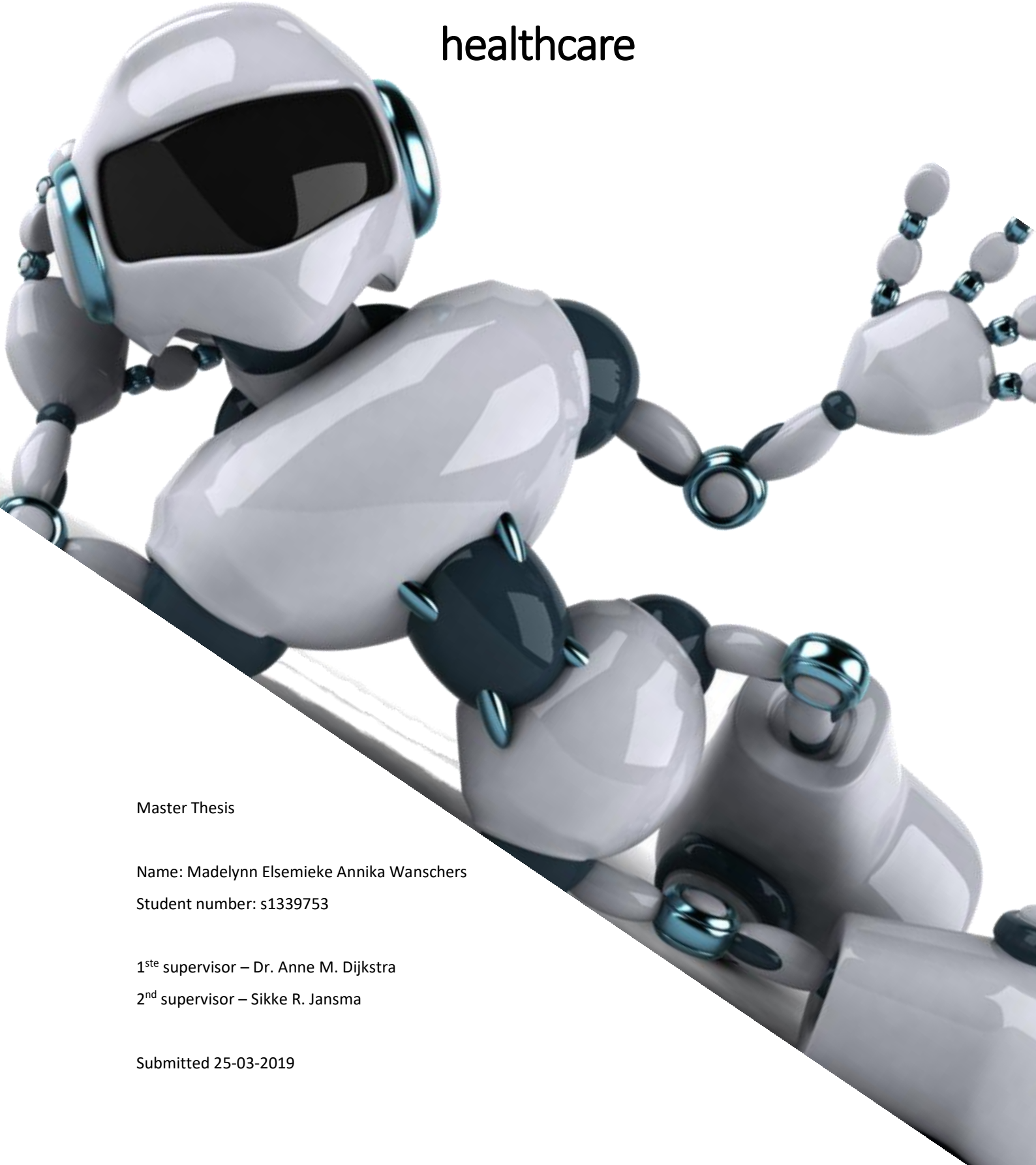
Taking public participation in healthcare a step further: Co-creation in the development of social robots in elderly healthcare



Master Thesis

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Management Summary

Background – The current society is characterised by an aging population, an increase in comorbid diseases and a declining number of formal and informal caregivers. For these issues, social robots might be the answer. Many different types of these social robots have already been developed and adopted in practice. This has resulted in information on the abilities and the effects of social robots. Since social robots can be seen as directly affecting its users, it is interesting to look at possibilities to engage different stakeholder groups in different iterative processes of robotic design. Therefore, the research question of this research is: *To what extent will co-creation in social robot development support the development of social robots that are accepted by elderly retirement home residents and healthcare professionals?*

Methodology – To answer the research question, two rounds of qualitative research methods were conducted. The first round were semi-structured interviews conducted with robotic researcher, healthcare professionals and elderly retirement home residents. The second round existed of two focus groups, one with healthcare professionals and one with elderly retirement home residents. Both qualitative methods were chosen, because of their ability to give participants the opportunity to do a co-creation activity and to discuss their personal interests surrounding the topic of the research.

Results – The results show that the different participant groups of the semi-structured interviews first became acquainted with social robots in indirect ways through study, work environments and television/radio. Different approaches were used in the semi-structured interviews by the different participant groups. The robotic researchers focused more on co-creation, the healthcare professionals on the place of the social robots in care environments and the elderly retirement home residents more on ethical issues as for instance limited communication with humans. All participants thought it was difficult to talk in general terms about social robots. This was caused by high and low levels of experience with social robots. The participants also varied in their preference to engage in co-creation. The elderly retirement home residents were afraid that they would lose privacy. The healthcare professionals agreed that everyone should be included but mentioned that there might be practical limitations. The robotic researchers thought that co-creation is fundamental to the further development of social robots. The focus groups provided a clear understanding of the important points related to social robots as perceived by healthcare professionals and elderly retirement home residents.

Discussion – This research shows that co-creation is a possibility in future social robot development. A challenge in the social robot development is that a lot of individuals have not yet any experience with this product. Therefore, individuals should get acquainted with social robots as soon as possible. This is very important since the research has shown that the three participant groups perceive social robots differently. When the different participant groups have more experience with social robots than future co-creation activities become more beneficial.

Abstract

People in current society are getting older, are more often faced with comorbid diseases and have less formal and informal caregivers that can take care of them. Social robots might be an answer to these problems. There are already many different types of these social robots. This research focused on the possibility to include three different stakeholder groups in the development of these social robots. Therefore, the research question of this research is: *To what extent will co-creation in social robot development support the development of social robots that are accepted by elderly retirement home residents and healthcare professionals?* To answer this question, semi-structured interviews and focus groups were conducted. The results show that the participant groups in the semi-structured interviews got acquainted with social robots in indirect ways through study, work environments and television or radio. The different groups also emphasized different points in their interviews. The robotic researchers focused on co-creation, the healthcare professionals on the place of the social robot in the healthcare environment and the elderly retirement home residents on ethical and social issues. Additionally, they approached co-creation differently. Robotic researcher thought it is fundamental in the development of social robots, healthcare professionals agreed with the importance but had some practical points to consider. The elderly retirement home residents often discussed a loss in their privacy. The focus groups provided a clear understanding of the important points related to social robots as perceived by healthcare professionals and elderly retirement home residents. This research concludes that co-creation can be a possibility in future social robot development. Co-creation can become beneficial because it connects stakeholder groups that perceive social robots differently.

Keywords Social robots; Co-creation; Elderly; Healthcare professionals; Robotic researchers

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1. Introduction

Observed demographic and epidemiological changes produce far-reaching changes in our environments (Pinto, Caldeira, Marques, & Da Conceição, 2018). Once change is the rise in average age in developed countries around the world (for example: Breazeal, 2011; Chu, Khosla, Khaksar, & Nguyen, 2017; Karam, Brault, Van Durme, & Macq, 2018). This is accompanied by an increase in comorbid chronic diseases (Paauwe, Hoorn, Konijn, & Keyson, 2015; Aria & Archer, 2018; Karam et al., 2018; Tavares, 2018). Additionally, a shortage in formal and informal caregivers can be observed (Johnson et al., 2014; Royakkers & Van Est, 2015; Baisch et al., 2017) since birth rates in many developed countries are reducing (Breazeal, 2011).

Comorbid chronic diseases exist of two categories, namely bodily and psychological health (Misselhorn, Pompe, & Stapleton, 2013). Bodily health problems are walking, climbing stairs, getting out of a chair, bed or shower, driving, using public transportation, writing, holding objects and using technology. This is often caused by weakness of limbs, loss of balance, tremors, loss of mobility and sensory impairment. For these issues, technological products such as lifts, walkers and hearing aids have been developed.

It becomes more complicated when elderly individuals are facing psychological impairments. These elderly individuals might experience lethargy, fear, social isolation, depression, inactivity, listlessness, extreme sadness, confusion, forgetfulness, and disinterestedness resulting in difficulties of tracking one's schedule, keeping the house in order, forgetting things, operating technology, taking medication, self-preservation, interacting with strangers, recognising familiar individuals and finding the way home (Misselhorn et al., 2013). These challenges have increased interest in how technological devices can be custom-made to suit the needs of different individuals (Baisch et al., 2017).

Conventional healthcare settings, assistance and recommendations are arranged by individuals or teams of healthcare practitioners (Lee, Kim, Kim, & Kwon, 2017). Many of their tasks are highly repetitive and menial. These tasks can be done by robotics. Social robots are such an example of robotics. "Social robots, as social assistive technologies, are the catalyst for aged care service innovation, because not only do they seek the best solutions to aging problems, but they also play a preventive role for any other problem that might happen to them in the future" (Khaksar, Khosla, Chu, & Shahmehr, 2016, p. 441). This technology is employed in elderly care, but also in physical rehabilitation and special needs care (Šabanović, 2010; Frennert & Östlund, 2014; Lorenz, Weiss, & Hirche, 2016; Cao et al., 2017). Robots are thus not uncommon in the healthcare sector (Stengler & Escudero Perez, 2017).

Powell and Colin (2008), Šabanović (2010) and Kaipio et al. (2017) showed that technological innovations in robotics is led by academics, industrial experts and governmental figures who are the primary drivers of social development. At the same time, society has had a passive role in accepting and adopting the innovations (Šabanović, 2010). However, health and maintenance of quality of life is becoming a relevant issue for many individuals (Freund, Reychave, McHaney, Goland, & Azuri, 2017; Martins, Gonçalves, & Branco, 2017).

These social robots are surrounded by pro- and con-movements. The pro-movement is based on technological and futuristic enthusiasm, the con-movement is concerned with ethical questions related to dignified and humane care (Misselhorn et al., 2013). This resulted in findings by Damholdt et al. (2015) and Coeckelbergh et al. (2016) that 60% of the citizens think that robots should not be a part of children's, elderly and disable care. Only, 3% believed robots can be used in these sectors.

1.1. Theoretical and Practical Relevance

Neubeck et al. (2016) made the following remark in their research: "Technology changes rapidly, perhaps faster than paradigms about human behavior evolve to inform understanding of end-user preferences for, uptake of, and attribution for technology-based health promotion strategies" (p. 35). Additionally, ageing is a process that is often experienced differently by individuals and depends on the time of day and years, situation and context of individuals (Frennert, Eftring, & Östlund, 2017). Therefore, the acceptance of innovative assistive technologies will benefit from the users' point of view (Khosla, Nguyen, & Chu, 2017).

If groups of stakeholders that are normally not considered to participate in the development of new innovations or public policy are asked to participate, it is called public participation. The first public participation activities date back to the 1960s (Joss, 1999). It is becoming especially relevant again, because science communication has been pushed on current research agendas to encourage exchange in information between different disciplinary boundaries and to engage different stakeholders (Constant & Roberts, 2017).

This trend can already be observed in the design of social robots. According to Salichs, Encinar, Salichs, Castro-González and Malfaz (2016) the needs of patients are considered, but the needs of caregivers are often not contemplated. Contrary, there are researchers as for instance Ienca, Jotterand, Vică and Elger (2016), who have established that designers and developers have limited information about needs, wishes and expectations of all different users.

These researchers give three different reasons for this observation. The first reason is that research on this topic is still in its infancy. Secondly, this research is time-consuming, because the end-users of social robots are often difficult to reach and protected by high standards of ethics. Thirdly, the implementation of social robots is faced with structural limitation such as memory learning and orientation problems, limited understanding of verbal instructions, problems with execution of purposeful activities, poor recognition of audio-visual prompts and other cognitive and physical disabilities.

It can be concluded that there has been a scarce focus on co-creation and elderly individuals (Karahsavonić et al., 2009). However, innovations like the Internet and other associated information technologies (IT) have given end-users of different products the opportunity to produce marketable value. As a result, roles of customers and organisations have been changing (Zwass, 2010). Van Dijck and Nieborg (2009) indicated that the involvement of individuals in the production and distribution of products is celebrated as the best thing that has happened since the establishment of worker's comp and voting rights for women.

