robots in healthcare contexts.

Finally, *Chapter 4* presented two related experiments in which participants had an actual, face-to-face conversation with a robot. The aim of these two experiments was to test effects of the emotional state, appraisals, and emotional coping on how participants perceived a social robot during an *actual* human-robot interaction. Just like in Study 2 (in *Chapter 3*), we manipulated emotional state and coping potential, this time using a scenario method instead of a recall procedure. In the first of the two experiments reported in *Chapter 4*, participants were not informed about the fact that they were to interact with a robot further on in the study to avoid possible confounds. Even though our emotion and ease-of-coping manipulations were effective, we did not find the effects of the appraisal of coping potential as expected (like those we seemed to have found in the previous experiments; see *Chapters 2* and *3*), nor any effects of coping strategies on perceptions of the robot. Rather, it appeared that participants were so surprised about being confronted with a robot all of a sudden, that this seemed to have disrupted or overruled any prior emotion induction in this experiment.

To account for these surprise effects, we replicated the study with a slight change in the procedure in the second experiment of *Chapter 4*. This time, participants were informed beforehand that they would interact with a robot, and had a brief introductory meeting with the robot at the start of the experiment. Results of this experiment, however, again showed that the appraisal of coping potential was not related to perceptions of the robot (even though our manipulations were shown to be effective again), and neither did the hypothesized effects of the coping strategies occur. Thus, it became apparent that the mere physical presence of the robot disrupted any influence that prior emotions, as induced in a lab situation, could have on people's perceptions of the social robot.

Theoretical implications

Many studies in the field of human-robot interaction (HRI) have focused on the effects of robot features on users' perception or evaluation of robots (e.g., Heerink, Kröse, Evers & Wielinga, 2006; Robinson, MacDonald, Kerse, & Broadbent, 2013; Tung, 2016). Even though a few authors already suggested that the user's prior emotions may also be important in influencing users' perceptions of robots (e.g., Broadbent, Stafford, & MacDonald, 2009; Stafford, MacDonald, Jayawardena, Wegner, & Broadbent, 2014), to our knowledge, no-one has systematically studied these effects of prior emotions on user perceptions of robots. Broadbent and colleagues (2009) did look into the role of existing emotions and attitudes towards robots, yet they only looked into general positive and negative affect, instead of the effects of different discrete emotions on people's perceptions of the robot (which we studied in this dissertation). The experiments reported in this dissertation show that the prior emotional perspective of the user could indeed be very important in influencing users' evaluation of robots. Hence, it seems crucial in the design of robots to consider the user's perspective with regard to emotions and coping in relation to the robot's functionality and purpose: The robot's features should align not only with the intended purpose of the robot, but also with the user's perspective and emotional needs. Furthermore, not only robot design but also future theorizing in the field of HRI should incorporate both user perspectives *and* robot features: It should take into account the balance between the robot's technical possibilities and purpose(s) as well as the psychological processes that take place in the user when the user interacts (or is about to interact) with the robot.

The studies reported in this dissertation thus add to the growing literature on HRI from the perspective of prior emotions in the user. Given the fact that healthcare situations are often quite emotion-loaded, we looked into the prior emotions that users bring to the table when a social robot would be applied as an assistant or to support them, and how those emotions influence their perceptions of such a robot. Suppose, for instance, that a patient is very sad after a disappointing or unexpected diagnosis, and is being confronted with a social robot as part of the healthcare plan. This (potential) user's prior feelings may then interfere with his/her willingness to interact with the robot as well as his/her perception of the robot, which may obstruct any of the potential benefits that the robot may

provide. The results of our studies show that such prior emotions, that already exist in the user prior to meeting the robot, sometimes indeed seem to be influential for perceptions of the robot (i.e., as results of the first two studies seemed to suggest). We studied the potential effects of two theoretical perspectives on emotion in this respect: A valence-based perspective (cf. Broaden-and-build; Fredrickson, 1998; 2001), which relies on the direct effects of the valence of the emotion, and an appraisal-based perspective, which distinguishes effects according to emotion-based appraisals (cf. appraisal tendencies; Lerner & Keltner, 2000; 2001). The specific results of our first two experiments (see *Chapters 2* and *3*) showed that the valence of an emotional state did not influence the perception of the robot. The appraisal-based approach seemed to provide a better fit with the results. For instance, we found that people's emotional appraisal of coping potential (i.e., 'whether I feel I can deal with my emotion') differed between people in different emotional states, and that this appraisal of coping potential appeared to influence robot perceptions. Thus, the lack of direct effects of valence did not support the valence-based approach, whereas the finding that the emotion-based appraisal of coping potential affected perceptions of the robot seemed to lend (more) support to the appraisal-based perspective. Hence, the appraisal-based perspective seems very promising for the field of HRI, especially when it comes to social robots in the context of healthcare.

Yet, we do not feel that the valence-based broaden-and-build framework by Fredrickson (1998; 2001) should be dismissed altogether. Results seemed to suggest that people who appraised their situation as relatively easy to cope with were more positive about the robot in terms of perceptions compared to those who appraised their situation as relatively hard to cope with. This seems to support the idea that the way people appraise their ability to cope with the situation is an important factor that may determine whether or not they are open to robots. Thus, it seemed as though the appraised coping potential led to a narrowing/widening of the worldview of the participants, instead of the *valence* of the emotional state which the broaden-and-build framework suggests to be responsible for narrowing or widening of one's worldview. Additionally, one of the important assets of the broaden-and-build framework is that it considers the potential of positive emotions, whereas most emotion psychological research focuses on studying (the function of) negative emotions (Fredrickson, 1998). This potential of positive emotions also appears to show in our studies, although it is not through positive valence but rather through the

positive influence of the appraisal of coping potential. Furthermore, the broaden-and-build framework is not only focused on the short-term effects of emotional valence (which is the approach that we studied in this dissertation), but the framework is also focused on long-term effects of emotional valence. That is to say, broaden-and-build predicts not only that the experience of positive emotions *broadens* one's worldview, but the cumulative experience of positive emotions also *builds* resources to deal with future setbacks. Based on this, positive emotions experienced in the past may thus be reflected in a higher appraisal of coping potential in the present. In other words, positive emotions experienced before the current emotional state may thus build a feeling of coping potential – which in turn, as our results appeared to show, may affect people's perceptions of social robots in healthcare contexts.

Although our results in the first studies (*Chapters 2* and *3*) seemed to suggest that the appraisal of coping potential may influence people's perceptions of social robots in a healthcare context, it is essential to realize that the way in which people *think or feel* about their own potential to cope with an emotional situation does not equate their *actual* ability to cope with that emotional situation. Even though the two have been recognized as being related in prior work (e.g., Bippus & Young, 2012; Chiavarino et al., 2012; Glanz & Schwartz, 2008; Lazarus, 1999; Lazarus & Folkman, 1984), the results of the studies presented here (in *Chapters 3* and *4*) showed that the appraisal of coping potential is not directly related to the actual use of specific coping strategies. This is in line with Carver, Scheier, and Weintraub (1989), who suggested that coping strategies are not inherently (mal)adaptive or (in)effective. Thus, the choice of coping strategy (and whether or not it is effective) does not necessarily align with the appraisal of coping potential. It may very well be the case that two people who appraise their own potential to cope with an emotional situation similarly may actually choose very different strategies to cope with the situation and may be differentially successful in doing so. Furthermore, the results of the studies reported in the current dissertation suggested that the choice of coping strategy did not have an effect on the perceptions of the social robot. Thus, when considering the role of emotional coping, it is essential to make a clear distinction between the appraisal of coping potential and *actual* coping ability, or the coping strategies that an individual actually uses. Further research on the relationship between appraisals of coping potential and actual coping is thus needed to extend existing emotional coping theory.

Another important issue for further theory development relates to the finding that *actual* encounters with a robot (as reported in *Chapter 4*) seemed to yield different results than imagining an encounter with a robot through reading about it (*Chapter 2*) or interacting with a representation of a robot that is only visible on-screen (*Chapter 3*). Actually interacting with a robot as a physically present social entity apparently was quite a different experience for our participants in the two experiments reported in *Chapter 4*. This encounter with an actual humanoid robot that started talking to the participant disrupted the influence of appraised coping potential that we seemed to have found in the earlier experiments. Earlier studies that compared physically present robots to virtual or on-screen versions of the robot also found differences (e.g., Hoffman & Krämer, 2013; Jung & Lee, 2004; Powers, Kiesler, Fussell, & Torrey, 2007; Kiesler, Powers, Fussell, & Torrey; 2008), although the differences found in those studies were more related to actual behavior or the experience of the interaction. For instance, the physical presence of a robot, compared to an on-screen version thereof, led to more engagement, healthier eating behavior (Kiesler et al., 2008), more time spent on the interaction, more favorable attitudes (Powers et al., 2007), less (sensitive) information disclosure (Powers et al., 2007; Kiesler et al., 2008), more experienced social presence (Jung & Lee, 2004; Powers et al., 2007), more positive evaluations (Jung & Lee, 2004), and less experienced control over the interaction (Hoffman & Krämer, 2013). Based on the results of those studies, we would have expected that prior emotions, appraisal, and coping could explain these differences. However, in our studies, a different process seemed to have started upon encountering the physically present robot as compared to the on-screen version of the robot or reading about the robot. One possible explanation for this may be the difference in study set-up used. For instance, the aim in our studies was not to provide a comparison of a physically present robot to a virtual, on-screen version of the robot (as was the aim of those previous studies), but rather to understand the effects of prior emotions on the perceptions of a robot. Furthermore, the task that users had to perform in those previous studies was clearly different from the task in our studies. As Hoffman and Krämer (2013) showed, the nature of the task may influence people's preferences for either a virtual agent or a physically present robot. In the studies reported by Powers and colleagues (2007), Kiesler and colleagues (2008), and one of the conditions in the study by Hoffman and Krämer (2013), the participants had a persuasive interaction with the robot about their health (followed by a measure of persuasion with regard to healthy and

unhealthy food choices), while in Jung and Lee (2004) the participants merely watched and touched the robots. In the other condition in the Hoffman and Krämer (2013) study, participants had to perform a physical task (Towers of Hanoi) in as few moves as possible with the robot/agent giving them feedback. In our own studies, however, participants interacted with the robot unaware of the 'task', as they were only told they would be interacting with the robot about their health and wellbeing (i.e., the actual task was for the robot to assess information about the participants' health and wellbeing based on the MANSA questionnaire; Priebe, Huxley, Knight & Evans, 1999). Finally, those previous studies used three different types of robots (such as the small rabbit-like robot Nabaztag in the study by Hoffman & Krämer, 2013), none of which were humanoid. The robots that we used in our studies (i.e., Alice and Zora/Nao) were both humanoid social robots, which may have invoked the instantaneous application of human schemata to the robot.