Applying this participation to the development of social robots is important, because even though this research field is still in its infancy, it has the potential to become a part of the daily lives of humans by working together and alongside individuals (Wolbring & Yumakulov, 2014; Chang, Lu, & Yang, 2018). Additionally, new types of technology with the potential to self-manage healthcare conditions might have high economic value (Aria & Archer, 2018). This innovation is also expected to support elderly individuals in staying in contact with the outside world (Chang et al., 2018). Lastly, it can provide new insights in the discussion why social robots should be used in comparison to other assistive technologies that might be cheaper and equally accessible (Chu et al., 2017).

1.2. Research Aim and Article Structure

The aim of this research is to discuss whether co-creation can be a form of public participation in the healthcare sector in the scientific and/or technological social robot innovation. The research question of this thesis is:

'To what extent will co-creation in social robot development support the development of social robots that are accepted by elderly retirement home residents and healthcare professionals?'

As discussed, social robots are no longer futuristic possibilities in the healthcare sector. Furthermore, the position of a social robot is consciously modified by its users (Meister & Schulz-Schaeffer, 2016). There are already different healthcare institutions relying on social robots in the care and therapy of elderly individuals (Misselhorn et al., 2013). Additionally, these authors indicate that our knowledge on social robots should be increased since its mingling with the core of human self-understanding.

To answer the research question, literature findings about social robots, public participation and co-creation are discussed. This is followed by the methodology chapter which explains the use of individual interviews and focus groups as research methods. This thesis ends with the results section and the discussion and conclusion section which highlight the important findings of this research and relates past findings to the findings of this study and gives practical advice.

2. Theoretical Framework

The lives of every individual are characterised by their interactions with other individuals (Paiva, Leite, Boukricha, & Wachsmuth, 2017). This means that individual well-being and survival is based on the understanding of intentions, motivations and feelings of other individuals that are a part of ones' complex social environment. Since social robots have the ability to communicate with humans on a social and emotional level (Edwards, Edwards, Spence, & Westerman, 2016; Cao et al., 2017), they are going to be a part of this complex social environment and thus influence many facets of human lives (De Graaf & Allouch, 2013; Paiva et al., 2017; Thimmesch-Gill, Harder, & Koutstaal, 2017; Vallès-Peris, Argulo, & Domenech, 2018). In recent years, researchers have paid increasing attention to these social robots (Frennert & Östlund, 2004; Chang et al., 2018).

2.1. Social Robots

Lee et al. (2017) define social robots as "physical entities utilized in complex, dynamic, social environments that are sufficiently empowered to behave in a manner conducive to their own goals and those of their community, including other robots or people" (p. 728). They are not the only researchers that have defined social robots. Piçarra, Giger, Pochwatko and Możaryn (2016) define social robots as robots "with high levels of autonomy, capable of interacting with people, following contextually correct social norms, attentive to gaze and emotional cues, and able to adapt its responses to user's specific traits and personality" (p. 17). This definition is focused on the technology that makes robotics social. Lorenz et al. (2016) indicate that social robots are developed with the intention to enhance the quality of life of its users. Therefore, social robots are often used in education, therapy and training.

Social robots are different from other assistive technologies and devices especially regarding elderly individuals, because social robots will be able to meet challenges that influence the well-being of the elderly (Khaksar et al., 2016). For the elderly, social robots have been developed to reduce loneliness, mediate social interaction and assist in the household (Lorenz et al., 2016). Therefore, this innovation can boost the physical and cognitive abilities of elderly individuals (Frennert et al., 2017). This means that social robots need to be constructed in socially accepted manner (Chang et al., 2018).

Additionally, social robots can relieve healthcare professionals from their workload (Royakkers & Van Est, 2015). Social robots can be equipped with sensors that can record large amounts of quantitative data, which offer unique insights into their patients (Dipietro et al., 2012; Jenkins & Draper, 2015). This data can be processed fast and objectively by social robots (Bemelmans, Gelderblom, Spierts, Jonker, & De Witte, 2013). Another reason given by these researchers in relation to the ability of social robots to limit workload is that technology can never become sick, tired or experience stress. The social robots are also able to work with a higher degree of exactitudes than humans can.

Thus, social robots are developed to improve social contact and psychological well-being and they improve everyday functioning of their end-users (Baisch et al., 2017). This means that social robots do not exert serious

force on human bodies, but they use multimodal interfaces that mimic social interaction (Bemelmans et al., 2013). This mimic is achieved by enabling independence and augmented mental and physical activities of users when required (Khaksar et al., 2016). In other words, they are used to enrich the social world of users (Lorenz et al., 2016). They can enrich the world of their users by delivering personalised services, entertainment and socialisation (Khaksar et al., 2016). This also means that there are different ways to classify social robots (Looije, Neerincx, & Hindriks, 2017). These different classifications will be further explained in the next section.

2.1.1. Types of Social Robots

There are already different commercial and proprietary social robots (Tan et al., 2018). There are several different categories of social robots. The different definitions and categories of social robots describe how these social robots should interact to be perceived as a social entity (Frennert & Östlund, 2014). Chu et al. (2017) found pet-like robots to be one category of social robots. Piçarra and Giger (2018) outline three other types of social robots, namely machinelike robots, human-like robots and humanoid robots.

Pet-like Robots

Pet-like robots are often seen as companion robots (Khosla & Chu, 2013; Sung, Chang, Chin, & Lee, 2015). "A companion robot is typically a reactive agent to respond to stimulation since that robot mimics a pet's behavior consulting mainly reactive actions" (Cao et al., 2017, p. 15). The goals of these social robots are to increase well-being and enable autonomy of the user by reducing loneliness (De Graaf, Allouch, & Klamer, 2015; Lorenz et al., 2016).

Pet-like social robots have limited human-like abilities as for instance a voice, gestures, emotions and combinations of other human attributes (Khosla & Chu, 2013). This makes it easier to build behaviour models, because animals have less communicational capabilities than humans do (Konok, Korcsok, Miklosi, & Gácsi, 2018). Research of Coeckelbergh et al. (2016) indicate that pet-like social robots have a preference over object-like or imaginary shaped social robots. There is also a preference over the use of pet-like social robots in relation to real animals, since there are no health issues as for instance allergies, diseases and hygiene threats (Cao et al., 2017).

There are some concerns regarding companion robots. The controversial image portrayed is that elderly individuals will only have contact with a social robot (Royakkers & Van Est, 2015). Despite this concern there are many different pet-like social robots that are used in research, but also in practice. A few of these pet-like social robots will be discussed.

One often discussed pet-like social robot in research and practice is PARO. PARO was developed by Intelligent System Co. Ltd (Misselhorn et al., 2013; Baisch et al., 2017). PARO has already been commercially marketed in 2005 in Japan and was introduced in 2009 in Europe and the United States of America (Pfadenhauer & Dukat, 2015). This social robot can often be encountered in retirement homes and other forms of formal care settings. PARO has been developed to have three types of effects: psychological, physiological and social effects

(Lorenz et al., 2016). It was designed to reduce stress, promote socialisation and improve patient motivation (Salichs et al., 2016). PARO realises this by showing proactive and reactive behaviours (Lane et al., 2016).

PARO resembles a real animal a seal that is designed to evoke positive emotional reactions (Lane et al., 2016; Baisch et al., 2017). This seal weighs 3kg and is 60cm long (Misselhorn et al., 2013). PARO is able to move its head, neck, flippers, tail and eyelids and emit noises. Furthermore, PARO has primary senses such as sight, hearing, balance and tactile sensation. This means that PARO is associated with fragility and immaturity and often perceived as a children's toy or therapeutic robot for individuals with forms of dementia (Lane et al., 2016).

PARO is the most well-known social robot, because of its relatively wide dissemination and its position in research in which its effectiveness is measured using quantitative and qualitative methods (Pfadenhauer & Dukat, 2015). There are other pet-like robot as for instance the Huggable. The Huggable is a social robot that is "capable of active relational and affective touch-based interactions with a person" (Lorenz et al., 2016, p. 132). Other pet-like robots are PleO (Misselhorn et al., 2013), Puppy and JustoCat (Scholten, Vissenberg, & Heerink, 2016).

Picture 1. Pet-like social robots, in order PARO, Huggable, PleO, JustoCat and Nabaztag.

Without a doubt, these are not the only pet-like social robots. De Graaf et al. (2015) based their research on, for instance, Nabaztag also often called Karotz. This pet-like social robot is a 30cm large bunny that operates on Wi-Fi and has movable ears, has blinking LED's in the belly that have three different colours, infrared motions sensors, a microphone and a webcam which records interactions on a voluntary basis. Nabaztag also has a hook that can track whether keys are taken or put back. This social robot has been created to initiate three interactions a day. These interactions are based on the following topics: good morning dialogue, going out and coming home dialogue, evaluation of the day's activities, information about the social robot and read out loud messages of the researchers (De Graaf et al., 2015).

Different pet-like social robots are being displayed in picture 1. As picture 1 shows there is a wide variety in pet-like social robots. One is more realistic in resembling a pet than the other. Machinelike robots, as shown in picture 2, also differ in shape and design. Furthermore, machinelike robots serve a different purpose than pet-like social robots.

Machine-like Robots

Another type of social robot is characterised by mobile platforms with touch screens (Cao et al., 2017). These social robots are often service-oriented and have no human-like capabilities and abilities (Khosla & Chu, 2013). They are generally developed to prevent users from getting harmed (Ienca et al., 2016). The remote telepresence robot is a machinelike social robot that is already commercially available (Ienca et al., 2016; Baisch et al., 2017; Salichs et al., 2016). This type of social robot is focused on telecommunication and remote presence (Jones, Sung, & Moyle, 2015).

Cao et al. (2017) found the following machinelike social robots; Scitos-G5, CcompanionAble platform, MOBISERV platform, Kinova and Hobbit. Another example is Giraff (Baisch et al., 2017). Giraff is most often used in home-based healthcare environments. It is a computer-based videoconferencing system which provides users with the opportunity to have social contacts over long distances. When using Giraff a few things should be considered (1) the user needs additional instructions when they want to operate Giraff, (2) the user needs to keep in mind that the robot moves without the user's control, (3) Giraff relies on internet and (4) Giraff is quite tall and has an appearance that can be described as technical. Additionally, Baisch et al. (2017) found in their research that their participants were afraid that Giraff could be perceived as a surrogate for personal visits.

Picture 2. Machine-like social robots, in order Scitos-G5, CompanionAble plaform, Hobbit, MOBISERV platform, MobiNa, Giraff, Care-O-Bot.

Salichs et al. (2016) and Cao et al. (2017) worked with another type of machinelike social robot called the Care-O-Bot. Care-O-Bot is a robotic butler with the abilities to fetch and carry objects, detect emergency situations and contact help when necessary (Lorenz et al., 2016). Furthermore, they discussed MobiNa in their research which is another machinelike social robot. This social robot is a small (vacuum-sized) robot created by Fraunhofer with the abilities to detect a fallen person and make video calls in emergency situations. Picture 2 displays different machinelike social robots.

Humanoid and Human-like Robots

After an extensive literature study, it became apparent that making a distinction between humanoid and human-like robots is not possible. Most of the researchers use humanoid and human-like robots interchangeably. Therefore, both types of social robots will be discussed together.

Past research has shown that there is an increased interest in social robots that have human similarities (Strait et al., 2017; Konok et al., 2018). According to Lee et al. (2017) human-like social robots could be a promising contribution to technology in the healthcare sector that is able to communicate with patients and increase patient compliance since these robots are able to secure multimodal interactions through gestures, speech and facial expressions. This phenomenon is called anthropomorphism. Anthropomorphism entails that we will feel attached to robots and attribute human traits to them because of their human resemblances (Royakkers & Van Est, 2015). Since Khaksar et al. (2016) found that there is an increased demand in human-like social robots compared to pet-like robots. Therefore, there are already quite a few human-like social robots on the market.

An example of such a social robot is Kaspar. This social robot is designed to establish joint attention, imitation, turn-taking, cause and effect and collaboration (Mengoni et al., 2017). Another one is called ELLIQ, an active aging buddy (Chang et al., 2018). This social robot developed by Intuition Robotics has a "head" as a display that can move. Other characteristics of this social robot are a voice able to speak a natural language and the ability to interact with its user. ELLIQ can remind its user about appointments, medicine use, and support the user in staying connected with the outside world (Chang et al., 2018).

The most often used commercial human-like social robot is NAO (Tan et al., 2018). Developed by Aldebaran Robotics, this social robot is interactive, autonomous and programmable (De Graaf & Allouch, 2013; Lee et al., 2017). Nao weighs 4.3 kilo and exists of a head, pelvis and hands. This social robot communicates by walking, talking and recognising faces and speech (Lee et al., 2017). Furthermore, it has a voice synthesizer, LED lights, and two speakers (De Graaf & Allouch, 2013).

Picture 3. Humanoid/Human-like robots in order Kaspar, ELLIQ, NAO, Matilda, Pepper and Babyloid.

Other human-like social robots on the market are Pepper, Sophie and Jack, Matilda, Hector and Babyloids. Pepper has wheels, is 1.2m tall and has limited capabilities in facial expressions (Tan et al., 2018). Nippo Electric Company developed Sophie and Jack (Chu et al., 2017). Both these social robots have baby-faces and enact diversion therapy based on face recognition, subject registration and tracking, emotion change recognition, voice vocalisation, gestures, emotive expressions, singing and dancing.

The same organisation in collaboration with RECCSI researchers develop Matilda (Khosla et al., 2018). The human attributes of Matilda are the baby-face like appearance, human voice, facial expressions, gestures and her body movements. Additionally, Matilda is capable of recognising voices, human faces, emotion detection and speech acoustic recognition. Matilda can communicate through speech mode, tough panel mode and facial recognition mode (Khosla et al., 2018).

Hector, on the other hand, is a robotic assistant to elderly individuals (Lorenz et al., 2016). Hector is integrated in smart home environments and a remote-controlled centres which provides support for elderly individuals that live independently in a cost efficient and comprehensive manner. Furthermore, babyloids have been developed to give the users a context that resembles caring for babies (Salichs et al., 2016). They are developed to reduce psychological stress and increase motivation of the patient without risk that could exist when using real babies.

As shown above there are numerous social robots being researched, developed and sold around the world. However, the social robot development may be in its infancy, it is on a fast pacing trend to become more prominent in our lives. Since there are so many different types of social robots, the next section will outline different characteristics that belong to a robot to make them social.

1.1.1. Characteristics of Social Robots

Social robots can be constructed with qualities that will make them social partners (Konok et al., 2018). Since social robots are involved in healthcare environments, they need to be able to obey complex and changing rules that may even differ among patients (Azkune et al., 2013). This means that social robots need to be able to understand their environment, its users' intentions and performances, follow therapeutic goals and to initiate meaningful and personalised interaction (Cao et al., 2017). Vallès-Peris et al. (2018) classified the different characteristics of the social robots in five categories and gave examples of the characteristics belonging to the categories:

1. Movement: walking, dancing, moving its ears, flying, swimming, turning somersaults.
2. Care activities: taking care of you, kissing, hugging, feeding you, smelling like mum.
3. Social abilities: playing instruments, hearing, thinking, laughing, crying, telling tales, telling jokes.
4. Non-human stimulus-responses: flashing when pressed or touched.
5. Appearance elements: tails, soft, long hair, half boy-half girl, with wheels (p. 979).

Besides the five categories given by Vallès-Peris et al., there have been additional general findings on how social robots need to be designed. It is according to Sim and Loo (2015) imperative that social robots have abilities to estimate friendship, imitate empathy, understand their user, learn and improve itself based on gained knowledge. The user must be able to interpret and make sense of the behaviours and actions of the social robot without having to understand the technical capabilities of this technology (Frennert et al., 2017).

In other words, social robots should display an equal intelligence as humans (Frennert et al., 2017). This means that current developed social robots will mainly focus on providing social services and less on entertainment (Khaksar et al., 2016). Therefore, social robots do not have to have well-defined tasks, they only need to be able to socially interact with their users (Tan et al., 2018). According to Konok et al. (2018) it also means that a social robot should not be perfectly obedient, because minor imperfections provide the social robot with a sense of realness. When focusing on the five characteristics, the following findings can be found.

Movements

For social robots to be used in the everyday lives of elderly individuals, it is important that they fit in the living spaces of these individuals (Meister & Schulz-Schaeffer, 2016; Frennert et al., 2017; Tan et al., 2018). According to these authors, this means that a social robot is able to move within a room that is filled with furniture, carpets and thresholds and it should be able to handle light reflections coming from lamps and the sun. In other words, the living environment of a user consists of a large number of important variables that all have to be programmed into the social robot so it can sense them, but at the same time this environment is dynamically changing (Meister & Schulz-Schaeffer, 2016). Furthermore, to increase interaction social robots need to show reactive and attentive behaviours (Cao et al., 2017). All these movements and rotations a social robot has to make need to happen at the appropriate speed (Tan et al., 2018).

Care Activities

Social robots are developed for a wide variety of activities that assist elderly individuals (Baisch et al., 2017). These activities can be carried out by the social robot at home and/or at work (Piçarra, Giger, Pochwatko, & Gonçalves, 2015). Because there are so many different activities that can benefit elderly individuals it is important that the social robot understands its role so that cues can be given when activities are performed that do not align to expectations of the social robot or user (Meister & Schulz-Schaeffer, 2016). Though in general, activities should be focused on promotion and extension of independent living of elderly individuals (Chang et al., 2018). Therefore, social robots can take on the roles of tutors, peers, buddies, assistant or companions (Bemelmans et al., 2013; Baxter, Ashurst, Read, Kennedy, & Balpaeme, 2017; Chang et al., 2018).

Concrete care-activities that a social robot should be able to do according to Wolbring and Yumakulov (2014) are making a bed, housekeeping, cleaning the house, peel potatoes, read to the person, change the television channel, mowing the lawn, teaching tool guide, companionship, reach objects, replacing light bulbs, reminder cues, GPS, building games and reading aid. These activities should provide social and cognitive stimulation (Šabanović, 2010). Furthermore, the activities must be perceived as nurturing (Lorenz et al., 2016) and giving a sense of autonomy by providing the users with a sense of control (Misselhorn et al., 2013).

Additionally, these activities should increase social activity and provide a sense of safety (Bemelmans et al., 2013).

Social Abilities

These days, most social robots are characterised by social interaction and predictability (Royakkers & Van Est, 2015). Social interactions are specifically human, this means genuine social interaction is a situation in which the interaction partners are wilful and a bit unpredictable. However, it also means that we might perceive them as threatening (Misselhorn et al., 2013). Since social robots are predictable, they are often perceived to be only fascinating for a limited amount of time (Royakkers & Van Est, 2015).

Additionally, Edwards et al. (2016) pointed out that users of social robots expect their interaction with the social robot to be based on human-to-human interaction. Therefore, according to Tan et al. (2018) it means that there is an expectation that these interactions are friendly and competent. Trying to meet these expectation, social robots should be based on polite computing. This means the following design principle should be used: respecting user's choice, disclosure, offering useful choices, and using polite expressions (Lee et al., 2017).

Social robots also need to be described by their users to have empathy (Paiva et al., 2017). Empathy is described by Pavia et al. (2017) as "feelings that are more congruent with another's situation than with his own situation" (p. 3). This can be expressed through facial expressions, body expression, physiological responses and action tendencies. However, most social robots still lack in emotional interactions. They are often only able to pretend to care but this is not enough to support a social relationship (Misselhorn et al., 2013).

Only when there is reciprocity the interaction becomes meaningful, because there is a response to the deviating needs, desires, sentiments, and thoughts of the interaction partner (Misselhorn et al., 2013; Paiva et al., 2017). It means there is natural interactions between user and the social robot based on multimodal dialog which means that the social robot understands what its users is saying and why it is being touched (Salichs et al., 2016). The ability to learn and communicate will make a social robot even more social (Khaksar et al., 2016). To facilitate effective communication, it is important that the social robot will not violate the user's personal space (Johnson et al., 2014). Other important points in social interaction are that social robots need to be able to find direction or location by using sound and vision, they should be able to identify the user through speaker identification and face recognition. To take part in a conversation, it needs to have automatic speech recognition and speech synthesis (Tan et al., 2018).

Non-human Stimulus-responses

Not much attention has been paid to non-human stimulus-responses. However, a few remarks can be found. Jones et al. (2015) indicate that appearance, texture, movement, sounds and social qualities effect the level of engagement. This interaction between different stimulus will influence the engagement with the social robot which influences behavioural symptoms. This means that when non-human stimulus-responses do no react as

expected that this might negatively influence behaviour. The use of a friendly interface will improve the social robots potential (Salichs et al., 2016). This might again positively influence behaviour.

Appearance Elements

It is most likely that appearance influences the meaning individuals will ascribe to the social robots (Frennert et al., 2017). Piçarra et al. (2016) indicate that many robotic designers have used human physical and psychological traits in the development of their products to enhance interaction metaphors. However, Edwards et al. (2016), Frennert et al. (2017) and Strait et al. (2017) found a phenomenon called "uncanny valley". According to these researchers this phenomenon states that entities that highly resemble humans can cause aversion in users. In their research, participants scored human-like agents as eerier than agents with low levels of human similarities and prototypic individuals.

In general, a social robot should have a pleasant appearance (Tan et al., 2018). However, Khaksar et al. (2016) indicate that social robots with a face, ears and voice make the social robot more social. Even when individuals have more experience with social robots, it will not affect the "uncanny valley" phenomenon (Strait et al., 2017). This phenomenon is thus learned or dissipated over time and exposure. Additionally, social robots that can be described as atypical, having characteristics that do not belong to one particular category, are also judged eerier, because they cause unnerving feelings. These researchers therefore put forward that designing social robots that exist of greater consistency between features and a larger distance from the robot-human boundary will be practical.

1.1.2. Acceptance of Social Robots

Social robots are considered to be radical innovations (Piçarra & Giger, 2018). These types of innovations are often considered to be unfavourable. According to these researchers this means that for us to use this type of innovation, we need to be able to identify with the social robot and be able to evaluate the consequences of adopting the social robot. A social robot needs to show continually the appropriate behaviours that conform to the array of requirements of the user to retain engagement and motivation to use the social robot (Cao et al., 2017).

To gain user acceptance, revelations and experiences there should be a wide spread adoption and market share of social robots (Frennert et al., 2017). This means there should be an understanding of public perception of emerging scientific and technological innovation to perceive why an innovation will be accepted (Wolbring & Yumakulov, 2014). This is challenging, because accepted social robots are a combination of state-of-the-art technology and social interactions (Tay, Jung, & Park, 2014). How we perceive technical characters when interacting with them is based on ethics (how good or evil is the character?), affordance (is the character helping or obstructing in fulfilling the goals?), aesthetics (how beautiful or ugly is the character?) and realism (how real or fake is the character?; Paauwe et al., 2015).

Furthermore, acceptability can be reached when the social robot is easily classifiable which means there is a clear understanding on robot type, role and behavioural identification (Sim & Loo, 2015). This is achieved

when social robots interact naturally and when interaction is inspired by human interaction abilities (Paiva et al., 2017). Additionally, issues as reliability of services, cost of purchasing and maintenance of a social robot should be considered (Khaksar et al., 2016).

It may be an open door, but social robots should not harm their users and should be safe to work with (Coeckelbergh et al., 2016). This can be assured by a display of ethical behaviours by the social robot (Khaksar et al., 2016). Spekman, Konijn and Hoorn (2018) found in their research that the emotion-based context is also important in adopting social robots. Users who think they can cope with their emotions are more open to be supported by a social robot. So, when considering elderly individuals and their acceptance of social robots, it is important to consider the user-technology fit (Baisch et al., 2017), but also how this technology co-evolves with these elderly users (Frennert & Östlund, 2014).

This first section discussed past and current knowledge on social robots. It outlined the definition of social robots, there application sectors, different types of social robots, the various characteristics of social robots, and what should be kept in mind when acceptance of social robot is considered. As the above showed, the development of social robots might benefit from involvement of different stakeholder groups. How different stakeholder groups have been involved in the past will be discussed below by providing background on public participation and co-creation.

1.2. Public Participation

"Public participation is, in a broad sense, the engagement in the processes of policy- and decision-making not just of the usual professional experts, policy analysts and decision-makers, but also a wider spectrum of social actors" (Joss, 1999, p. 290). Another prominent meaning is that public engagement campaigns for democratic empowerment of non-scientist in decision-making about science (Založnik, 2014; Orthia, 2016). These non-scientist stakeholders can be non-governmental organisations, local communities, interest groups, grassroots movements and individuals (Joss, 1999). Thus, public participation happens in the triangular relationship between science and politics, science and public debate and politics and public debate and is often organised in public (Joss, 1999).

The first author on public participation was Arnstein. Arnstein (1969) explains a ladder of different forms of public participation. The bottom steps are (1) manipulation and (2) therapy. These two steps represent non-participation and enable the participants to be educated and cured by the experts. Step (3) informing and step (4) consultation can be described as giving the participants a voice. Here, the participants can speak and be heard. Though, there is no assurance of change in the status quo. Step (5) placation is an improvement, because participants may give advice. Step (6) partnership is a place where the different groups can negotiate and engage. The last two steps, (7) delegated power and (8) citizen control give the participants full power.

Even though, this ladder was applied especially to the politics and public debate, it is also applicable to other groups that perform public participation activities. Or as Rowe and Frewer (2005) put it in their research: "there has been an international trend toward increased involvement of the public in the affairs and decisions of policy-setting bodies" (p. 251). The use of this approach is increasingly becoming normal practice in democratic

societies (Rowe, Poortinga, & Pidgeon, 2006). Since public participation became more important the research field Science Communication gained much more interest. Therefore, this research area is explained further below.

1.2.1. Public Engagement

"Scientific knowledge aims to produce generalizations based on cause and effect relationships and is in the hands of experts. Practical knowledge belongs to everyone and derives from continuous interaction with reality." (Cornall, Pomatto, & Agnella, 2017, p. 4).