In all, the physical presence of the robot – or the lack thereof in virtual versions – seems to be an important factor in theorizing on human-robot interaction. It appears as though humans respond to physically present robots as if they are responding to humans, in that they appear to apply schemata from human-human interaction to human-robot interaction (cf. Konijn & Hoorn, 2018). Findings by Konijn and Hoorn (2018) seem to suggest that this effect may be strengthened if the robot face is more human-like in appearance. We propose that seeing a virtual representation of a robot or reading about a robot is more of a cognitive process, while actually encountering a physically present humanoid robot is more of an affective process. This can be explained by the two different pathways that act in parallel for processing mediated information or encountering media figures as described by Konijn (2013). The cognitive processing of the text about a robot (in *Chapter 2*) or the video images of the robot (in *Chapter 3*) has probably led to processing through the higher pathway (i.e., reflective processing of the information about the robot), possible also because no immediate action was required and thus cognitive resources were available for such reflective processing. Meeting the robot 'in person' (in terms of its physical appearance, cf. *Chapter 4*), however, likely elicited an instantaneous response, processed fast through the lower pathway, including the older evolutionarily brain structure with the amygdala. An important point raised by Konijn (2013; and empirically tested in Konijn, Walma van der Molen, & Van Nes, 2009) is that this fast, emotion-based processing through the lower pathway can be hard to balance with reflective processing of

the encounter. Furthermore, this fast emotion-based processing colors the media experience as real (i.e., as a psychologically real experience) because the aroused feelings are real. Konijn (2013) argues that experienced emotions lend realness to the object of emotion because it signifies to the user that something of 'real' importance is going on. Physiological change accompanying emotions is thus felt as 'proof of reality' and ultimately colors the object of emotion (Konijn, 2013). Therefore, she concludes, with the lower pathway being more immediate and faster than the higher pathway, emotions that are triggered in a mediated encounter demand time and effort of the individual to reflect on the mediated or artificial nature of that encounter. In this view, it can be understood why the 'artificially' induced emotions through a recall or scenario procedure in the lab may have been overruled by the 'real' emotions evoked by encountering a physically present humanoid robot that started talking like a 'real human being'.

Importantly, the fact that we did not find the relationship between the appraisal of coping potential and perceptions of the robot in the studies in which people interacted with the physically present robot (in *Chapter 4*) may have also been caused by a novelty effect of the robot. For many participants, their participation in our studies marked their first real-life encounter with a robot. It could very well be that the effects of prior emotions (or, to be more precise, the appraisals accompanying these emotions) are reinstated when the novelty effect has worn off and people are more accustomed to and experienced with interacting with robots. Furthermore, the situation in which people will encounter such robots in real-life are also likely to be different in that actual healthcare circumstances are likely to be related to very intense and *real* emotions, especially when compared to emotions induced in a lab situation, and things might turn out quite differently when these actual situations and *actual* emotions come into play. Such *actual* emotions may turn out to be much stronger, more impactful, and/or longer lasting compared to our lab-induced emotions and may not be disrupted by some novelty effect of meeting a robot. Or perhaps the novelty effect only disrupts the effects of the prior emotions only temporarily, and because these people may have to interact with the robot on a more regular basis as part of their healthcare plan it may be the case that the emotion-based appraisals may return to influence their perceptions of the robot as in our first two studies (*Chapter 2* and *3*). Thus, if people become more accustomed to robots, if they gain more experience with robots, or if they encounter robots in an actual, emotionally intense healthcare context, it might well be that influence of prior

emotions (or, to be exact, of the appraisals accompanying these prior emotions) may crop up again.

Finally, the studies presented in this dissertation show the importance of a multi-dimensional approach to understanding how people perceive humanoid social robots in different contexts. For the perceptions, we applied the I-PEFiC framework (cf. Van Vugt, Hoorn, & Konijn, 2009) in this dissertation from the idea that forming a perception of a humanoid social robot in view of its possible role in interacting in a healthcare context goes beyond simply (dis)liking the robot. Forming perceptions is a more elaborate and partly affect-based process that often goes hand in hand with experiencing a socio-affective bond (cf. Van Vugt et al., 2009; Hoorn & Winter, 2017; Konijn & Hoorn, 2017). On the one hand, this process involves the encoding of robot characteristics in terms of 'input' (e.g., affordances, ethics, etc.). On the other hand, a comparison process is involved in which the user compares how the 'input' of the robot matches the user's goals, needs, and wishes. The 'output' of these processes is balanced in a response based on the (mis)match between the encoding and comparison phases that include both involvement and distancing processes and both cognitive and affective evaluations. These evaluations are processed in parallel such that the 'outcome' will be defined by a trade-off between affective involvement tendencies and more reflective detachment/distancing tendencies (cf. Konijn & Hoorn, 2005; 2017). Together, the entire process predicts the extent to which people will appreciate the robot in its broadest sense, including liking and acceptance. It is thus important to not only look at people's liking of the robot or their attitude towards the robot (i.e., the response phase in I-PEFiC) when assessing people's perceptions of the robot, but also at the encoding and comparison phases and the (mis)match of robot features to user's goals to get a more complete picture of how the user relates to the social robot.

Methodological considerations

Limitations and recommendations

An important limitation of the studies reported here is the fact that the emotion induction procedures used did not produce the strong emotions that we expect in actual healthcare situations. Even though we took great care in choosing the way we manipulated emotions,

we still encountered problems related to the relatively weak induction of emotions in our studies. In the study reported in *Chapter 3*, for instance, we found that half of the participants did not really experience the intensity of emotion that we intended. This problem with the efficacy of our emotion induction procedures is, however, not unique to our studies, as evidenced by results from meta-analyses by Angie, Connely, Waples, and Kligyte (2011) and Lench, Flores, and Bench (2011). Both these meta-analyses showed that emotion induction via recall or scenarios led to relatively small effect sizes, especially when compared to emotion induction via movie clips. However, using movie clips to induce emotions brings other problems to the table, such as the content of the clips that may also have an effect on the variables of interest (Lench et al., 2011). Additionally, film clips may also induce more empathic emotions instead of personally experienced emotions. For instance, when inducing sadness through the use of a video about a character falling terminally ill, the induced sadness in the participant may be hard to discern from the empathy that the participant feels for the character in the movie. Because we deemed the personal relevance of emotions crucial for our studies, we therefore chose to use recall and scenario methods despite the larger effect sizes that may be sorted when using film clips to induce emotions. In addition, one might argue about the general nature of emotion induction procedures and their efficacy as compared to naturally occurring emotions. When we are inducing emotions to see what the effects are on people's perceptions or judgments, can we really know if we really measure the effects of the (induced) emotions? Or do we perhaps measure the effects of people's expectation with regard to the effects of those emotions? In other words, we have to wonder how *real* induced emotions (and their effects) are in relation to actual emotions.

Another limitation of the studies reported here is related to sampling. Participants in the experiments were recruited from a participant pool in a university setting or through convenience sampling. We recognize that these participants are, generally speaking, not the type of people that are the first to be confronted with robots in healthcare settings. However, studying the effects of emotions, appraisals and coping among the participants within a controlled environment did offer the possibility to study the underlying mechanisms at work in influencing perceptions of social robots. It would have been much more difficult, if not impossible, to do the same in a field research setting, as field research is inherently associated with complexities such as ethical issues, distraction, unintended

confounds, availability of participants, etc. Nevertheless, now that we know more about the role of emotions and coping in affecting perceptions of robots in controlled environments, it is important to study these mechanisms in more natural environments (such as actual patient groups that are likely to be confronted with healthcare robots in the near future). For instance, interviewing actual patients about their emotional experiences in relation to their health might reveal important information about the effects that their prior emotions may have in real-life. Furthermore, observations of patients (not) interacting with social robots in healthcare situations combined with interviews of their experiences with the robot may provide valuable information with regard to the possible effects of emotions, appraisals and coping in real-life.

In terms of methodology, we measured quite a large number of variables in the studies reported in this dissertation. For instance, in the studies reported in *Chapter 4*, we measured perceptions with nine I-PEFiC subscales (Van Vugt, Konijn, Hoorn, & Veldhuis, 2009), coping strategies with five scales based on the Brief COPE questionnaire (Carver, 1997), *and* four appraisal dimension scales. Because our theoretical basis did not allow excluding any variables a priori, we decided to retain all of them. However, in combination with the number of participants in our experiments, our studies may have been somewhat underpowered. Nevertheless, the two experiments reported in *Chapter 2* and *3* did find stable, significant results, which suggests that our results show up even when the balance between the number of participants and the number of variables is somewhat at odds. It is thus advisable to restrict the number of variables and to increase the number of participants in future studies.

Furthermore, when participants interacted with the humanoid robots Alice or Zora/Nao in the studies of *Chapters 3* and *4*, they all performed the same task with the robot. This interaction was modeled after the Manchester Short Assessment of Quality of Life (MANSA; Priebe et al., 1999), and more closely resembled an interview (cf. a healthcare intake) than a conversation. Several participants noted (either implicitly or explicitly) that they felt that the conversation with the robot was unnatural. For instance, when Zora/Nao introduced herself at the start of the conversation ("Hi, my name is Zora"), participants instantaneously introduced themselves in return, thereby interrupting Zora/Nao's next question ("and what is your name?") because the script was predefined. Similarly, some participants started to ask Zora/Nao questions, which Zora/Nao could not

respond to due to the scripted fixed protocol. A more natural conversation would probably have made a difference for several participants, although introducing more freedom in the conversation also means that the environment becomes less controlled, thus making it harder to compare results. Finding the right balance between experimental control and a natural feel to the conversation with the robot is an important challenge for future studies in social robotics.

Related to the aforementioned point is that the task performed with the social robot was the same in the experiments reported in *Chapters 3* and *4*. In all cases, the participants' interaction with the robot about their health and wellbeing was based on the MANSA questionnaire (Priebe et al., 1999). Thus, we used a single task in all studies, the nature of which was purely informative and communicative. However, a study by Hoffmann and Krämer (2013) showed that the nature of the task may also be of influence on people's preferences for either a virtual agent or a robot: They found that a robot was preferred for execution of specific tasks (e.g., how to efficiently solve a Towers of Hanoi task), whereas the virtual agent was preferred for conversational/persuasive purposes (e.g., persuading the participant to eat more healthy foods and exercise more). This may also explain why the results of the experiments in *Chapter 4* were different from those in *Chapter 3*, since the interaction in *Chapter 3* used on-screen videos whereas the interactions in *Chapter 4* took place with a physically present robot. The main advantage of using the same task in all of our experiments was the fact that results could be compared between studies, which would have been virtually impossible if we would have adapted the task (especially in light of the changes in the interaction setting and robot). More research is needed into the influence of task content and context on perceptions of robots, especially in relation to the influence of prior emotions.

Methodological strengths

This dissertation includes four different experiments that tested the influence of prior emotions, related appraisals and coping on how people perceive robots in different environments. We tested emotional effects in people's own chosen environment (i.e., in *Chapter 2* people could participate online) and in different lab situations (in *Chapters 3* and *4*). Furthermore, the first two experiments used robot Alice, whereas robot Zora/Nao was

used in the experiments reported in *Chapter 4*. In doing so, we ensured that the emotional effects were tested in a variety of environments, which adds to the ecological validity of the studies' results. Another strong point of the current dissertation is the fact that we used different methods to induce emotions in participants, based on emotion literature. In the first two studies we used a recall procedure (cf. Lerner & Keltner, 2001; Small & Lerner, 2008), whereas we used a scenario method in the studies reported in *Chapter 4* (cf. Green & Sedikides, 1999; Harmon-Jones, Sigelman, Bohlig, & Harmon-Jones, 2003). The recall procedure has the advantage that the emotion induced is personally relevant, that it has the potential to induce quite intense emotions, and it does not prescribe the cognitive content of the emotion (Lench et al., 2011). However, it also has some disadvantages, such as inability to determine whether the current experience of the recalled emotion is similar to the actual (past) experience of the emotion, that successful induction depends on the willingness of participants to actually engage in recalling the emotion (Lench et al., 2011), and that there is no real standardization possible (i.e., participants may all recall different emotional experiences). The scenario method has the advantage that standardization is possible while still providing the opportunity to relate the scenario to their own experiences (Lench et al., 2011). Similar to the recall method, however, participants must be willing to engage in the scenario for the induction to be successful. Both emotion induction methods thus have their advantages and disadvantages (cf. Angie et al., 2011; Lench et al., 2011). Using both these methods provided us with the opportunity to see whether the effects of both methods were equally effective, and results of pretesting showed that this was the case. Thus, even though effects of our emotion induction procedures were rather small (in line with meta-analyses by Angie et al., 2011 and Lench et al., 2011), using both these methods added to the validity of our results.

Furthermore, the studies presented in this dissertation are strongly theory-driven, thereby answering a call for more theory-driven research in human-robot interaction (Eyssel, 2017). The hypotheses in all studies were based on well-developed theoretical frameworks such as the broaden-and-build theory (Fredrickson, 1998; 2001) and the appraisal-tendency framework (Lerner & Keltner, 2000; 2001). In using these theoretical frameworks, we relied on two prevailing theoretical approaches in the emotion literature. The theory-driven nature of the studies is further strengthened by the use of validated measures, such as the Brief COPE (Carver, 1997) and I-PEFiC (e.g., Konijn & Hoorn,

2005; Van Vugt et al., 2009; Van Vugt, Hoorn, Konijn & De Bie Dimitriadou, 2006). These are strong points especially in view of other studies in the field that used single attitude or liking scales to assess participants' perceptions of the robot (e.g., Broadbent, Kuo, Lee, Rabindran, Kerse, Stafford, & MacDonald, 2010; Stafford et al., 2014).

Future research

Besides some of the suggestions already discussed in the previous sections, the studies reported in the current dissertation provide plenty of new and interesting research lines for the future. First of all, we would like to stress the importance of replication studies, for which the current studies provide guidelines. Next, as already discussed in the section on theoretical implications, it is intriguing that actually interacting with a social robot seems to be a very different experience than interacting with an on-screen robot; let alone reading about it in the media. By the same token, it is not unthinkable that interacting with a robot one single time in a lab may be a distinct experience from having regular interactions and actually forming a bond with a robot at home. Actually using a robot for a longer period of time may have different consequences with regard to the formation of perceptions about the robot as well as feelings of bonding with the robot. Therefore, longer-term studies are needed to study not only these processes, but also the influence of user emotions on these processes. Furthermore, the predominant challenge for future research lies in trying to capture these effects and processes in systematic research in the field.

This dissertation employed humanoid social robots, modeled to resemble humans to some extent for communicative purposes. Both Alice and Zora/Nao are humanoids with a face that resembles a human face, moving eyes, a mouth and ears, and they have a body with two arms and two legs. If we had used a social robot such as Paro – a seal-like robot – our results may have been different due to differences in expectations about the robot (i.e., we do not expect a seal robot to behave humanlike or start a conversation, whereas we do have such expectations about a human-looking robot). This is in line with the theory of affective bonding (Konijn & Hoorn, 2017), which suggests that these kinds of robots have affordances that make that people respond to the robot (almost instantaneously) as if it were human and apply human schemata to conversing with a humanoid robot (cf. Computers as

Social Actors; Nass, Steuer, & Tauber, 1994; Reeves & Nass, 1996), and these affordances also shape the relationship between person and robot. Based on the results found by previous researchers (Hoffman & Krämer, 2013; Jung & Lee, 2004; Powers, Kiesler, Fussell, & Torrey, 2007; Kiesler, Powers, Fussell, & Torrey; 2008) with non-humanoid robots, we predict that different kinds of robots may have differential effects on how (potential) users perceive them. However, future research is needed to show whether the effects of prior emotions also manifest themselves with other kinds of robot than humanoid social robots, or rather that these effects are unique for humanoid social robots.

Practical implications

Complementary to the theoretical contributions of the current dissertation, there is a range of implications for the use of social robots in healthcare practice. First of all, the results of the latter two studies (reported in *Chapter 4*) suggest that an actual interaction may be a different experience for the user compared to an interaction with an on-screen robot or reading about a robot. Furthermore, participants' non-verbal reactions in the lab suggested that it might take some time for people to get accustomed to interacting with a robot. People need some time to adjust to the idea of talking to a robot, and may at the same time be trying to figure out how exactly the robot works. We saw in practice in the last experiment that users already got used to interacting with the robot a bit more compared to the first time meeting the robot at the start of the study, as evidenced by a lower number of interruptions in the conversation. Thus, even though interaction with a robot may seem mostly intuitive, in practice there still is a little bit of a learning curve involved. This is important to keep in mind when presenting people with a robot.

Related to this learning curve is the natural feeling of the interaction with the robot. A number of participants clearly showed a little discomfort with the robot due to the lack of smooth conversation. It felt unnatural to these participants. In our experience, the robot interaction was smoother when the robot used non-verbal signals (such as hand and arm gestures), as it could gesture that it was about to speak. Additionally, similar small non-verbal features (such as gaze, body movement, gestures, etc.) can help in making the conversation appear more natural. Finally, the nature of the conversation in the current study did not really allow for 'free', unscripted conversation with the robot, but in practice,

this could also make a world of difference with regard to the natural feeling of the conversation.

Besides making human-robot interaction feel more natural, it is important we think about the contexts in which we deploy robots. Not all situations or patients may benefit equally from a robot being introduced. Even though the research described here only touches upon a small part of this context (i.e., the effects of prior emotions), it seems wise not to confront anyone with a robot that experiences intense emotions that s/he appraised as potentially very hard to cope with. Apart from these emotional contexts, one might also have to consider ethical aspects of the situation. Questions arise such as: Do we want to deploy robots for particular groups (e.g., demented elderly, physically challenged people), or do we want everyone to be able to benefit equally? What are the consequences of robotic interactions for different kinds of user groups? What happens to users (and their cognitions and emotions) when the robot breaks down, or when the robot is taken away after a period of time? And is it okay to 'fool' people who are unaware of the robotic nature of their interaction partner? Of course, these questions go beyond the scope of the current dissertation, yet these are important questions that have to be taken into account when robots are actually deployed in practice.

Finally, another important point to consider when introducing robots to actual users is the emotions and coping abilities that people (think they) have. As the results of the studies in this dissertation have shown, people's emotions and appraised coping potential may affect the way in which people perceive robots. When they appraise their emotional situation as potentially hard to cope with, they perceive the robot less positive (compared to those who appraised their situation as potentially easy to cope with). These less positive perceptions may in practice lead to the dismissal of a robot when people have the choice. In other words, when people are preoccupied with their own emotional troubles, they may not be open to a robot, and thus not benefit from the potential the robot offers them. It is thus wise to carefully consider not only *whom* we give such a robot to, but also *when* we give it to them.