The above described perspective shows that both kinds of knowledge are critical and should interact (Cornall et al., 2017). Especially, since current changing science-society relationships, public engagement becomes more important (Dijkstra, 2017). Science has become an innovative economy which relies on the acceptance of science (Gregory, 2016). Additionally, the invention of, for instance, the Internet makes traditional one-way communication between scientists and their public obsolete (Schäfer & Kieslinger, 2016; Jones, 2017). Reinsborough (2017) confirms this finding by pointing out that scientists need to have a two way communication with their publics to update them on future possibilities of their research and for their public to react to these future possibilities. This is where the research field Science Communication has erupted.

Guenther and Joubert (2017) confirm that science communication has been a growing and maturing field over the last 30+ years. Most chronologies of science communication started in 1985 with the Bodmer Report by the Royal Society of London (Orthia, 2016). However, Gregory (2016) and Orthia (2016) do indicate that there are historical archives giving evidence for public communication of natural knowledge in theatres, parlours, marketplaces and fairs before the word science was invented. The Netherlands is one of the top 10 countries within the Science Communication research field (Guenther & Joubert, 2017).

It is imperative to note that the public communication of science and technology should echo social needs and priorities and determine relevance of science in public health, food security, shelter and safety (Guenther & Joubert, 2017). Constant and Roberts (2017) define science communication as "a process which is increasingly integrated into research projects with 'engaged' methodologies rather that occurring only in separate one-off science communication initiatives or forms of 'dissemination'." (p. 1). Since science communication is a maturing research field, it is important to review its evolution.

Evolution of Public Engagement

Broks (2017) has seen a shift in science communication from PUS to PEST. This means there has been a shift from Public Understanding of Science to Public Engagement with Science and Technology. Science communication is no longer only concerned with selling science and its products, it is focused on involving the public in the process of science and the creation of its products (Broks, 2017).

Schäfer (2009) already observed the creation of newer, programmatic and normative documents forcing the need to engage the public. In the past, the gathering of information was the starting and ending point of

public participation (Merson, 2017). In this Public Understanding of Science discipline there has been a struggle to lose the assumption that public is ignorant of science (Medvecky & Macknight, 2017). This assumption, later known as the deficit model, was acknowledge in the 1970s when respondents were asked in a questionnaire to answer fact-based questions. A wrong answer was confirmations that the public needed to be taught more about science.

Public Engagement with Science is "intentional, meaningful interactions that provide opportunities for mutual learning between scientists and non-scientists" (Peterman, Robertson Evai, Cloyd, & Besley, 2017, p. 783). Here, scientists and the public delve into the benefits and risks of science and technology, get familiar with the other's perspective and detect common grounds on scientific problems. When involved in PES there is no need to reach consensus on decisions (Saikkonen & Väliverronen, 2014). According to Fogg-Rogers, Bay, Burgess and Purdy (2015) the public needs might better correlate with PUS knowledge acquisition while PES interactivity might be considered the overall goal for science in society. Though, PEST does have a considerable interest in 21st century (Saikkonen & Väliverronen, 2014).

Furthermore, Jones (2017) indicates that in the earlier days of science communication the focus was on the public who was traditionally thought of to be problematic. However, more recently there has been a focus on the role of scientists in science communication and their motivations to promote science. This trend can also be observed in the science communication activities, discussed below.

Public Engagement Activities

Science communicators work on crafting messages to boost the likelihood that data is noticed, relevant, and easily understandable (Longnecker, 2016). Many different forms and practices of engagement activities have been adopted (Saikkonen & Väliverronen, 2014). Activities range from participatory conferences, workshops and roundtable discussions to knowledge cafés and alternative techniques (Založnik, 2014).

Ironically, engagement projects are often top-down exercises (Powell & Colin, 2008). Carr, Grand and Sullivan (2017) found the four most used science communication activities to be talks/presentations, media interviews, school-age children outreach programs and publishing for non-scientific publics. Other explicitly named outreach strategies are media appearances on radio, television and in newspapers, participation in science cafés and science museum events and the use of social media platforms (Poliakoff & Webb, 2007; Ndlovu, Joubert, & Boshoff, 2016).

Del Savio, Prainsack and Buyx (2016), Kasperowski and Brounéus (2016), Schäfer and Kieslinger (2016) and Martin (2017) adds citizen science as a science communication activity. During this activity, the public is volunteering in research projects. Projects belonging to citizen science are initiatively started and run by citizens outside of the context of institutional and institutionally-driven projects where non-professional scientist have a small role or are confined to strict formats (Del Savio et al., 2016). In other words, citizen science moments represent a passive citizen contribution to science (Schäfer & Kieslinger, 2016).

It is observed by Jennett et al. (2016) that participants of citizen science develop scientific literacy by observations and experience. Kasperowski and Brounéus (2016) focused on scientific citizenship that is focused on citizens engaging in the discussion about the role of science, research in society and the influence of policy

decisions through the formation of scientific valid data. Science festivals, on the other hand, are one of the fasted growing and exciting forms of public engagement with science (Bevc, Young, & Peterman, 2016). According to these researchers, science festivals are dynamic, diverse and action-packed celebrations. So, what are the advantages of public engagement?

Advantages of Public Engagement

Engaging the public with science can improve public understanding of scientific facts, concepts and have additional influence beyond these aspects (Lee & Kim, 2018). For instance, it can influence cognitive and behavioural outcomes, but gaining knowledge can also affect acceptance of science and its products. Knowledge is widely studied and has a complicated role in public engagement (Rose, Korzekwa, Brossard, Scheufele, & Heisler, 2017). It can be an important measure of individual comfort and/or familiarity with an issue. An advancing level of knowledge is related to different attitudes and trust (Lee & Kim, 2018).

It is known that attitudes often promote behaviours that are comparable (Detenber, Ho, Ong, & Lim, 2018). The attitude towards a behaviour is the extent to which an individual has a positive assessment of an experienced behaviour (Cheung & To, 2016). Furthermore, the power that comes with sharing and creating this knowledge when shared provides also advantages (Broks, 2017). The even distribution of power will be able to quash existing patterns of privilege and therefore minimise unequal representation in Science Communication (Medvecky & Macknight, 2017). This means it provides the opportunity to achieve sustainable development, because of a radical change in attitudes, social equality and political power (Založnik, 2014). But where there are advantages there are also often a few challenges to face.

Challenges of Public Engagement

Rose et al. (2017) have found that it can be quite difficult to make an impact with public engagement. Trying to have different actors interact in public arenas is not simple or straightforward, because of often observed diversities of languages, misunderstandings and mutual distrust (Cornall et al., 2017). Reinsborough (2017) points out that the parties participating in two-way communication are faced with uncertainties about the future, because there is no certainty what the future will look like. This means that all communication will be based on differing images of the future among the participants.

Additionally, scientific results entail uncertainty (Van der Sanden & Flipse, 2016). Often resulting in more questions than answers, which makes communication challenging. Another issue that makes communication difficult is the fact that scientific and political stakeholders consider the role of the public 'post fest' which means there is only a limited role for the public (Založnik, 2014). Carr et al. (2017) and Martin (2017) found that communication is also made more difficult, because there is no understanding of the knowledge of science a public possesses. Gustafson and Rice (2016) indicates that it might be expected that the general public has a deficient and discrepant science knowledge, because of different levels of training, awareness, access to information and interests compared to scientists. This facilitates the deficit model. This deficit model is still

prevalent in addressing the blockade to communication (Winter, 2004; Johnson, Ecklund, & Lincoln, 2014; Založnik, 2014; Merson, 2017).

Additionally, when given the opportunity to engage in new developments, the public often only engages in small numbers (Dijkstra, 2017). This researcher indicates that most of us are interested in the information concerning a new development but have no time or priority to engage more actively and reach higher steps on the ladder of Arnstein. That is a shame, because volunteers are the backbone of public engagement (Alender, 2016).

This lack of engagement might not only be caused by limited participation, but it may also be caused by the fact that the public has always a disadvantage, because they defer to regulators and scientists, abandon their right to interpret information and conform that with their existing knowledge (Merson, 2017). Broks (2017) uses harsher words when talking about science communication. This researcher has the opinion that science communication has failed. However, not everyone agrees with this notion. There are still different methods researched that might enlarge the role of the public in science and product development.

Methods used to involve non-scientists in scientific work have emerged into their current shapes during the post-war period (Kasperowski & Brounéus, 2016). These methods have proven to always make money (Gregory, 2016). Therefore, it can be a weapon in the attack against commercial supremacy. In other words, scientific knowledge has become a commodity that is raw material. This provides opportunity to a greater diversity in scientific backgrounds in leading roles in science processes (Schäfer & Kieslinger, 2016). That is why it is important to think of new ways of integrating public's knowledge with the scientific knowledge landscape. Especially in environmental challenges, medical advancements, scientific innovations and emerging technology will benefit from engaging the general public (Dudo, 2013). This research is researching if co-creation is such a new method.

1.2.2. Co-creation

Michel, Vargo and Lusch (2008) and Grönroos and Voima (2013) have observed the change in focus from a firm-centric to a customer-centric market. In current economy collaboration, social media and values that reflect social, collaborative and shared perspective are important (Busser & Shulga, 2018). Accordingly, customers of products and services are no longer only understood to be receivers, but to actively co-create with organisations (Michel et al., 2008). This also entails a changed focused from good-centred logic to a service-centred logic (Merz, He, & Vargo, 2009). This means that there has been a shift from one-way communication to a dialogue communication process between organisations and their customers (Grissemann & Stokburger-Sauer, 2012). This also makes the implication that consumption and production activities cannot be separated from each other, but that they should be connected (Etgar, 2008).

Traditionally, goods and services are created by suppliers of these products and services and customers only purchase these goods and services (Payne, Storbacka, & Frow, 2008). In 2008 by Payne et al. (2008), the observation was made that customers can engage in a dialogue with suppliers during the whole process of product design and delivery. "Co-creation is the participation of consumers along with producers in the creation of value in the marketplace" (Zwass, 2010, p. 13). It can be examined from various perspectives. However, the

value of the co-creation process "involves the supplier creating superior value propositions, with customers determining value when a good or service is consumed" (Payne et al., 2008, p. 84). However, according to Marshall (2013) academics and practitioners are disconnected from each other. In other words, research has still little influence on the practice.

This section is focused on consumers and suppliers. The reason for this is the fact that co-creation has its origins in the marketing communication field. This marketing communication field has evolved to a focus on combining tacit and codified knowledge (Bolton & Saxena-Lyer, 2009). This means that the division between the collective (non-market, public) and commercial (market, private) approach to production and division between producers and customer is being erased (Van Dijck & Nieborg, 2009). This prior knowledge indicates that even though co-creation is often used as a marketing tool, it can also be used in other domains since it is conceptualised in many ways (Sugathan, Ranjan, & Mulky, 2017). Especially in the Dutch healthcare sector. The Dutch healthcare sector is privatised and thus commercial. This means that the general public, but also the government and other parties have a say in the use of services and products. Accordingly, the referral to customers and producers in this research field can be applicable to the participants referral in this research.

Formation of Co-creation

There has been a shift from a goods-centred model of economic exchange to a service-centred model of economic exchange (Merz et al., 2009). The good-centred model is focused on operand resources. These are resources "on which an operation or act is performed to produce benefit" (Merz et al., 2009, p. 329). They are often static (Edvardsson, Tronvoll, & Gruber, 2011). In the service-centred model, customers can co-create value with their service and product providers, giving them service and products that serve their needs and give them enhanced satisfaction (Dong, Evens, & Zou, 2008).

Therefore, co-creation can be understood to be fundamental (Suntikul & Jachna, 2016; Immonen, Sintonen, & Koivuniemi, 2018). In co-creation customers are perceived to be important, because they are treated as operant resources (Merz et al., 2009). These resources are dynamic and can be rejuvenated and replenished (Edvardsson et al., 2011). This shift can be summarised in four different eras. These eras differ because of how customers are perceived; it started with the Individual Goods-Focus Brand Era (1900s-1930s), followed by the Value-Focus Brand Era (1930s-1990s), to the Relationship-Focus Brand Era (1990s-2000) and currently we are in the Stakeholder-Focus Brand Era (2000 and forward; Merz et al., 2009).

Currently, the stakeholder becomes the focus of value extraction (Van Dijck & Nieborg, 2009; Merz et al., 2009; Zwass, 2010). This era is described by Kang (2017) as the social era. In other words, co-creation is the engagement of both consumers and producers in the creation of value (Zwass, 2010). However, the reaction to co-creation may differ depending on product types and usages and the willingness to engage in co-creation with that product (Kang, 2017). Füller, Hutter and Faullant (2011) found that relational resources of an organisation are important along all stages in product development which starts with the problem recognition and idea generation phase

and ends with prototype testing. Another very important fact is that co-creation can be a cost-efficient strategy for organisations (Roggeveen, Tsiros, & Grewal, 2012).