References

Angie, A.D., Connelly, S., Waples, E.P., & Kligyte, V. (2011). The influence of discrete emotions on judgement and decision-making: A meta-analytic review. *Cognition and Emotion, 25*(8), 1393-1422. doi: 10.1080/02699931.2010.550751

Bippus, A.M., & Young, S.L. (2012). Using appraisal theory to predict emotional and coping responses to hurtful messages. *Interpersona, 6*(2), 176-190. doi: 10.5964 /ijpr.v6i2.99

Broadbent, E., Kuo, I.H., Lee, Y.I., Rabindran, J., Kerse, N., Stafford, R., & MacDonald, B.A. (2010). Attitudes and reactions to a healthcare robot. *Telemedicine and e-Health, 16*(5), 608-613. doi: 10.1089/tmj.2009.0171

Broadbent, E., Stafford, R., & MacDonald, B. (2009). Acceptance of healthcare robots for the older population: Review and future directions. *International Journal of Social Robotics,* 2009(1), 319-330. doi: 10.1007/s12369-009-0030-6

Carver, C.S. (1997). You want to measure coping but your protocol's too long: Consider the Brief COPE. *International Journal of Behavioral Medicine, 4*(1), 92-100. doi: 10.1207/s15327558ijbm0401_6

Carver, C.S., Scheier, M.F., & Weintraub, J.K. (1989). Assessing coping strategies: A theoretically based approach. *Journal of Personality and Social Psychology, 56*(2), 267-283. doi: 10.1037//0022-3514.56.2.267

Chiavarino, C., Rabellino, D., Ardito, R.B., Cavallero, E., Palumbo, L., Bergerone, S., … Bara, B.G. (2012). Emotional coping is a better predictor of cardiac prognosis than depression and anxiety. *Journal of Psychosomatic Research, 73*(6), 473-475. doi: 10.1016/j.jpsychores.2012.10.002

Eyssel, F. (2017). An experimental psychological perspective on social robotics. *Robotics and Autonomous Systems, 87*, 363-371. doi: 10.1016/j.robot.2016.08.029

Fredrickson, B.L. (1998). What good are positive emotions? *Review of General Psychology, 2*(3), 300-319. doi: 10.1037/1089-2680.2.3.300

Fredrickson, B.L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *The American Psychologist, 56*(3), 218-226. doi: 10.1037/0003-066X.56.3.218

Glanz, K., & Schwartz, M.D. (2008). Stress, coping, and health behavior. In K. Glanz, B.K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education: Theory, research, and practice* (pp. 211- 236). San Fransico, CA: Jossey-Bass.

Green, J.D., & Sedikides, C. (1999). Affect and self-focused attention revisited: the role of affect orientation. *Personality and Social Psychology Bulletin, 25*(1), 104-119. doi: 10.1177/0146167299025001009

Harmon-Jones, E., Sigelman, J.D., Bohlig, A., & Harmon-Jones, C. (2003). Anger, coping, and frontal cortical activity: The effect of coping potential on anger-induced left frontal activity. *Cognition and Emotion, 17*(1), 1-24. doi: 10.1080 /02699930143000635

Heerink, M., Kröse, B., Evers, V., & Wielinga, B. (2006). The influence of a robot's social abilities on acceptance by elderly users. *Proceedings of 15th IEEE international workshop on robot and human interactive communication (RO-MAN)*, pp. 521-526. doi: 10.1109/ROMAN.2006.314442

Hoffmann, L., & Krämer, N.C. (2013). Investigating the effects of physical and virtual embodiment in task-oriented and conversational contexts. *International Journal of Human-Computer Studies, 71*(7-8), 763-774. doi: 10.1016/j.ijhcs.2013.04.007

Hoorn, J.F., & Winter, S.D. (2017). Here comes the bad news: Doctor robot taking over. *International Journal of Social Robotics.* Advance online publication. doi: 10.1007/s12369-017-0455-2

Jung, Y., & Lee, K.M. (2004). Effects of physical embodiment on social presence of social robots. *Proceedings of PRESENCE 2004*, 80–87.

Kiesler, S., Powers, A., Fussell, S.R., & Torrey, C. (2008). Anthropomorphic interactions with a robot and robot-like agent. *Social Cognition, 26*(2), 169-181. doi: 10.1521 /soco.2008.26.2.169

Konijn, E. A. (2013). The role of emotion in media use and effects. In K. Dill (Ed.), *The Oxford handbook of media psychology* (pp. 186-211). New York/London: Oxford University Press.

Konijn, E.A., & Hoorn, J.F. (2005). Some like it bad: Testing a model for perceiving and experiencing fictional characters. *Media Psychology, 7*(2), 107-144. doi: 10.1207 /S1532785XMEP0702_1

Konijn, E.A., & Hoorn, J.F. (2017). Parasocial interaction and beyond: Media personae and affective bonding. In P. Rössler, C.A. Hoffner, & L. van Zoonen (Eds.), *The international encyclopedia of media effects*. Wiley Blackwell. doi: 10.1002/9781118783764.wbieme0071

Konijn, E.A., & Hoorn, J.F. (2018). *Differential facial expressivity in humans and robots elicit different levels of responsiveness, empathy, and projected feelings*. Abstract accepted for presentation at the Technology, Mind, and Society conference of the American Psychological Association, to be held April 5-7, 2018 in Washington D.C., USA.

Konijn, E.A., Walma-Van der Molen, J.H., & Nes, S. van (2009). Emotions bias perceptions of realism in audiovisual media: Why we may take fiction for real. *Discourse Processes, 46*(4), 309-340. doi: 10.1080/01638530902728546

Lazarus, R.S. (1999). *Stress and emotion: A new synthesis*. New York, NY: Springer Publishing Company.

Lazarus, R.S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York, NY: Springer Publishing Company.

Lench, H.C., Flores, S.A., & Bench, S.W. (2011). Discrete emotions predict changes in cognition, judgment, experience, behavior, and physiology: A meta-analysis of experimental emotion elicitations. *Psychological Bulletin, 137*(5), 834-855. doi: 10.1037/a0024244

Lerner, J.S., & Keltner, D. (2000). Beyond valence: Towards a model of emotion-specific influences on judgment and choice. *Cognition and Emotion, 14*(4), 473-493. doi: 10.1080/026999300402763

Lerner, J.S., & Keltner, D. (2001). Fear, anger, and risk. *Journal of Personality and Social Psychology, 81*(1), 146-159. doi: 10.1037/0022-3514.81.1.146

Powers, A., Kiesler, S., Fussell, S., & Torrey, C. (2007). Comparing a computer agent with a humanoid robot. *Proceedings of the ACM/IEEE international conference on human-robot interaction*, pp. 145-152. doi: 10.1145/1228716.1228736

Priebe, S., Huxley, P., Knight, S., & Evans, S. (1999). Application and results of the Manchester Short Assessment of Quality of Life (MANSA). *International Journal of Social Psychiatry, 45*(1), 7-12. doi: 10.1177/002076409904500102

Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places.* Stanford, CA: CSLI Publications.

Robinson, H., MacDonald, B., Kerse, N., & Broadbent, E. (2013). The psychosocial effects of a companion robot: A randomized controlled trial. *Journal of the American Medical Directors Association, 14*(9), 661-667. doi: 10.1016/j.jamda.2013.02.007

Small, D.A., & Lerner, J.S. (2008). Emotional policy: Personal sadness and anger shape judgments about a welfare case. *Political Psychology, 29*(2), 149-168. doi: 10.1111/j.1467-9221.2008.00621.x

Stafford, R.Q., MacDonald, B.A., Jayawardena, C., Wegner, D.M., & Broadbent, E. (2014). Does the robot have a mind? Mind perception and attitudes towards robots predicts use of an eldercare robot. *International Journal of Social Robotics, 6*(1), 17-32. doi: 10.1007/s12369-013-0186-y

Tung, F.-W. (2016). Child perception of humanoid robot appearance and behavior. *International Journal of Human-Computer Interaction, 32*(6), 493-502. doi: 10.1080/10447318.2016.1172808

Van Vugt, H.C., Hoorn, J.F., Konijn, E.A., & De Bie Dimitriadou, A. (2006). Affective affordances: improving interface character engagement through interaction. *International Journal of Human-Computer Studies, 64*(9), 874-888. doi: 10.1016/j.ijhcs.2006.04.008

Van Vugt, H.C., Hoorn, J.F., & Konijn, E.A. (2009). Interactive engagement with embodied agents: An empirically validated framework. *Computer Animation and Virtual Worlds, 20*(2-3), 195-204.

Van Vugt, H.C., Konijn, E.A., Hoorn, J.F., & Veldhuis, J. (2009). When too heavy is just fine: Creating trustworthy e-health advisors. *International Journal of Human-Computer Studies, 67*(7), 571-583. doi: 10.1016/j.ijhcs.2009.02.005

Summary

The increasing pressure on healthcare, due to decreasing resources, shrinking workforces, and an aging population, creates the necessity for solutions that enable us to provide everyone with the care that is needed while at the same time relieving (some of) the pressure on healthcare. One of the potential solutions for this problem is the deployment of technology such as robots. However, people that oppose the use of robots and other technology in healthcare note that caring is not just about performing practical tasks, but also about the patient's experience. In fact, patients also have emotions and cognitions that have to be taken care of. Thus, it is essential to take this experience into account when considering potential solutions for healthcare. After all, it is not unthinkable that a patient in a negative emotional state will not be open to a healthcare robot, and if that is the case it may not be the right choice to turn to robots to relieve the pressure on healthcare. Therefore, this dissertation is focused on the influence that emotions may have on people's perceptions of robots in a healthcare context.

The studies reported in this dissertation are centered around the influence of emotions on the perceptions that people have of humanoid social robots in the healthcare domain. Humanoid social robots are characterized by humanlike looks and behavior. For instance, they have legs, arms, and a face just like us, and they are increasingly able to behave and communicate like us. Thus, the focus of this dissertation is not on robots that can perform all kinds of practical tasks (such as vacuum robots) or that monitor the user (such as fall detection robots), but we focus explicitly on robots that are meant to communicate with human users (i.e., social robots). We used two different social robots in our research: Alice and Zora (see *Chapter 1* for pictures of both robots).

In the emotion literature, we found two theories that provide a possible explanation for how and why people's emotions may influence their perceptions of social robots such as Alice and Zora. The first of the two theories, Barbara Fredrickson's (1998; 2001) broaden-and-build theory, is based on the valence of an emotional state. According to this theory, negative emotions make people focus their attention to the issue at hand (i.e., it narrows their focus), whereas positive emotions lead to a broader and more open focus. From this, it seems logical to expect that people that experience positive emotions see more possibilities with the robot and will be more open for robots compared to people that

experience negative emotions. Thus, based on this theory, the valence of an emotional state plays a crucial role in influencing perceptions of robots. The other theory, the appraisal-tendency theory by Lerner and Keltner (2000; 2001), assumes that not only the valence of an emotion matters, but also several other appraisal dimensions related to the emotional situation may be important in influencing perceptions of a robot. Different emotional states are characterized by distinct patterns of these appraisals. For instance, anger and fear are both appraised as having negative valence, yet anger is characterized in addition by appraisals of other-responsibility, high personal control, and certainty, whereas fear is characterized by appraisals of low personal control and uncertainty about the emotional situation. Based on this, the appraisal-tendency theory predicts that the appraisals associated with an emotional state may lead to a tendency to appraise future situations in a similar fashion. For instance, the appraisal-tendency theory predicts that fearful people have a higher tendency to appraise future situations as uncertain compared to angry people. Similarly, people that experience different emotions will have different appraisal tendencies when they are confronted with a robot, even if those people experience emotions of the same emotional valence. Thus, based on the broaden-and-build theory we may expect that the valence associated with one's emotional state influences his/her perceptions of a robot, whereas the appraisal-tendency theory predicts that differences in appraisals between emotional states may lead to differences in the influence on perceptions of the robot.