Co-creation Framework

Co-creation theory "postulates that value co-creation stimulates customers' engagement with the brand" (Huang & Chen, 2018, p. 126). Co-creation according to the economic perspective is not a production relation but a voluntary exchange relation based on complex and subtle incentives and forms (Banks & Potts, 2010). The approach is based on interaction and dialog (Shaw, Bailey, & Williams, 2011). Payne et al. (2008) put forward a "robust process-based value co-creation framework" (p. 85). This model exists of three components:

1. Customer value-creating processes – These are the resources and practices of customers which they use to conduct their activities.
2. Supplier value-creating processes – These are the processes, resources and practices of suppliers which they use to manage and maintain their businesses and its relationships with various stakeholders.
3. Encounter processes – these are the processes and practices of interaction and exchange between customers and suppliers that are needed to manage successful co-creation opportunities.

Busser and Shulga (2018) define this co-created value as "a personal appraisal of the meaningfulness of a target (product or service) based on what is contributed and what is realized through the process of co-creation" (p. 69). The three areas that might have potential positive outcomes, namely organisational, personal and collaborative outcomes (Busser & Shulga, 2018). Co-creation is starting to be applied more often by organisation to ensure that the product aligns more with the customer needs (Buonincontri, Morvillo, Okumus, & Van Niekerk, 2017).

Co-creation in the customer interface can be digitally or in direct human-to-human interaction (Grönroos & Voima, 2013; Immonen et al., 2018). All activities however do take place in a social system (Edvardsson et al., 2011). However, during co-creation activities the group should resemble an emergent coordination of voluntary endeavours without role assignment and/or managerial structure (Zwass, 2010; Iandoli, Quinto, Spada, Klein, & Calabretta, 2018). Interaction of these different groups happen in random order and sequence (Grönroos & Voima, 2013). Important to notice is that there is a wide range of activities belonging to co-creation. Additionally, customer involvement is an evolving field with a lot of unclear definitions (Cui & Wu, 2016).

1.3. Variables Related to Social Robots, Science Communication and Co-creation

The above shows that past research has dived in many different aspects of social robots, science communication and co-creation, especially when it comes to variables related to these research fields. This knowledge is highly relevant and therefore will be discussed here with the intention to already receive an understanding of topics that might be discussed by the participants of this research.

Tay et al. (2014) indicated that the Theory of Planned Behaviour (TPB) and perceived trust predicts the acceptance of social robots. The TPB is focused on intention, attitude, perceived behavioural control and subjective norm (Poliakoff & Webb, 2007; Piçarra et al., 2016). Dong et al. (2008) and Zheng, Li and Hou (2011) define participation intention as the prediction of the actual participation in a co-creation task which can be engagement in the production and/or delivery of products/services. Intention is also related to engagement in future co-creation activities (Dong et al., 2008).

When participating in science and technology attitudes are affected (Vitone, Stofer, Steiniger, Hulcr, Dunn, & Lucky, 2016). Attitudes towards using a technology are determined by perceived usefulness and perceived ease-of-use (Piçarra & Giger, 2018). Perceived usefulness is the perception of an individual that the use of technology is going to improve its performance. Perceived ease-of-use is the effort an individual uses to operate a technology. Attitudes are understood to have three different components, namely cognitive, affective and behavioural (Damholdt et al., 2015). Attitudes towards a behaviour is an individual's evaluative stance against a behaviour and the consequences of that behaviour (Piçarra & Giger, 2018).

Tay et al. (2014), Martin, Smith, Bowling, Christidis, Lloyd and Pecl (2016) and Piçarra and Giger (2018) define perceived behavioural control as the evaluation of the ease or difficulty of displaying the behaviour of interest based on personal competencies, available material resources and behavioural constraints. This variable directly influences the individual's own behaviour (Cheung & To, 2016). Subjective norms are the perceptions of an individual regarding the approval or disapproval of significant others when performing a behaviour (Poliakoff & Webb, 2007; Tay et al., 2014; Piçarra & Giger, 2018).

The importance of trust is already pointed out in the TPB model and Bolton and Saxena-Lyer (2009), Zwass (2010), Zheng et al. (2011) and Huang et al. (2018) confirm this importance of trust in their research. Trust can be defined as the confidence one has that the other party will keep its promises (Busser & Shulga, 2018). The level of mutual trust between the participants contribute to the weight of the contribution (Zwass, 2010). In other words, "trust determines the acceptance level of suggestions made by the automated devices, and proper trust is pivotal in helping users overcome the perception of risk and uncertainty before the use of a new technology" (Tay et al., 2014, p. 77).

At the same time, De Graaf and Allouch (2013) find that there are three considerations influencing the decision to use a social robot, namely (1) user's evaluation (2) social normative believes of the user and (3) contextual factors. Social normative believes are dispositions we hold towards our general behaviour. This is based on dispositions and rules that are used to determine appropriate and inappropriate values, beliefs, attitudes and behaviours. These same variables are also found when talking about successful science communication.

Fogg-Rogers, Sardo and Boushel (2017) found individual capabilities, believes, normative believes and support to also be important. Here normative believes are described as the approval or disapproval of the behaviour shown and the motivation to show the expected behaviours (Martin, Christidis, Lloyd, & Pecl, 2016). De Graaf et al. (2015) found another five hedonic factors related to user's experience when using a social robot,

namely enjoyment, attractiveness, anthropomorphism, sociability, and companionship. In earlier research, De Graaf and Allouch (2013) had additional factors namely adaptability and usefulness.

Other variables that are important when considering introducing science communication are behavioural beliefs, injunctive norms, descriptive norms, control believes and social norms (Martin et al., 2016). Behavioural norms are beliefs an individual has about the result of a behaviour. Injunctive norms is the pressure an individual can feel from other individuals that are important to them while descriptive norms are perceptions of behaviour of others, whether they show that behaviour or not. Furthermore, control believes or the degree to which someone can perform and control their control over performing a certain behaviour. The last variable, social norms is about the influence of others.

This whole research is focused on seeing if engagement in the development of social robots is possible. Therefore, engagement is also a very important variable to consider. O'Connor and Stevens (2015) explain engagement as a "sense of enhancing the audience's sense of level of involvement in the scientific process" (p. 1). To be robustly engaged, three different dimensions should be considered, namely cognitive engagement, affective engagement and behavioural engagement (Geiger, Swim, Fraser, & Flinner, 2017). Another important variable is visibility (Johnson et al., 2014). Visibility is the extent to which a scientist or the work of the scientist is known (Johnson et al., 2014). Longnecker (2016) further indicates the importance of information availability, community approval and external support in implement any change.

The information above entails variables found in prior research into social robotics and public engagement. The above can thus be expected to be important in research related to social robots and public engagement. It may be expected that these variables may then also be reproduced in this research.

1.4. Social Robots and Co-creation in Elderly Healthcare

Now might be the time in which it is very relevant to study potential conflicts. We are namely faced with stories ahead of their time which might already be influencing legislation related to existing societal issues about the presence of social robots among us (Stengler & Escudero Perez, 2017). Especially in Europe and the United States in which the development of robotics for domestic use, healthcare environments, traffic, policy and army are embraced by policymakers and industry (Royakkers & Van Est, 2015).

Currently, the context of use of the social robot is only considered after the social robot has been developed and is ready to be evaluated (Šabanović, 2010). According to this researcher, we are not yet included in the production and design processes, because we as the public are faced with the complexity of an advanced socio-technical system which leads us to leave the direction of future development in social robots to experts. However, when there is only a focus on the technical side of the development of social robots, the complexity of the social world in which social robots need to operate is not considered (Pfadenhauer & Dukat, 2015). But making social choices is an integral part of the daily practices of social robots that is why Šabanović (2010) already advocated for the inclusion of users in early stages of design.

Šabanović (2010) indicate that individuals who are going to be directly impacted by a technology and who have tacit knowledge of the application domain should have the chance to influence the design of the technology, the use of the technology and the social meaning of the technology. This researcher points out that the mutual moulding of a social robot offers the opportunity to consider different social values and meanings of diverse groups through the process of the design of the social robot. There are three groups directly related to the development of social robots, namely patients/users, employees that need to work with and work alongside robots and the technical experts. All these different stakeholders represent a complex network of different interests and desires (Jenkins & Draper, 2015).

Elderly individuals and healthcare professionals should be considered separately as stakeholders in the design process of a social robot, since there is serious tension between the two groups regarding the introduction of social robots (Jenkins & Draper, 2015).However, Frennert and Östlund (2014) point out that often elderly users of the social robots are used as objects in research, but are not involved in the research itself. Thus, they have a limited or no role in the design process. Healthcare professionals should engage, because social robots can support them in their work (Bemelmans et al., 2013). This support might become more and more necessary since there is an observed limited availability of healthcare professionals in the future (Bemelmans et al., 2013; Frennert & Östlund, 2013; Khosla & Chu, 2013). Therefore, Royakkers and Van Est (2015) advocate for a value sensitive design in which developers and researchers take into account wishes and needs of caregivers and care recipients.

At this moment, however, the research and development of social robots does not align with product delivery to the market (Bemelmans et al., 2013). Bemelmans et al. (2013) and Frennert and Östlund (2014) even indicate that successful implementations of social robots can only be achieved when users can contribute in the design process. This will support the development of attractive and acceptable social robots (Šabanović, 2010).

Co-creation in Science Communication has become a relevant goal for increasing engagement and democratisation (Rock, McGuire, & Rogers, 2018). The extent to which different types of engagement mechanisms for controversial scientific issues are successful in real-world settings remains an empirical question (Rose et al., 2017). Each different group and individual holds different believes about science and the application of science and thus crave contrasting methods of learning, understanding and engaging with science. Therefore, with all the gained knowledge over the past decades, the methodology chapter will explain how this research tries to observe whether or not co-creation is a form of public participation that can engage robotic researchers, elderly individuals and healthcare professionals in developing a robot together.

3. Methodology

As discussed in the introduction, the changing healthcare sector presents a challenge for countries around the world. Additionally, it is believed that social robots might offer a solution to this challenge. The claim of this research is that co-creation can support the development of these social robots. To study this claim, this chapter will start by discussing the research design followed by the description of participants, data collection, research procedure and data analysis.

3.1. Research Design

The aim of this research is to explore and understand why robotic researchers, healthcare professionals and elderly retirement home residents will engage in co-creation of social robots. Therefore, the choice was made to base this research on interviews and focus groups. These two qualitative research methods are able to uncover social norms (Martin et al., 2016). This is very important since the theoretical framework pointed out that a large part of deciding to join engagement activities is based on the opinions, support, and believes of the external environment of an individual. Additionally, qualitative methods are useful in "gathering complementary evidence on relational aspects involving participants" (Cornall et al., 2017, p. 15). Another reason for choosing these qualitative research methods is that Johnson et al. (2014) found that most research into public engagement is based on quantitative research methods.

The use of semi-structured interviews provides a research environment in which the use of flexible and open-ended questions creates richer data and a genuine conversation flow between the participant and the interviewer (Grand, Holliman, Collins, & Adams, 2016). Additionally, semi-structured interviews can give participants the opportunity to give an insight in their lives (Bizzi & Langely, 2012). This will give the participants of this thesis the freedom to provide information they perceive to be important, but is not drafted in the interview guide (Newman, Bidargaddi, & Schrader, 2016).

Focus groups were used to enact a co-creation activity. This is an activity in which value or experience is created (Suntikul & jachna, 2016). By conducting the focus groups, the participants could indicate how much they liked to participate in these kinds of assignments and how they appreciated their participation.

3.2. Participants

This research is focused on three different participants groups which are robotic researchers, healthcare professionals of two large healthcare organisations in the eastern part of the Netherlands, and elderly retirement home residents. The interviews were conducted in collaboration with all the three participant groups. The focus groups were done in collaboration with the healthcare professionals and the elderly retirement home residents. Important to notice is that all participants involved in this research have no diagnosed cognitive disabilities. They were thus all capable of indicating if they wanted to participate in this research. Furthermore, there was no overlap in participants between the interviews and the focus groups.

The three robotic researchers are three Dutch women (participants 1, 2 & 3). Two of these researchers were asked to participate based on an Internet search of robotic researchers in the Netherlands. The third researcher was asked based on the recommendation of the already involved robotic researcher found in the Internet search. All robotic researchers participating were connected to three different higher educational institutions in the Netherlands. Their research interest was all focused on (social) robots, making these three participants the robotic research experts of this research.

The healthcare professionals (participants 4, 5 & 6) participant group exists of two females and one male participant. The healthcare professionals were asked by their own management to participate in this research. They all worked on the 'somatiek' department of an elderly retirement home. All three represented different ages, but they were all long-time employees at the healthcare organisation. This makes them the healthcare experts of the semi-structured interviews.

The elderly retirement home residents were three women (participants 7, 8 & 9). These elderly retirement home residents were contacted based on recommendations made by a healthcare professional working at the elderly retirement home. In other words, there was limited control on participant choice regarding healthcare professionals and elderly retirement home residents by the researcher.

The two different focus groups were conducted in two different healthcare organisations. The focus group of the elderly retirement home residents were done at an inhouse day-care facility at an elderly retirement home. In total six of the regular attending elderly individuals were asked to participate by the organisation. In total, six participants were asked based on two reasons. The first reason is that this number facilitates good interactions and discussions between the participants. Secondly, six is an equal number which has a preference for this research because the participants have to work together. An equal number is than often perceived to be easier. On the day of this focus groups, one participant fell ill and could not participate. Therefore, this group had five participants. Two of these five individuals were male and the remaining participants were female.

The other focus group was conducted with healthcare professionals at a home care department. In total eight individuals were asked to participate. In total, six individuals were able to attend. Again, an equal number of participants were asked to participate, because of the above mentioned reasons. Of these participants, one was male and five were female. They all differed in their work experience in the healthcare sector.

3.3. Data Instrument

As earlier mentioned, the data instruments of this research are individual semi-structured interviews and focus groups. This section will clarify the data instruments that were used.

3.3.1. Semi-structured Interviews

The main focus of the semi-structured interviews is to get an understanding of utilitarian factors (practicality and usability) related to social robots (De Graaf & Allouch, 2013). This means that most of the pre-defined questions are related to getting to know why participants would accept and/or use social robots and if they would mind participating in social robot co-creation.

The interview guides of the robotic researchers, healthcare professionals and elderly retirement home residents (Appendix A, B, C) were built on three themes. These themes are individual context, social robots and co-creation. In the individual context, participants were asked about background information related to their work or living conditions and their technological experience and attitudes. Within the social robot theme questions are related to knowledge about social robots, the usability of social robots in healthcare and the influence of social robots on healthcare. In the last theme, co-creation, questions are asked concerning the willingness to co-create and conditions that should be created to have a successful co-creation activity.

During the interviews with the healthcare professionals and the elderly retirement home residents a small news item about social robots from RTL News was shown. This decision was made to make sure that all the non-experts had the same reference frame. Additionally, since the interview guides were semi-structured multiple questions were asked to the participants regarding clarification of answers given by the participant groups.

The semi-structured interviews of the robotic researcher lasted between the 29 and 40 minutes. The interviews of the healthcare professionals lasted between the 16 and 26 minutes. The elderly retirement home residents took between the 22 and 26 minutes to finish their interviews. After the interviews were conducted, the two focus groups were arranged.

3.3.2. Focus Groups

In total, two focus groups were conducted. They lasted between the 113 minutes and 56 minutes. These focus groups were based on one focus group protocol (Appendix D). The same focus group protocol was used for the elderly retirement home residents and the healthcare professionals. This decision was made, because the goal of the focus groups was to gain generic information based on what social robots should be able to do, how they should look and what the involved participant thought about their participation in this activity.

To get these insights, the focus group protocol was quite extensive. The first part of the focus groups was based on the same small news item from RTL News as used in the interviews. Again, this decision was made to give all the participants the same reference frame.

To support the participants, the next two sections had supporting materials. These support materials were provided to give the different participants more confidence in the fact that they could do the task. The supporting materials are, firstly, the rules participants should adhere to during the focus group session (Appendix E). When the participants were asked to indicate what they want a social robot to be able to do, they were provided with a paper with three different characteristics that belong to a social robot (Appendix F). These characteristics are based on findings of the theoretical framework and were listed on an A4 to give guidance to the participant. During the last activity in the focus groups, the creation of a social robot, the participants were given scissors, markers, paper and glue. Additionally, multiple visual cues were given to be able to make the social robot (Appendix G).

The elderly retirement home residents focus group were provide with additional support materials. They received a filled out A4 paper with different characteristics of social robots (Appendix H). Furthermore, they

received three differently designed social robots (Appendix I). These materials were provided to this participant group to give them more inspiration for filling out their own A4 and creating their own social robot.

3.4. Research Procedure

To make sure that the research was one in the most objective way, the same research procedure was used as often as possible. Here, the different research procedures in this research will be discussed.

3.4.1. Semi-structured Interviews

The semi-structured interviews were done in locations that were of convenience for the participants. As a result, the semi-structured interviews with two of the three robotic researchers were done through telephone applications. All the other interviews were done on location and face-to-face. All the semi-structured interviews started by asking the participant to read the informed consent form (Appendix J, K & L) and when agreeing with this to sign it. After the document was signed, the audio tape was turned on and the interview started.

3.4.2. Focus Groups

The focus groups were conducted on location and face-to-face. The focus group with the elderly participants took place at the day care location. The participants were first asked to read the informed consent form (Appendix M). After reading the document, they were asked to sign the document. During the focus group with the elderly individuals one of the leaders of the day care location was requested to be present. During this focus group, this individual often translated asked questions to make them more understandable for the participants. This involvement was very valuable, because it made the elderly individuals more talkative.

The focus group with the healthcare professionals was also conducted on location and face-to-face. The participants of this group were also first asked to read the informed consent form. When they agreed with the form, they were asked to sign it. After signing, the recording was started.

3.5. Data Analysis

After the semi-structured interviews and focus groups were conducted, they were fully transcribed from the available audio. These transcripts were uploaded in Atlas.Ti8. Here they were analysed. To analyse the transcripts codes were used. Coding is the activity in which sections of text get assigned codes that can be words or phrases (Buckland-Nicks, Castleden, & Conrad, 2016). The coding scheme of this research is shown in table 1.

Coding was done by using the inductive approach. This means that the data received in the interviews and focus groups was clustered in different codes which were formed based on this information. This approach is most appropriate, because this research is focused on understanding if co-creation is a possibility in social robot development. This means that there is not yet a concrete answer to be found on this question and that this research is focused on understanding what is going to be important in co-creation in social robots.

The used codes are displayed in table 1. Coding was checked by an independent coder without prior coding knowledge. Two different transcribed semi-structured interviews were re-coded by this independent coder. Comparing the analysis resulted in a Cronbach's Alpha of .876 (Appendix N). A measure with such a high

reliability will produce the same value when all conditions are the same (Warrens, 2015). The alpha of this study was above .7, a score above the acceptable threshold explained by Terwee (2007).

Table 1

Coding scheme semi-structured interviews and focus groups

Theme	**Code**	**Definition**
Individual Context		This theme is based on understanding their frame of reference.
	1. Background	The personal story and opinions of the participant related to the participants' current situation and thoughts about different topics
	2. Technical Expertise	The experience the participants have with technology in general.
	3. Advancements	The experienced changes in the environment of the participant especially technological changes.
Social Robots		This theme is based on finding personal feelings, thoughts and experiences based co-creation.
	4. Social Robot Expertise	The experience and the definition the participant has with social robots.
	5. Appearance	The explanation by the social robot of how the social robot looks.
	6. Movements	The explanation given of particular movements different parts of the social robot should be able to make.
	7. Care Abilities	The explanation given of what kind of tasks the social robot is able to do in regard to taking care of their user.
	8. Social Abilities	The explanation given of what kind of social behaviours a social robot should be able to display to be of added value
	9. Future Expectations	The expectations the participant has about the evolution of the social robot.
Co-creation		This theme is based on finding personal feelings, thoughts and experience based on co-creation.
	10. Co-creation Circumstances	The circumstances that need to be created to have a successful co-creation.
	11. Motivation	The reason why someone wants to be involved in the creation of social robots.
	12. Added Value	The belief of the participant of the value of co-creation in social robots.

The codes displayed in table 1 provides this research with valuable information that will be explained in the result section. Since the qualitative research methods were done in Dutch, the quotes used in this research to illustrate findings have been translated. The original quotes and the translation can be found in Appendix O.

4. Results

This chapter will outline the findings of the semi-structured interviews and the focus groups. Both results will be discussed separately. First, the semi-structured interview findings will be shown. Secondly, the findings of the focus groups will be presented.

4.1. Semi-structured Interviews

Since the semi-structured interviews were built on the use of three themes, the results will be presented conform these themes. This section will start with the individual context, followed by the social robot theme and end with the co-creation theme.

4.1.1. Individual Context

This research was based on the opinions, feelings, thoughts and predictions of three different participant groups. These three groups differed in experiences related to technology in general and more specifically related to social robots. Important to point out is that all participants became acquainted with social robots or assistive technologies through indirect ways such as their studies (robotic researchers), their work environment (healthcare professionals) or television/radio (elderly retirement home residents). This means that experience levels differed between the participant groups and the participants within a group.

For instance, robotic researchers had more technical and usability knowledge of social robots in comparison to the other groups. Within this group, the participants had different expertise areas. This means that they all had different levels of knowledge about certain parts of the social robot research area. Healthcare professionals, on the other hand, had knowledge about the application of robotics in the healthcare environment. An often mentioned application was the patient lift. Furthermore, the elderly retirement home residents experienced the development of different technologies as for instance computers and the Internet. However, they indicated that these products went beyond their comprehension since they never received appropriate education about these innovations.

The indicated difference in knowledge of social robots is important to notice, because this prior knowledge influenced the focus of the different interviews. The robotic researchers were more often focused on the importance of co-creation in the development of social robots. Their experience showed for instance that "after one/two year(s), an organisation is bankrupt, because the social robot application is not something people want to spend their money on" (Participant 2). This was a reason for this participant group to indicate that they perceive co-creation to be beneficial.

The healthcare professionals focused more on the place of social robots in healthcare situations. They experienced that technologies for instance the computer and blood pressure devices brought them relief in their work. They indicated that they do not want to work without these innovations anymore. However, since most changes they faced were not related to technological changes, they are cautious about the part of social robots in healthcare. Participant 5, for example, mentioned the following: "In regular elderly care social robots are not

often used. Currently, they are most often used in dementia care". This participant group thus has knowledge about social robots in the care of individuals with limited cognitive abilities but had not gained yet experience with these technologies by working with them. Furthermore, it is not totally clear to these participants as to what the social robot is going to be able to do. Participant 4 indicated "I do not yet know what such a robot is going to do for me. Look, when I know I will be able to say what the added value of the robot is".

However, during the interviews, it turned out that besides the robotic researchers, two healthcare professionals had prior experience with social robots. All this gained experience in social robotics, as earlier mentioned, was obtained in the healthcare areas that are concerned with individuals with limited cognitive abilities as for instance dementia and autism. Nevertheless, this experience was positive. The healthcare professionals agreed that the social robots were able to calm their clients making it easier for healthcare professionals to work with them.

The elderly retirement home residents had experience with technological innovation, for instance, the patient lift. However, in general, they indicated that they do not feel like a lot of technology is used in their care. They indicated that they were willing to try these social robots, but they were quite reserved; "Yes, yes, well open, if there is no other way, it is a logical development" (Participant 9).

4.1.2. Social Robots

All participants had difficulties with talking in general terms about social robots. The robotic researchers found it difficult, because they believed that the development of social robots should be related to the context in which it has to operate. Thus, the development depends on target groups and environments. Participant 3 made the following remark: "Can you make it more specific, because I think it makes a difference in context, ownership, related individuals, which applications. I, I see a difference".

The healthcare professionals and elderly retirement home residents found it difficult, because they had not much experience with social robots. However, they indicated that they wanted to try out working with social robots: "I think, it seems fun to try out such a thing. To see how it works in the care environment and how people will react to it and which benefits we will experience. What problems we will encounter or not encounter." (participant 6). Participant 7 said the following: "I do not know. I first have to work with such a robot and then maybe I can say something about this innovation. I cannot just say that I like them. No, I first need to have worked with the robot".

Additionally, all participants agreed that attention should only be focused on developing social robots that do things we as humans cannot do or cannot do well. Furthermore, the social robot needed to have added value. This meant for the elderly retirement home residents that they would keep the freedom to keep doing the activities that they are able to do. Healthcare professionals expected the social robots to take over those tasks that would provide them with more time to spend with their clients. The robotic researchers added that their work is focused on finding solutions for human limitations and are therefore not interested in developing social robots for situation that can be perfectly handled by humans.

The points above were points on which the different participant groups agreed. There were also a few points on which the different participant groups disagreed. One of these points were the abilities of social robots. The robotic researchers already indicated that the development of social robots should depend on the user group and the context in which it would be used. This is illustrated by the explanation of the healthcare professionals and the elderly retirement home residents when they described the abilities a social robot should have.

The healthcare professionals of this research indicated that they would prefer to have a social robot that is able to do bodily controls (sugar levels, temperature, etc.) and send them signals when something is wrong with the client. Additionally, the social robot should represent a general communicative tool that can provide the user with attention. On the other hand, the elderly retirement home residents wanted to have a social robot that is able to vacuum clean, read out loud, give support during toilet breaks and going to bed, take the client out for a walk, provide support to the healthcare professionals and play games. In other words, they should improve mobility and provide general support when no formal or informal caregiver is around.

The robotic researchers agreed with the elderly retirement home participants that the social robots should give them more autonomy. This meant that they thought that social robots should support users in doing more things alone without the support of for instance healthcare professionals. However, were healthcare professionals and the elderly retirement home residents often talked about the abilities one social robot should have, robotic researchers indicated that they thought that the use of one social robot that can do multiple tasks is a future scenario or might not even be developed: “Yes, I do not know. If you want a robot that can cook and bring you to school or, I do not know, therapy and mow the grass. That, then he has to. Than it will be a kind of Swiss Army Knife of a robot.” (participant 1).