To study the influence of users' existing emotions on their perceptions of robot Alice and the fit of both these theoretical perspectives with our results, we performed a first experiment (N = 184) in *Chapter 2*. To assess the fit of the two theories with regard to the influence of emotions on perceptions of the robot, we compared different emotional states in the experiment. We used both negative and positive emotional states to study the role of valence. Additionally, we used multiple emotional states that were characterized by different appraisal patterns, so that we could study the influence of appraisals (i.e., we used multiple negative and positive emotional states). Study participants were instructed to recall a situation related to healthcare or illness in which they experienced the emotion that was randomly assigned to them (for example, sadness due to pain and loneliness during a long period of illness). Next, they read a (fictitious) newspaper article about robot Alice that was going to be introduced as a healthcare robot, followed by a questionnaire to assess their perceptions about Alice. Results of this experiment seemed to suggest that the people in the

different emotional states did not directly differ from one another with regard to their perceptions of robot Alice. Yet, as expected, the emotional states did turn out to be related to different appraisals. Of those appraisals, the appraisal of coping potential (i.e., an evaluation of beliefs about one's ability to cope with their emotions) did appear to influence some of the perceptions that people had about robot Alice. Participants who appraised their potential to cope with their emotions as high had generally more positive perceptions about the robot than participants who appraised their potential to cope with their emotions as rather low. Thus, the appraisal-tendency theory seemed to provide a better fit with the results than did broaden-and-build theory.

The aim of the next study (in *Chapter 3*) was to further study the role of appraisals and coping. Specifically, we wanted to study how emotion-related appraisals would influence the coping strategies that participants (N = 132) used and how those coping strategies in turn would affect the perceptions of the robot. In the literature on coping, a distinction is made between problem-focused and emotion-focused coping strategies. The first are aimed at changing or tackling the problematic situation that is causing the emotion, while the latter are aimed at changing the emotion itself. Earlier studies suggested that appraisals of control or power could be related to the choice of coping strategies. That is, when people experience control or power over an emotion-invoking situation, they are more likely to choose problem-focused coping strategies compared to people who do not experience control or power over an emotion-invoking situation (whom are more likely to choose emotion-focused coping strategies). To see whether this also played a role in influencing the perceptions of the robot, we did not only ask participants to recall a situation in which they experienced a particular emotion, but we also asked them to think of a situation that was either really hard to cope with (i.e., low coping potential), or relatively easy to cope with (i.e., high coping potential). After this recall procedure, participants talked to robot Alice via on-screen videos. In line with the findings from our previous study, the results seemed to suggest that participants that appraised their coping potential as high had more positive perceptions about the robot than participants that appraised their coping potential as low. Even though we did expect an influence of the appraisal of coping potential on the coping strategies that people would use, the experiment did not provide support for this hypothesis. However, results hinted that the use of the positive emotion-focused coping strategy was positively related to perceptions of the robot, whereas the use

of other coping strategies was not related to perceptions of the robot. So, we again seemed to have found that the emotions indirectly influenced perceptions of the robot via the extent to which people though they would be able to cope with their emotions (i.e., the appraisal of coping potential) and the use of the positive emotion-focused coping strategy.

In order to see whether we could replicate these findings when participants were to talk to a physically present robot (instead of talking to the robot on a screen), we performed two additional experiments in *Chapter 4*. This time, we used a different procedure to induce emotions and high or low coping potential: Instead of asking participants to recall an emotional situation participants were asked to imagine an emotional scenario. The participants in the first experiment in *Chapter 4* (N = 101) were instructed to have a conversation with robot Zora after having read (and imagined) the emotional scenario. These participants were told that they would be participating in a study about emotional experiences, and thus did not know beforehand that they would talk to a robot during the experiment. Interestingly, this experiment led to different results than the two earlier experiments (in *Chapters 2* and *3*) in that we did not find the influence of the appraisal of coping potential in this experiment. We reasoned that this may have been due to the surprise effect that the sudden presence of the robot had on the participants. After all, it was the first time that the majority of the participants met a real-life humanoid robot, let alone that they had any experience in talking to such robots. In hindsight it make sense that such a new experience could cancel out any previous (emotional) influences. Therefore, we decided to replicate this experiment, yet this time we informed participants (N = 110) beforehand that the study would entail talking to a robot as well as letting the participants have a short 'practice talk' with the robot before they were instructed to recall any emotions (using the same emotional scenario method). Again, we could not replicate the results of the first two experiments, nor any of the hypothesized effects via the use of coping strategies. It seemed as though physically meeting and talking to the robot triggered other influences for the participants than the emotional influences that were found when reading about a robot or talking to the robot on a screen. This finding is very relevant in light of the fact that quite some research on robots is being done using pictures and on-screen versions of robots, while our studies show that meeting a robot 'in the flesh' appears to be a different experience than meeting a virtual or 2d version of a robot.

In *Chapter 5*, the General Discussion, we discuss the conclusions that can be drawn from our studies as well as how they relate to the existing research literature. The results of the first two experiments in particular seem to provide some theoretical support for the appraisal-tendency theory, as the appraisal of coping potential appears to play an important role in influencing the perceptions that participants had of the robot. However, this does not mean that we should bluntly dismiss the broaden-and-build theory. In fact, the finding that people who appraised their coping potential as high were more positive about the robot than people who appraised their coping potential as low could be an indicator that it might not so much be emotional valence but rather that it may be the appraisal of coping potential that can influence whether or not a person is willing to engage with a robot. Another important finding from our studies is the fact that the physical presence of the robot seems to have led to different results compared to the studies in which the robot was not physically present. It appeared as though actually meeting a physically present robot led to a different way of processing of the robot compared to when people only read about the robot or talked to it on-screen. Particularly, physically meeting a robot appeared to activate a process in which schema's that we have about human-human interaction were applied to human-robot interaction. However, it is also very well possible that the fact that we did not find the same results in the latter two studies (reported in *Chapter 4*) as we did in the first two studies (in *Chapters 2* and *3*) could be related to the surprise about meeting the robot, or the fact that meeting a robot was such a new experience. Perhaps the influence of existing emotions may show up again when people are becoming more experienced and proficient with robots.

Besides discussing the conclusions and theoretical implications, we also discussed several methodological strengths and weakness of our studies in *Chapter 5*. For instance, our studies showed that inducing emotions was not an easy feat. We explicitly looked for rather intense emotional experiences that are similar to those actually found in healthcare contexts. Yet, despite our best efforts to find fitting and relevant emotion induction procedures, it appeared to be quite difficult for most participants to really engage emotionally with the emotion induction procedures. For this reason, we used two different procedures to induce emotions (i.e., recalling an emotional experience and reading an emotional scenario) in our studies. Nevertheless, it still appeared difficult for participants to really imagine or recall the emotional experience, which is a known problem in emotion

research. The use of both methods to induce emotions is at the same time also a strong point, as it allowed us to take advantage of the benefits of both methods without losing sight of the relevance of the emotion to the user (the latter sometimes being the case when using videos or music to induces emotions). Another strength of this dissertation is the fact that it is highly theory-driven, based on literature from human-robot interaction as well as literature on emotion and coping. Thus, our results also provide valuable guidelines for new research in these fields.

One of the important challenges for future research is to try to replicate these findings in studies in both the lab as well as the field. Furthermore, it is interesting to study these emotional influences on the longer term and with different kinds of physically present robots. As discussed earlier, the influence of emotions on perceptions of the robot (as we seemed to have found in *Chapters 2* and *3*) may again resurface when people get more accustomed to robots. So it would be interesting to study the long-term influence of existing emotions among users on their perceptions of robots, but also on their willingness to interact with the robot, and the way they bond with robots. Furthermore, it is important to consider that the results in this dissertation all came from controlled lab environments, mostly using a student population. This guided us to interesting insights about the role of emotions, appraisals, and coping, yet at the same time this makes it difficult to translate our results to everyday practice. Of course, (potential) users will not meet robots in such controlled environments when robots are deployed in actual healthcare settings. Thus, to better understand how emotions, appraisals, and coping may actually have an influence in practice, research in the field is needed in which the way patients and robot interact are studied in great detail, as well as studying these patients' emotional and coping experiences. In addition, we limited ourselves to one interaction task with the robot in the studies reported in this dissertation (i.e., an interview to gain information about the participant). Perhaps the influence of emotions on perceptions of the robot would be different if other kinds of interaction tasks were performed (such as jointly solving a puzzle, or the robot trying to convince the user to behave more healthily), although more research is needed to see if this is indeed the case.

Finally, we also discuss some practical implications in *Chapter 5*. For instance, the studies in this dissertation seem to suggest that users probably need some time to get used to talking to robots. From our personal observations during the last experiment, we saw that

participants already appeared to be more at ease with talking to the robot if they had a short talk with the robot before the emotion induction procedure. Related to this was the fact that some participants in the experiments in *Chapter 4* indicated that the conversation with the robot had a somewhat artificial, unnatural feel to them, which may have been caused by the strict protocol that was followed to ensure that all participants experienced the conversation with the robot similarly. Less artificial conversations could very well be possible in practice, for instance by letting the conversation flow more freely and by letting the robot use non-verbal behaviors such as gaze or gestures. Furthermore, it is important to think about the ethical aspects related to the deployment of robots in actual healthcare situations. One may, for instance, wonder about the moral acceptability of using robots to fob off patients in desperate need of care. Or about who will be responsible if a patient has really bonded with a robot and the robot breaks down. Or about what happens to the data that the robot collects, who is able to see these data and how we can ensure that these data are protected. These are the kinds of questions that become increasingly important when robots are deployed in actual healthcare settings.

In all, it seems to be important to account for the user's emotions and appraisal of coping potential when robots are introduced. It appears that it may not be beneficial to confront people with a healthcare robot when they experience emotions that they appraise as very hard to cope with (regardless of the valence of their emotions and their actual ability to cope with their emotions). When people appraise their emotional situation as hard to cope with (i.e., low coping potential), they appear to be be less positive about the robot and subsequently they may be dissatisfied with the way they are cared for. The results of these studies thus show that it seems important to take into account the context in which people will be facing such social robots. Healthcare professionals are thus advised to critically reflect not only on who may (potentially) benefit from social robots, but also on the best moment to introduce such robots.

Samenvatting

De grote druk op de zorg (door onder andere vergrijzing, krimpende middelen en een krimpende beroepsbevolking) zorgt ervoor dat we genoodzaakt zijn te zoeken naar oplossingen om de zorg te ontlasten en toch iedereen de zorg te bieden die gewenst en benodigd is. Eén van de mogelijke oplossingen is de inzet van technologie, zoals robots. Tegenstanders van robots en andere technologie in de zorg wijzen erop dat zorg om meer gaat dan alleen het praktisch uitvoeren van handelingen. De patiënt heeft immers ook emoties en cognities waar rekening mee dient te worden gehouden. Het is daarom essentieel dat we dit aspect meenemen bij het bekijken van mogelijke oplossingen. Het is tenslotte goed denkbaar dat een patiënt die een negatieve emotie ervaart absoluut niet openstaat voor een zorgrobot, en, als dit inderdaad het geval is, is het inzetten van zorgrobots wellicht niet de juiste oplossing. Het onderzoek in dit proefschrift gaat daarom over de invloed die emoties (mogelijk) hebben op hoe mensen aankijken tegen robots in een zorgcontext.

De verschillende onderzoeken in dit proefschrift bestudeerden dan ook wat de rol van emoties van gebruikers was op hun beleving van humanoïde, sociale robots in de zorg. Humanoïde, sociale robots kenmerken zich door mensachtige gedragingen en uiterlijkheden. Bijvoorbeeld het feit dat ze net als een mens armen, benen en een gezicht hebben en (steeds beter) in staat zijn om op mensachtige wijze te communiceren. Het onderzoek richtte zich dus niet op robots die allerlei praktische taken kunnen uitvoeren (zoals stofzuigen of herinneren aan het innemen van medicijnen), maar expliciet op robots die bedoeld zijn om te communiceren met mensen. Hiervoor werden in het onderzoek twee robots gebruikt: Alice en Zora (zie hoofdstuk 1 voor foto's van beide robots).

Om te begrijpen welke invloed emoties kunnen hebben op hoe mensen aankijken tegen robots zoals Alice en Zora, hebben we in de literatuur twee theorieën gevonden die een mogelijke uitleg bieden voor hoe emoties invloed uitoefenen. De eerste theorie, de *broaden-and-build* theorie van Barbara Fredrickson (1998; 2001), gaat uit van de positieve of negatieve aard van een emotie. Volgens deze theorie zorgen negatieve emoties ervoor dat men alleen focust op datgene wat op dat moment belangrijk is, terwijl positieve emoties er juist voor zorgen dat mensen hun blikveld verbreden en juist minder focussen op specifieke zaken en meer voor zaken openstaan. Vanuit deze gedachte is het dus logisch te

verwachten dat mensen meer mogelijkheden zien en meer openstaan voor robots wanneer ze positieve emoties ervaren, en juist minder openstaan voor de robot wanneer zij negatieve emoties ervaren. De valentie (of richting) van de emotie speelt hierbij dus een cruciale rol. De andere theorie, de *appraisal-tendency* theorie (Lerner & Keltner, 2000; 2001), gaat er – in tegenstelling tot de *broaden-and-build* theorie – van uit dat niet alleen de valentie van een emotie van belang is, maar dat ook andere evaluatiedimensies (*appraisal dimensions*) van de emotie-situatie een belangrijke rol kunnen spelen. Verschillende emoties hebben elk een eigen patroon van deze *appraisals* en kunnen daarmee dus van elkaar worden onderscheiden. Boosheid en angst zijn bijvoorbeeld beiden negatieve emoties (negatieve valentie), maar onderscheiden zich van elkaar doordat boosheid gekenmerkt wordt door *appraisals* als ander-verantwoordelijkheid, hoge persoonlijke controle en zekerheid over de situatie, terwijl angst gekenmerkt wordt door een zeer lage persoonlijke controle en onzekerheid over de situatie. De *appraisal-tendency* theorie voorspelt vervolgens dat deze *appraisals* die samenhangen met een emotie kunnen leiden tot een neiging (*tendency*) om een toekomstige situatie in ditzelfde licht te evalueren. Volgens de *appraisal-tendency* theorie zouden angstige mensen dus eerder geneigd zijn om toekomstige situaties als onzeker te evalueren dan boze mensen. Mensen met verschillende emoties zullen dus waarschijnlijk ook andere evaluatie-neigingen hebben wanneer zij geconfronteerd worden met een robot, zelfs als die verschillende emoties dezelfde valentie hebben. Dus om beide theorieën samen te vatten: De *broaden-and-build* theorie voorspelt dat de valentie van de emotie bepaalt welk effect een emotie heeft op de beleving van de robot, terwijl de *appraisal-tendency* theorie voorspelt dat verschillen in *appraisals* tussen emoties leiden tot verschillen in de beleving van de robot.

Om de effecten van bestaande emoties bij (potentiële) gebruikers op hun beleving van robot Alice te bekijken en te zien of één van beide theorieën daar beter bij paste, voerden we in hoofdstuk 2 een eerste experiment (N = 184) uit. Om te zien of één van de theorieën beter paste bij de invloed van emoties hebben we verschillende emoties uitgekozen om tijdens het experiment met elkaar te vergelijken. We kozen daarbij voor zowel positieve als negatieve emoties om de rol van valentie te bestuderen. Daarnaast kozen we ervoor om twee verschillende positieve en negatieve emoties te gebruiken, omdat deze gekenmerkt worden door verschillende *appraisal*-patronen en we zo ook het (eventuele) effect van *appraisals* konden opsporen. De deelnemers werd gevraagd terug te

denken aan een zorg-gerelateerde situatie waarin zij de emotie ervoeren die hen was toegewezen (bijvoorbeeld verdriet door pijn en eenzaamheid tijdens een lange ziekteperiode), zodat zij deze emotie opnieuw zouden beleven. Vervolgens lazen zij een (fictief) krantenartikel over robot Alice die – volgens het artikel – in de zorg geïntroduceerd zou worden, gevolgd door een lijst met vragen om hun mening over Alice te polsen. De resultaten van dit experiment lieten zien dat er geen directe verschillen waren tussen de deelnemers in de verschillende emotiegroepen wat betreft de mening over robot Alice. De emoties bleken – zoals verwacht – echter wel van elkaar te verschillen op een aantal *appraisals*. Van die *appraisals* bleek vooral dat de inschatting van het vermogen om met de situatie om te gaan – de *appraisal* van *coping potential* – van invloed was op de percepties van robot Alice. Deelnemers die hun *coping potential* hoog inschatten waren over het algemeen positiever over de robot dan deelnemers die hun *coping potential* laag inschatten. De *appraisal-tendency* theorie lijkt dus beter te passen bij de bevindingen dan de *broaden-and-build* theorie.

In het volgende onderzoek, beschreven in hoofdstuk 3, wilden we verder ingaan op de rol van *appraisals* en *coping*. Bovendien wilden we bekijken welk effect deze *appraisals* hadden op de copingstrategieën die deelnemers (N = 132) gebruikten en hoe deze copingstrategieën vervolgens invloed hadden op de percepties van de robot. In de coping-literatuur wordt onderscheid gemaakt tussen probleemgerichte coping en emotiegerichte coping. De eerste strategie is vooral gericht op het veranderen of aanpakken van het 'probleem' dat de emotie veroorzaakt, terwijl de tweede strategie gericht is op het veranderen van de emotie zelf. Eerder onderzoek suggereerde dat mensen die een gevoel van controle of macht ervaren vaker kiezen voor een probleemgerichte copingstrategie om met een situatie om te gaan dan mensen die geen controle of macht over de situatie ervaren (die op hun beurt vaker kiezen voor emotiegerichte copingstrategieën). Om te zien of dit ook speelde bij de beïnvloeding van percepties van de robot, lieten we deelnemers aan ons volgende onderzoek niet alleen terugdenken aan een situatie waarbij zij de emotie ervoeren die hen was toegewezen, maar lieten we hen ook denken aan een situatie die óf heel moeilijk was om mee om te gaan (lage *coping potential*) óf relatief eenvoudig was om mee om te gaan (hoge *coping potential*). Daarna lieten we de deelnemers een gesprek voeren met robot Alice (via video's op een computerscherm). De resultaten lieten wederom zien dat deelnemers die hun *coping potential* hoog inschatten positiever waren over de robot dan

deelnemers die hun *coping potential* laag inschatten. Het onderzoek toonde echter niet aan dat de *coping potential appraisal* gerelateerd was aan de keuze voor bepaalde copingstrategieën, terwijl we dit vooraf wel hadden verwacht. Wel bleek dat het gebruik van de positieve emotiegerichte copingstrategie leidde tot een positievere perceptie van de robot, maar de andere copingstrategieën hadden geen effect op de percepties van de robot. Kortom, we vonden wederom dat de emoties indirect van invloed waren, via de mate waarin men dácht dat men met de emotionerende situatie kon omgaan (dus via de inschatting van iemands *coping potential*) en via het gebruik van de positieve emotiegerichte copingstrategie.