This indicated that robotic researchers do not expect that one social robot will be able to do many different tasks. However, the healthcare professionals and the elderly retirement home residents often only talked about the abilities one social robot should have.

This ‘one social robot’ might not happen quickly in the future since the current focus in robot development has been on the appearance and shape of social robots. This has resulted in social robots that fit in ones living space, are safe and look trustworthy to the user. These are important changes. However, it also represents a second point of disagreement since healthcare professionals and elderly retirement home residents did not refer to these characteristics when talking about the appearance of social robots.

They put the emphasis on the fact that social robots should fit the sense of reality that their elderly users have. This sense of reality depends on the cognitive ability of the users. For instance, one elderly retirement home resident stated that it was unlikely that she would every interact with a robotic doll or animal while another contradicted this statement by indicating to not minding having a robotic animal. This illustrates that even though general improvements in appearance of the social robots are important and advance the social robot acceptance, they might not be something the user groups think of when considering important improvements

The different participant groups also perceived different hurdles related to the use of social robots. This view of different hurdles can be based on how the different participant groups perceived the role of social robots. The

participant groups agreed with each other that social robots will never replace humans. Participant 3 illustrated this with the following statement “You often hear that, yes, that robots will replace us. I think that this will never happen. I think that it is an overestimation of robotics and a underestimation of the abilities of humans”.

Furthermore, speech recognition and speech interaction are not yet well enough development that a user is able to have a conversation with the social robot. The robotic researchers described existing interaction technology to facilitate disproportionate communication between the user and the social robot. This may cause a lot of irritation, because for a robot to be social it needs to be able to say the right things at the right moment and it needs to comprehend norms and values.

This is an important limitation to consider since elderly retirement home residents stated that they fear social robots will not possess human warmth and speech abilities. Therefore, they expected to feel uncomfortable when working with a social robot and kept preferring to conversate with family and healthcare professionals. Healthcare professionals shared a comparable concern. They thought social robots are cold and frigid and do not possess the empathy levels humans show. Additionally, they doubt that social robots will be able to support elderly retirement home residents as humans can, since humans often choose a healthcare profession based on an internal passion for caring for others.

When the different participant groups were asked about the future of social robots, they thought that this innovation would become more important in the future. Elderly retirement home residents and healthcare professionals expected that with the new generation it will become more easily to introduce social robots. Since the new generation will probably get more education and experience on working with social robots. However, healthcare professionals stated that social robot users with limited cognitive abilities will always earlier adopt social robots than other users.

Additionally, the healthcare professionals indicated that the development of future social robots should be focused on keeping healthcare humane. Therefore, the robotic researchers put emphasis on the importance of focusing on ethical and social issues related to the development of social robots in the healthcare environment. The robotic researchers additionally indicated that there were already a lot of robotic solutions used in the healthcare environments, for instance smart beds and other applications that are able to perform many task (taking temperature, etc.) less intrusive than when they are done by healthcare professionals.

4.1.3. Co-creation

The semi-structured interviews showed that there is a difference in how participant groups perceived the benefits of co-creation. During the interviews with the elderly retirement home residents, the participants often switched in their opinions related to co-creation. At one point in the interview they indicated to perceive the benefits of co-creation. However, at another moment they put forward some issues. One was privacy. These participants were unappreciated of the fact that they had to be observed. Another issue was a private personality. This issue was also mentioned by the healthcare professionals. According to these participants, this type of personality makes it difficult for individuals wanting to participate in co-creation activities. Participant 5 indicated “I have always been a little afraid that I, that I, yes. I always become a little insecure of these kinds of

things. I namely do not know if I am the right person for this". This type of personality can thus cause decreasing levels of comfort when participating in co-creation. However, the healthcare professionals and elderly retirement home residents stated that they would not walk away from new innovations.

An additional issue was mentioned by a robotic researcher. Participant 1 stated that current generations of elderly individuals can be described as "I listen to the doctor generation". This illustrated that this generation is often not known to engage in discussions with individuals who can be characterised as experts in their field of profession. Other robotic researcher validated this point by mentioning that it was difficult for individuals not engaged in technological innovations to understand or explain what they want.

Another reason given by the participants for not joining co-creation initiatives were time limitations. Therefore, according to the robotic researchers it was important to have time and the right mindset for successful co-creation. The mindset should be that the involved individuals believed that working together would provide better solutions. To achieve this, individuals need to be open and have a willingness to listen and work with individuals from different disciplines. This meant that different stakeholders involved needed to have a feeling of ownership of the project they are working on. Additionally, there should be no accessibility, availability and financial issues. Healthcare professionals put forward the following points: meeting on a regular basis to discuss benefits and challenges and providing a clear understanding on how the different stakeholder groups in the product development can support each other. Furthermore, everyone should be given the opportunity to join the discussion when selected for engaging in co-creation.

The robotic researchers also indicated that a lot of sceptics can be found surrounding the use of co-creation. Co-creation is a method that results in qualitative data and not quantitative data which is the norm in most health-related researches. Additionally, a mistake often made when co-creation is used is according to participant 1 the following "So, we are just going to ask these people what they need. How do they know?". In other words, this method still needs a lot of improvement according to the robotic researchers. Therefore, this participant group stated that it is important to share the success stories related to co-creation as much as possible.

On the other hand, there were also reason to engage in co-creation. The robotic researchers indicated that the development of social robots is a technical and innovative masterpiece. However, in the end the social robot needs to operate in working environments where they will be used by different users. Individuals with technical expertise are able to make the technical masterpieces, but often lack knowledge about the environments in which their technical innovation will operate. Therefore, other individuals with other types of knowledge need to be involved in the development. This point was also supported by a healthcare professional.

Another benefit of engaging in co-creation was the power different stakeholder groups would gain to steer different innovations. This power is distributed, because according to the robotic researchers when engaging in co-creation feedback of different stakeholder groups are considered in multiple phase of the design process. An additional experience of participant 3 related to co-creation is "often clients/patients think it is really nice to be involved and that they are consulted. On the other hand, yes, organisations and developers often think that they need these people. That they need the input to make an improved product".

4.2. Focus Groups

The focus groups were mainly built around two themes, namely the social robots and co-creation. Therefore, the findings related to social robots will be discussed first. Secondly, the co-creation activity results will be outlined.

4.2.1. Social Robots

The elderly retirement home residents focus group existed of five individuals. The focus group of the healthcare professionals existed of six individuals. The dynamics in these groups were that four out of five and five out of six individuals did not mind the use of social robots. However, in both the focus groups one individual indicated to have reservations about the implementation of social robots. Important to notice is that all participants indicated that social robots are a future scenario. Thus, no one expected them to be quickly widely adopted.

There are multiple benefits according to the two focus groups regarding social robots. According to the elderly retirement home residents, social robots can fill the gap when there are not enough healthcare professionals anymore. The focus groups with the healthcare professionals also talked about this problem. However, they indicated that social robots will never be able to replace humans.

Additionally, it was mentioned by the elderly retirement home residents that the social robots might be able to fill a social gap by engaging the user in some general conversations as for instance the good morning and good evening conversation. The healthcare professionals additionally mentioned that social robots should be responsible for social control. They expected that for instance animal-like social robots can counter loneliness since they can copy real animal behaviours and not have the limitations as real animals have by dying or the need for a walk.

The focus group of the healthcare professionals indicated that they thought social robots could be used to remind their clients of taking their medicine, eat and drink and support their users with for instance their morning rituals by opening curtains, etc. Another benefit is that social robots will be able to do the same routine over and over again with minimal difference in actions, offering the user more structure and less uncertainties in comparison to when they have to work with different healthcare professionals.

There were also a few limitations. One of these limitations is that the focus group of the elderly retirement home residents feared that the introduction would mean that they would have less interaction time with humans. This limited contact would be caused by the fact that the social robots will replace humans in their work environment and also in human contacts. The healthcare professionals had an additional concern that social robots might take over too many tasks which would mean that they would spend considerable amounts of time behind the computer. However, this was quickly countered by the fact that they could decide how the social robot could be used.

For the elderly retirement home residents to use the social robot, they expected the social robot to be financed by their health insurance. They otherwise thought it will only be an innovation that can be afforded by the rich. Additionally, they found it very important to learn from a social robot when they use one. By learning from these

social robots, they expected to get an improved understanding of the technique, its uses and purposes. Furthermore, they expect that the more they learn about the social robot the easier it would be for them to work with this robot. This participant group indicated that it is very important that there is an equal division between how much the user must learn about the social robot and how much the social robot needs to learn from the users. This is important, because in human contact both parties also have to equally adapt themselves to have successful communication.

Social Robot Characteristics

The participants of both focus groups were asked to fill-out a form to indicate what they wanted social robots to be able to do. The answers are displayed in table 2 and 3. Table 2 shows the results of the elderly retirement home residents.

Table 2

Social Robot Characteristics Found Important by Elderly Retirement Home Residents

Movements	Care abilities	Social abilities
Walking	Reminding patients of appointments	Listening
Robot cannot move on own initiative	Making the bed	Doing groceries
Supporting the healthcare professional	Dish washing	Playing carts
Packing groceries	Helping to put on shoes	Playing checkers
Making dinner	Support the patient with washing	Playing rummikub
Making coffee	Helping to get dressed	Vacuum cleaning
Pouring wine	Shaving	General cleaning
Hugging	Listening to sounds made in the environment	Controlling the television
Moving arms	Toothbrushing	Caring
Moving legs	Brushing hair	Read out loud the newspaper

The focus group of the healthcare professionals found the following characteristics as shown in table 3. There are a few differences between the two tables. First, the length. The healthcare professionals were able to think of more things than the elderly retirement home residents for social robots to be able to do. Secondly, even though there are a lot of similarities to be found within the two tables, there are differences related to the role of the social robot and the movements a social robot needs to make.

The healthcare professionals indicated that a social robot would have an added value if they could transport their user. This was not mentioned by the elderly retirement home residents. Furthermore, the healthcare professionals stated that a social robot should be a buddy to the users. This means that the social robot should have a lot of human similarities. These social robots should than be able to be described as a buddy, have empathy and also the ability to provide the users with a structure. In contrast, the elderly retirement home residents indicated that they needed a social robot that is able to do functional tasks. This meant that they should have abilities to conversate with the user. However, it is more important that this social robot is able to do tasks such as grocery shopping, playing games and householding tasks.

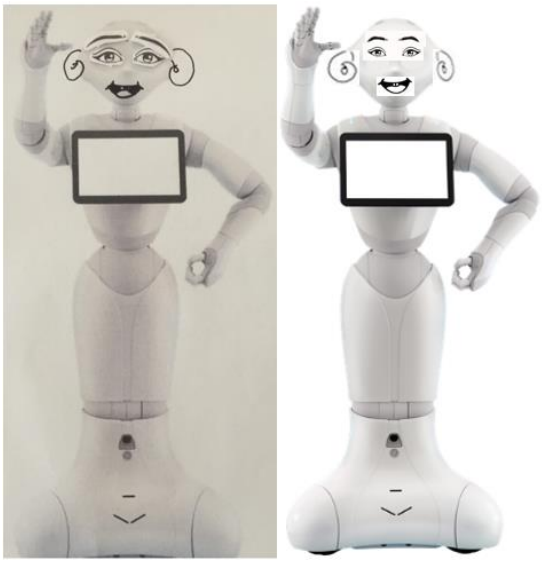
Table 3

Social Robot Characteristics Found Important by Healthcare Professionals

Movements	Care abilities	Social abilities
Writing	Medication control	Offering a listening ear
Walking	Offer structure	Answer questions
Free movement in a home	Put on support stockings	Conversationalist
All human/animal movements	Support remembering	Cuddliness
Eating	Give medicine	Providing a feeling of presence
Drinking	Alarm when behaviour changes	Reading to patient
Writing	Support in daily routine	Prevent loneliness
Taking mail out of the mailbox	Supporting in dressing patients	Be a buddy
Making coffee	Supporting in making food	Offer peace
Transport a patient	Washing of a patient	Playing games
Walk with a patient	Give eye drops	Going with the patient to dentist/doctor
Head movements	Control on general well-being	Going out with patients
Being able to reach for things	Alarm by falling/calamities	Making contact by use of sounds
Touching	Opening/closing curtains	Respond to emotions
	Doing dishes/operating dishwasher	Observations
	Keeping a dossier	Empathy
	Phoning	
	Picking patient up after falling	

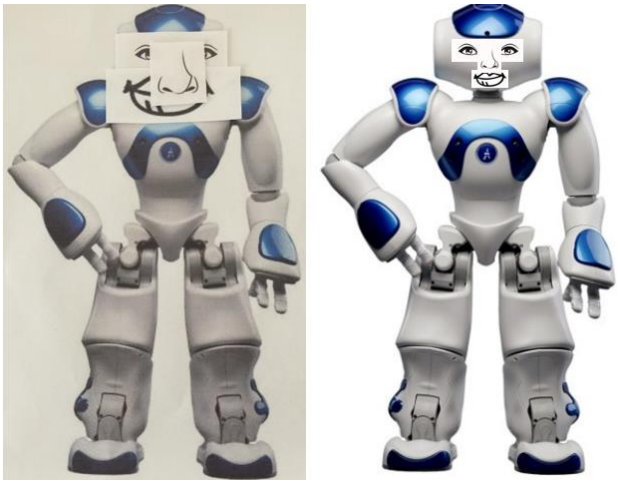
4.2.2. Co-creation

In both focus groups, social robots were created. In the focus group with the elderly retirement home residents two different social robots were created, because of mobility loss by the participants. This loss made it difficult for them to walk to each other and work on one robot together. The two robots created by this focus group are shown in picture 4 and 5.