In de twee experimenten die beschreven worden in hoofdstuk 4 wilden we kijken of we dezelfde invloeden zouden vinden als bij de experimenten in hoofdstuk 2 en 3 wanneer de deelnemer een gesprek zou voeren met een fysiek aanwezige robot in plaats van via een videoscherm. Om emoties en respectievelijk een hoge of lage *coping potential* op te wekken, vroegen we de deelnemers zich deze keer in te leven in een emotioneel verhaal (in plaats van terug te denken aan een eerdere situatie). In het eerste experiment in hoofdstuk 4 lieten we deelnemers (N = 101) daarna een gesprek voeren met robot Zora, zonder dat zij dit van tevoren wisten. De deelnemers was vooraf alleen verteld dat zij zouden deelnemen aan een onderzoek over emoties. We vonden bij dit onderzoek echter niet dezelfde resultaten als bij de eerdere experimenten en vermoedden dat dit kwam doordat deelnemers verbaasd waren dat ze ineens een robot voor hun neus hadden staan. Voor een groot deel van de deelnemers was dit namelijk de eerste keer dat ze überhaupt een mensachtige robot in levende lijve voor zich zagen, die ook nog eens met hen begon te praten. Achteraf bezien was het dus niet zo gek dat dit alle voorgaande effecten teniet zou doen. Daarom besloten we deze studie nogmaals uit te voeren, maar nu wel de deelnemers (N = 110) vooraf te vertellen over de robot en hen al een kort gesprekje te laten voeren met de robot voordat zij het emotionele verhaal te lezen kregen. Ook nu vonden we niet de resultaten die we in de eerste twee studies vonden, noch de voorspelde effecten via copingstrategieën. Blijkbaar trad er dus een ander effect in werking bij de fysieke ontmoeting met de robot dan wanneer de deelnemers alleen lazen over een robot of wanneer ze praatten met de robot via een scherm. Dit is een belangrijke bevinding omdat veel onderzoek over sociale robots gebeurt via plaatjes en videoschermen, terwijl dit

onderzoek liet zien dat het in levende lijven ontmoeten van een fysiek aanwezige robot kennelijk toch anders werkt dan een ontmoeting met een virtuele versie.

Tot slot worden de conclusies van deze vier experimenten uitgebreid besproken in relatie tot elkaar en de bestaande onderzoeksliteratuur in hoofdstuk 5, de algemene discussie. De resultaten van het onderzoek (voornamelijk die uit studies 1 en 2) lijken theoretisch gezien vooral de *appraisal-tendency* theorie te ondersteunen, aangezien de *appraisal* van *coping potential* een belangrijke rol bleek te spelen in het beïnvloeden van de perceptie die gebruikers hadden van de robot. Het is echter te kort door de bocht om daarmee ook direct de *broaden-and-build* theorie de deur te wijzen. Het feit dat mensen die hun *coping potential* hoog inschatten positiever waren over de robot dan mensen die hun *coping potential* laag inschatten, zou er op kunnen wijzen dat het niet zozeer de valentie van de emotie is, maar in plaats daarvan meer de richting van de geassocieerde *coping potential* van de emotie die beïnvloedt of men wel of niet openstaat voor een sociale robot. Een andere belangrijke implicatie van het onderzoek is dat de fysieke aanwezigheid van de robot leidde tot andere resultaten dan wanneer de robot niet fysiek in dezelfde ruimte aanwezig was. Het lijkt erop dat het daadwerkelijk oog-in-oog staan met de robot leidt tot een ander proces dan wanneer men alleen leest over de robot, of met de robot via een scherm praat, namelijk een proces waarbij schema's die we in ons brein hebben van mens-mens interactie worden toegepast op mens-robot interactie. Het is echter ook mogelijk dat hier vooral een effect van nieuwigheid en verrassing optrad, waardoor we bij de laatste experimenten niet de resultaten vonden die we in de eerste studies wel vonden. Wellicht dat de invloeden van de eerdere emoties wederom boven komen drijven wanneer mensen meer ervaring hebben opgedaan met robots.

In hoofdstuk 5 worden, naast de conclusies en theoretische implicaties, ook een aantal methodologisch sterke en zwakkere punten van het onderzoek besproken. Zo bleek bijvoorbeeld dat het opwekken van emoties niet eenvoudig was. We zochten naar behoorlijk intense emoties zoals men deze in zorgsituaties tegenkomt, maar ondanks de grote zorgvuldigheid waarmee we onze studies bedachten, bleek het voor veel deelnemers toch lastig zich goed in te leven in de emotie. Dit is ook de reden waarom we twee verschillende procedures gebruikt hebben in het onderzoek (het herinneren van een emotionele situatie en het lezen van een emotioneel verhaal). Desondanks bleek het in beide gevallen lastig voor de deelnemers om zich goed in de emotie in te leven – een

bekend probleem in emotie-onderzoek. Het gebruik van twee verschillende methoden om emoties op te wekken is echter ook een sterk punt van het onderzoek, aangezien we zo de voordelen van beide methodes optimaal konden benutten zonder de relevantie van de emotie voor het individu uit het oog te verliezen (iets wat vaak gebeurt wanneer er bijv. videoclips of muziek gebruikt wordt voor het opwekken van emoties). Een ander sterk punt van het onderzoek is het feit dat het onderzoek theorie-gedreven is vanuit zowel de literatuur over mens-robot interacties, als vanuit de emotie- en coping-literatuur. De resultaten geven daarmee ook input voor nieuw onderzoek op al deze raakvlakken.

Eén van de belangrijke uitdagingen voor vervolgonderzoek ligt in het bestuderen van dergelijke emotie-effecten op de lange termijn, in het veld, en met verschillende, fysiek aanwezige robots. Zoals eerder besproken zou het zo kunnen zijn dat de eerder gevonden invloed van emoties op percepties van een robot (zie hoofdstuk 2 en 3) weer tevoorschijn komen wanneer de nieuwigheid van de robot eraf is. Het zou dus zeer interessant zijn om te bekijken welke effecten gebruikersemoties op de langere termijn hebben op hoe de robot wordt waargenomen, de bereidheid tot interactie en de vorming van een band met de robot. Ook belangrijk is het besef dat dit onderzoek steeds heeft plaatsgevonden in de gecontroleerde omgeving van het lab, met voornamelijk studenten. Dit leverde interessante inzichten op over de rol van emoties, *appraisals* en *coping*. Het is echter lastiger om deze resultaten één-op-één te vertalen naar de praktijk, waar (potentiële) gebruikers de robot niet in een gecontroleerde omgeving zullen ontmoeten. Hiervoor is onderzoek in de praktijk nodig waarbij de interactie tussen patiënten en zorgrobots in detail wordt bekeken en de ervaring van de patiënten wordt geëvalueerd om de mogelijke invloed van emoties, *appraisals* en *coping* in de praktijk beter te begrijpen. Daarnaast hebben we ons in het onderzoek beperkt tot het bestuderen van sociale robots met één enkele taak, namelijk het voeren van een vraaggesprek met de deelnemer om informatie te verkrijgen. Toekomstig onderzoek is nodig om te zien wat de invloed van emoties op het beeld van de robot is wanneer gebruikers een andere taak uitvoeren met de robot (zoals bijvoorbeeld een raadsel oplossen, of wanneer de robot probeert de gebruiker te overtuigen om gezonder te gaan leven).

Tot slot worden in hoofdstuk 5 ook de implicaties voor de praktijk besproken. Allereerst laat het onderzoek zien dat gebruikers waarschijnlijk even zullen moeten wennen aan een gesprek met een robot. Observaties uit ons onderzoek laten zien dat deelnemers al

meer gewend waren aan de robot wanneer ze deze even daarvoor al kort gesproken hadden. Dit hing samen met de bevinding dat het gesprek met de robot voor sommige deelnemers wat onnatuurlijk aanvoelde, omdat het gesprek in essentie voor alle deelnemers hetzelfde moest zijn (en dus een strak protocol volgde). Door het gesprek meer vrij te laten en de robot bovendien non-verbale signalen zoals gebaren of blikrichting te laten inzetten, kunnen in de praktijk meer natuurlijke gesprekken ontstaan tussen de gebruiker en de robot. Het is daarnaast ook belangrijk voor de praktijk om goed na te denken over de ethische aspecten die gerelateerd zijn aan de inzet van robots in de praktijk. Men kan zich bijvoorbeeld afvragen of het moreel aanvaardbaar is om een patiënt in nood 'af te schepen' met een robot. En wie er verantwoordelijk is als iemand een band heeft opgebouwd met een robot en deze vervolgens stukgaat. En wat gebeurt er met de data die de robot eventueel verzamelt, wie kan deze inzien en hoe is deze beschermd?

Al met al is het belangrijk om de emoties en de inschatting van *coping potential* in het achterhoofd te houden wanneer men robots wil introduceren. Het lijkt erop dat het niet handig is om mensen te confronteren met een zorgrobot wanneer zij emoties ervaren waar zij moeilijk mee kunnen omgaan, ongeacht of dit een positieve of negatieve emotie is. Als mensen hun situatie inschatten als moeilijk om mee om te gaan (low *coping potential*), dan zullen zij minder positief zijn over de robot en zullen zij ontevreden zijn over de behandeling. De resultaten van het onderzoek laten dus zien hoe belangrijk het is om rekening te houden met de context waarin mensen met een sociale robot te maken krijgen. Professionals in de zorg doen er dan ook goed aan om niet alleen te bedenken wie er mogelijk baat hebben bij een sociale robot, maar ook om te monitoren welk moment het meest geschikt is om deze te introduceren.

Dankwoord

Het boekje dat u nu in handen heeft, is het tastbare resultaat van mijn promotietraject. Het traject was te vergelijken met het beklimmen van een berg. Als je onderaan de berg staat, weet je al waar je naartoe wilt: naar de top - de promotie in dit geval. Maar de weg daarheen is niet altijd te overzien. Ik had soms heel graag de vooraf uitgestippelde route willen volgen, maar op momenten was dat simpelweg onmogelijk. Bijvoorbeeld door het ontbreken van een routebordje of door een beer op de weg. Dan wijk je toch maar van het gebaande pad af.

Het feit dat u dit boekje in handen heeft, is het bewijs dat het gelukt is om de top van de berg te bereiken. Dit had ik echter nooit voor elkaar gekregen zonder de hulp en steun van een heleboel mensen. Daar ben ik intens dankbaar voor. Sommige mensen kruisten halverwege de berg mijn pad, anderen moedigden mij vanaf beneden aan, en weer anderen liepen (fysiek óf mentaal) stukjes met mij mee. Dank daarvoor! Ook als ik wellicht iemand vergeet bij naam te noemen.

Dat ik deze beklimming überhaupt kon gaan maken, heb ik te danken aan Elly Konijn en Johan Hoorn. Elly, al tijdens mijn onderzoeksmaster moedigde jij me aan om deze beklimming te wagen. In de tussentijd zorgde je ervoor dat ik in beweging bleef binnen de afdeling en regelde je samen met Johan ‘de berg’. Ik ben heel dankbaar dat je in me geloofde en dat al die tijd bent blijven doen. Daarnaast ben ik ook enorm dankbaar voor de uitdagingen die je onderweg voor me plaatste en voor je immer kritische blik op het onderzoek, om zo de kwaliteit ervan naar een hoger plan te tillen. Ook mijn enorme dank voor je persoonlijke betrokkenheid, niet alleen bij het project, maar ook bij het leven naast en ná de promotie! Johan, bedankt voor het bieden van de vrijheid om de berg op mijn manier te beklimmen, ondertussen wakend dat ik onderweg naar boven niet in het bos zou verdwalen . Als ik een moment had waarop ik door de bomen het bos niet meer zag, stuurde jij me naar buiten om mijn hoofd leeg te laten waaien of hielp je me om voor elke boom de unieke eigenschappen te zien of er iets creatiefs mee te doen. Bedankt voor al je hulp en steun bij het proces en voor het feit dat je me deze kans hebt gegeven!

Dear members of the reading committee, Prof.dr. Theo van Tilburg, Prof.dr. Shyam Sundar, Prof.dr. Astrid Rosenthal-von der Pütten, Prof.dr. Tony Belpaeme, and Prof.dr. Carlo Schuengel, thank you all so much for taking the time and effort to read my dissertation. I am very honored that you will come all the way to Amsterdam for my defense! I look forward to exchanging ideas and discuss the dissertation with you.

Daarnaast wil ik ook heel graag mijn mede-SELEMCA'nen bedanken die samen met mij aan deze reis begonnen zijn: Robert, Margo en Wang. Ik heb zo enorm veel van jullie geleerd (4 dingen ;-)). Niet alleen op het gebied van onderzoek, maar ook op allerlei andere gebieden. Dank voor de vele gezellige en productieve uren in de krochten van het Metropolitan. Ik wacht jullie met smart op bovenaan de berg: als ik het kan, kunnen jullie het ook. Het laatste liedje bij de verdediging is speciaal voor jullie! Margo, bedankt voor alle fijne gesprekken over randzaken en de gezellige etentjes met de mannen. En superfijn dat je mijn paranimf wilt zijn! Robert, nogmaals dank voor het prachtige verjaardagscadeau: een échte design-cover voor mijn dissertatie! Hij is geweldig, bedankt!

Dank ook aan alle andere mensen die bij het SELEMCA-project betrokken waren, zoals alle mensen uit de zorginstellingen. In het bijzonder wil ik graag Desmond en Marco bedanken. Heren, bedankt voor jullie technische en praktische ondersteuning bij de onderzoeken met Alice en Zora in de verschillende labs! En Sylvia, jij enorm bedankt voor al het regelwerk, lunches, je creativiteit (o.a. de breiles), en je gezelligheid!

Ook wil ik graag alle collega's van de afdeling Communicatiewetenschap bedanken! Christian, Amber, Ewa, Nadia, dank voor de vele tips, gezellige kletspraatjes en lunches. *Elly's Angels*, jullie kan ik uiteraard niet vergeten apart te benoemen! Anouk en Xanthe, dank voor jullie hulp bij allerhande statistiek- en methodologievragen en de gezelligheid tijdens etentjes en congressen. Jolanda, jij in het bijzonder enorm bedankt *for being you*. Je bent een grote inspiratie en ik bewonder enorm hoe je in het leven staat. Jij was vaak het *Angels*-rolmodel, en ik kan niet vaak genoeg zeggen hoe dankbaar ik ben dat ik daarvan heb mogen profiteren. Dankjewel dat je als paranimf naast me wilt staan op 30 mei! En natuurlijk ook voor alle gezellige lunches/bakkies, congres-logeerpartijtjes, goede gesprekken, knuffels, kaartjes en appjes vol met fotospam. Dat wordt echt enorm gewaardeerd!

Dank ook aan de andere collega's binnen de Faculteit der Sociale Wetenschappen die me op welke manier dan ook geholpen hebben tijdens mijn beklimming. In het bijzonder Tamara, Greetje en Marieke: bedankt voor de fijne samenwerking tijdens onze tijd als Graduate Platform/Council! Dank ook aan al mijn nieuwe collega's bij de afdeling Sociologie aan de VU en de afdeling Donor Studies van Sanquin voor het warme bad waarin ik terecht kwam. Eva-Maria, Lisanne en Rosa, jullie hebben me er echt doorheen getrokken toen ik in het zicht van de finish was, bedankt daarvoor! En Eva-Maria en Theo, dank dat jullie mij deze mooie kans hebben geboden verder te gaan in het onderzoek!

Daarnaast ook mijn enorme dank aan alle mensen die het onderzoek praktisch mogelijk hebben gemaakt. Allereerst natuurlijk aan alle deelnemers aan het onderzoek, zonder jullie was het nooit gelukt: hartelijk bedankt! Lieke Tel en Pouya Zarchin, jullie bedankt voor jullie praktische hulp bij het uitvoeren van de lab-studies – het ga jullie goed. Alice, jij liet je – als een echte diva – van hot naar her rondrijden in je rolstoel. Soms met een behoorlijk eigen wil, maar altijd stond (of zat, eigenlijk) je onvermoeibaar klaar voor het onderzoek, bedankt! Zora, jij hebt me enorm geholpen bij het onderzoek toen Alice dat niet (meer) bleek te kunnen. Jij staat altijd voor iedereen klaar en bent heerlijk consequent in de dingen die je doet – heel fijn, bedankt! Ik hoop dat jij net zoveel lol had in het dansen van de Gangnam Style tijdens het Weekend van de Wetenschap als ik had bij het zien van alle lachende gezichten van de kinderen die speciaal naar jou kwamen kijken die dag. :-D

Lieve vrienden en vriendinnen, jullie ook bedankt voor jullie support, in welke vorm dan ook. Lieve Natasja en Cynthia (a.k.a. zus en zus), thanks voor alle fijne jaren van interesse en afleiding (bij de scouting en daarna), waarbij we blindelings op elkaar konden varen in de meest ongeloofwaardige verhalen! Dorine, bedankt voor de fijne sauna-avonden (ook al worden ze steeds zeldzamer), en je bereidheid te helpen met de opmaak! ;-) Lisanne en Francis (a.k.a. Liz & Frens), bedankt voor alle gezellige draag(&dans)-momentjes en appjes! En Liz, jij nogmaals enorm bedankt voor het kritisch checken van de samenvatting en het dankwoord! Yuri, Phemmy, Ivan, Rogier, Pascale, Melissa, Rodney en al jullie lieve kids, bedankt voor de altijd welkome afleiding met voetbal, eten en gezelligheid. Dennis, bedankt voor alle etentjes, concerten en je eindeloze interesse in mijn onderzoek!

Lieve pap en mam, deze hele beklimming was niet mogelijk geweest zonder jullie nimmer aflatende steun en interesse in mijn onderzoek (én de vele uren oppassen in de afgelopen anderhalf jaar). Bedankt dat jullie mij altijd de mogelijkheid hebben geboden om mijn eigen weg te gaan en mijn eigen fouten te maken, en dat jullie mij de bijbehorende kans boden om het weer goed te maken. Ik kan niet goed in woorden uitdrukken hoe enorm jullie gewaardeerd worden. Bedankt, bedankt, bedankt! Klaas en Fien, jullie ook bedankt voor alle steun en interesse, dat wordt enorm gewaardeerd! En bedankt ook dat jullie ons in Oostenrijk regelmatig op sleeptouw namen, zodat ik naast die figuurlijke (promotie-)berg ook letterlijk bergen heb beklommen. Ik hoop dat we dat in de toekomst weer met jullie kunnen gaan doen!

En tot slot natuurlijk mijn geweldige gezin. Sven, jij bent mijn grootste motivatie én afleiding tegelijk – bedankt dat je mama geleerd hebt om haar aandacht beter te focussen (op jou ;-)). Baby, jij bent zo bijzonder dat jij nú al bij een promotie aanwezig mag zijn, en dan nog wel van zo dichtbij ook! Ik kijk er enorm naar uit om je binnenkort te mogen ontmoeten (maar wel even wachten tot ná 30 mei alsjeblieft ;-)). En *last but certainly not least*, mijn allerbeste vriend, de liefste en mooiste meneer ter wereld, en mijn altijd aanwezige rots in de branding. Lieve Frank, bedankt voor het aanhoren van al mijn verhalen, het afleiden, het tolereren van mijn koppigheid, het relativeren en het heldere denken als dat mij even niet meer lukte. Je bent echt de beste, bedankt voor alles, Pop! Ik hoop dat we samen nog vele bergen mogen gaan beklimmen!

Marloes Spekman meeting robot Alice for the first time (photo: Robert A. Paauwe)

About the author

Marloes Spekman was born in the small town of Nieuwveen, the Netherlands, in 1986. Being fascinated by human communication and language, she obtained a Master's degree (MA, 2009) in Communication and Information Studies from the Faculty of Humanities at the Vrije Universiteit Amsterdam. It was during this study that she realized she wanted to further study communication and media from a psychological viewpoint, and so she decided to pursue a Research Master's degree (MSc, 2011) in Social Research with a specialization in Communication Science/Media Psychology from the Faculty of Social Sciences of the Vrije Universiteit Amsterdam. During her graduate years, Marloes was a teaching assistant for a variety of courses (ranging from methods and statistics to persuasive communication and new media publishing) in both the Faculty of Humanities and the Faculty of Social Sciences. After graduation, she was a junior teacher for the dept. of Communication Science for a year (teaching in the fields of media psychology, health communication, persuasive communication, marketing, and statistics) before starting her Ph.D. project. Her Ph.D. project, under the supervision of prof.dr. Elly A. Konijn, led to this dissertation about the effects of prior emotions, appraisals, and coping in relation to social robots in healthcare. During her Ph.D. project, she was also active as chair of the Graduate Platform (now: Graduate Council) of Social Sciences, as a reviewer for several international, peer-reviewed journals, and as a guest lecturer in a variety of fields (ranging from Artificial Intelligence to Communication Science). Additionally, she presented her work at several national and international conferences.

Currently, she works as a postdoctoral researcher at the dept. of Sociology of the Vrije Universiteit Amsterdam. Her research there relates to the prevention of lapse amongst blood donors after temporary deferral from donation, in close collaboration with the dept. of Donor Studies of Sanquin – The Dutch national blood service institute (not-for-profit).