Picture 4. Social robot created by the focus group with elderly retirement home residents.

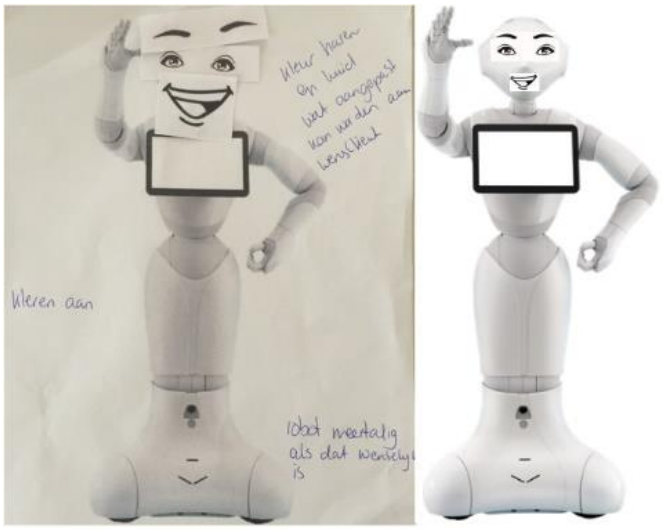
It is important to notice that the focus group with the elderly retirement home residents indicated that they preferred the body of the social robot displayed in picture 4. However, the body of the social robot displayed in picture 5 was also not negatively perceived by the participants, because it still looked very human. To emphasis, the participants of this focus group kept pointing out how important it was to them that the social robot looked like a human. One participant even explicitly indicated that animal-like social robots are more suitable for elderly individuals with dementia.



Picture 5. Social robot created by the focus group with elderly retirement home residents.

The focus group with the healthcare professionals also decided to design two different social robots. Their decision was not based on mobility issues. In their work, they have gained the experience that their clients have different needs during their ageing and stages of declining health. According to this participant group, their clients would want different social robots during the different stages of ageing. Therefore, they created a pet-like social robot which can be used in earlier stages of aging. In this stage, clients often only want more attention and interaction. The human-like social robot is appropriate for later stages of aging since the clients would need attention, interaction and more support in their daily activities. Their social robots are displayed in picture 6 and 7. In general, the participants indicated wanting to have a social robot that could be built to the appreciation of their users. Thus, that they could decide for instance on gender, skin colour, facial features, etc.

Picture 6. Pet-like social robot created by the focus group with the healthcare professionals.



Picture 7. Human-Like social robot created by the focus group with the healthcare professionals.

As can be seen by the social robots created by the elderly retirement home residents and the healthcare professionals is that both focus groups chose a human-like social robot to work with. Additionally, the healthcare professionals also created a pet-like social robot. None of the focus groups considered machinelike social robots.

General Remarks Related to the Co-creation Activity

When the elderly retirement home residents were asked if they appreciated the focus groups, they indicated that they thought it was interesting to be involved. Both focus groups indicated that they were only confronted by this new innovation on television or the radio. Therefore, they liked that such a session was organised, because they felt that they were better informed. However, they were not directly looking forward to be joining such initiatives in the future. The main reasons for this is that they thought they did not have enough knowledge about social robots. Furthermore, the session was quite strenuous on them. However, they understand the importance of being heard in this development.

Additionally, these participants are not used to being asked about decisions made about their care. Their autonomy or influence on life decisions is low. These participants also appreciated that they were given knowledge about an innovation that is the future in healthcare according to them.

The healthcare professionals made two side notes. Firstly, they stated that in particular the next generations should be included in the development of social robots. Since this generation will grow up with a larger knowledge of technology. This will make it easier for them to understand the technology and to work with it. Secondly, introduction and development of social robots should be executed in an intramural context. When the co-creation and implementation of social robots starts in an intramural context, there is more eye on the function of these social robots. When introduced in home care first, control is less since healthcare professionals are interacting with their clients only a few times a day.

5. Discussion and Conclusion

To conclude this research, this chapter will outline what the previously discussed results mean. Therefore, this section will discuss the theoretical and practical implications, limitations, future research areas and the conclusion. All these sections focus on answering the research question: "To what extent will co-creation in social robot development support the development of social robots that are accepted by elderly retirement home residents and healthcare professionals?".

5.1. Theoretical Implications

This research shows that co-creation should be considered as a tool in the innovation of social robots. There are different reasons for this finding. These reasons will be discussed below based on the three themes that have been used within this research.

When considering the individual context, it becomes clear that there is a knowledge deficit regarding social robots. The result section shows very clearly that the robotic researchers have an improved understanding of social robotics compared to healthcare professionals and elderly retirement home residents. These varying levels of exposure were also found by De Graaf and Allouch (2013). In this research, the robotic researchers were already in their studies confronted with social robotics. On the other hand, the healthcare professionals and the elderly retirement home residents were only getting acquainted with this technology in their work environments or on television/radio.

The robotic researchers indicated in their interviews that healthcare professionals and elderly retirement home residents in comparison to them have more knowledge about the healthcare and living situations of retirement home residents. Robotic researchers have difficulties to gain this information similar to the difficulties that the healthcare professionals and elderly retirement home residents have to obtaining information about social robotic since there is a one-way information flow between these groups. This flow is described by Rowe and Frewer (2005) as a situation in which the public is not consulted and when they try to get information they are often only getting information from recordings as for instance radio, newspapers and television. This thus means there is no dialogue between the two different stakeholder groups which according to this research does not constitute a positive situation. This situation was also found by Cui and Wu (2016), whom indicate that for successful innovations it is important to have a balance between user information and technological knowledge.

The results show that even though a knowledge deficit can be observed, it does not explain attitudes toward science. Healthcare professionals and elderly retirement home residents were all very interested in receiving more information about social robots and indicated that innovations should never be ignored. This has also been proven by Rose et al. (2017) and the enthusiasm showed by the participants of this research who all indicated to appreciate being involved in the interviews and focus groups.

When social robots were discussed multiple important findings were mentioned. It is important that currently developed social robots are going to be able to do things that we as humans are not able to do or are not able to do well. For the different participant groups in this research it made most sense that social robots are going to be used in the care environments of individuals with dementia and other limited cognitive abilities. Reasons given by the different participant groups were that the sense of reality of these individuals will make it easier for them to accept this innovation. Additionally, the gained experience of social robotics in healthcare environments has been gotten in these care environments.

Equally important to notice is that there are different user groups of social robots. This meant that there are also different needs among these groups. This finding was already found by Frennert and Östlund (2014). Additionally, Frennert et al. (2017) found that the design of the social robots would be influenced by acceptance and preference of users to work with social robots. This is shown by the focus group of the healthcare professionals that showed the importance of different social robots in different health stages of their clients. It was also shown by the many different abilities a social robot should have according to the different participants in this research.

There was some disagreement between the different participants about the social abilities of a social robot. Important to notice is that the social robots should have empathy. An important trait that is used to described human communication and interaction. Humans are social creatures that want to fit in (Fogg Rogers, 2017). This means humans need to have an understanding of the world around them. This finding can explain why the focus group of elderly retirement home residents indicated that these participants prefer social robots that resemble humans. This is contrary to the 'uncanny valley' findings by Tay et al. (2014) and Piçarra et al. (2016). However, it fits with their understanding of the care environment, because they expect humans to take care of them.

Since, the numerous named abilities of social robots, the fact that social robots need to do things humans cannot do and the notion that different ages and declining health stage might need different kind of social robots to have an added value, co-creation will be a future possibility for the development of co-creation. However, the results showed different outcomes related to co-creation. These will now be discussed.

Co-creation became a difficult topic to discuss. All the participants indicated that it is very important to use multiple perspectives when creating social robots. Thus, the results showed that the robotic researchers validated the findings of Vargo and Lusch (2016) that operant resources (knowledge of users) will provide strategic benefits for organisations. Additionally, this research found the same positive attitudes to co-creation as the research of Bemelmans et al. (2013) regarding how the participants react to the co-creation activity. This research showed that all participants in general were positive about the idea of being able to influence technological innovation that would have an influence on their lives.

Additionally, co-creation can become important since it is focused on aligning products with the needs of users (Buonincontri et al., 2017). This research showed that the users groups (healthcare professionals and elderly retirement home residents) did not quite understand what social robots are able to do for them, but did have ideas for actions that social robots could perform to have an added value. Even showing a news item

displaying several social robots did not change this. Knowing from the theoretical framework that many social robots have already been developed, it is a special situation. It is a special situation since it seems that social robots are not made for the needs of healthcare professionals working in home care and retirement home organisations and for elderly retirement home residents. However, since these participant groups were able to name different actions that a social robot could perform to have an added value, these group might be perfect for co-creation. The reason is the fact that current products do not align the needs of these participant groups providing a market with already a little knowledge about social robots and an idea of what these social robots need to do.

The participants also indicated that it is important to consider different practical problems such as personality, privacy, necessary time, mindset and financial means. Self-efficacy was also found Dong et al. (2008) to be important when considering co-creation. It is important, because the individuals involved need to have the feeling that they can contribute to the activity. This research showed that not all the participants thought they would be able to contribute to the co-creation activity. Xie, Bagozzi and Troye (2008) also already indicated that prosumption is important in co-creation. This is the willingness to provide money, time, effort and skills to a task. However, there is still an institutional resistance to adopting co-creation which was also found by Grand et al. (2016) and Rock et al. (2018). Meaning that there is not always the willingness to provide money, time, effort or skills to a task.

5.2. Practical Implications

Based on this research the following practical implications can be suggested. This research shows that co-creation is an option to consider in social robot development. The next suggestions show how different changes will create more successful co-creation activities in the future.

The first suggestion is for the robotic researchers. Robotic research in the healthcare environment is often based on the facts that we are getting older, are more often faced by comorbid diseases and have less formal and informal healthcare professionals to take care of the elderly. However, during the research it was often mentioned that every situation and context is different. These findings should indicate that robotic researchers should focus more on individual solutions. The robotic researchers of this research indicated that they often do not have enough knowledge about healthcare environments to be able to make solutions without the involvement of other involved stakeholders. Therefore, they should benefit from the involvement of these stakeholder groups in iterative phase of the development of the product. Furthermore, the emphasis was on different contexts and users of social robots. Therefore, robotic researchers and developers should think about making different social robotic components. With this focus it might become easier to see social robots as a package that can be built by individual users.

The healthcare professionals should get an opportunity to get acquainted with social robots. Without the appropriate knowledge, it is difficult for this group to have a feeling of self-efficacy when participating in co-creation. Therefore, it will be important for this group to learn about new types of innovations in their prior school educations. Furthermore, if healthcare professionals want to, they should be given the opportunity to

have time to learn about this innovation. These activities should provide the healthcare professionals with a confidence to be able to participate in co-creation activities.

The elderly retirement home residents should also get an opportunity to get acquainted with social robots. This participant group indicated that they appreciated to be kept informed in person about new innovations that they might be confronted with in the future. Therefore, this group should be provided with opportunities to visit specially made TED talks or College Tours formats for elderly. This should provide the elderly with a feeling that they can engage in discussion related to improvements in their care. Additionally, it might provide them with such information that they are able to comprehend their technological environment.

When these changes are implemented the different groups might gain the following benefits from social robotics. The robotic researchers can use co-creation in the development of social robots to make robots that are easily and more accepted, because they are developed around the preferences of their user groups. The healthcare professionals will have an additional team member that will be able to take over tasks that will provide the healthcare professionals to spend more qualitative time with their clients. Furthermore, they can have technology that can support them when there are not enough colleagues which could also support them in staying healthy. The elderly retirement home residents will benefit from co-creation, because they can indicate really clearly what they need. This can increase their quality of life.

5.3. Limitations

This research was able to produce a wealth of information. However, there are some limitation to the methods that were chosen. These will be outlined in this paragraph.

One important limitation is that, all the participants who did not belong to the robotic researcher group, indicated that they found it difficult to discuss social robots since they never interacted with one. This meant that a large part of the participants did not have prior knowledge of social robots and they perceived this to be a limitation when giving answers. In other words, the participant groups, healthcare professionals and elderly retirement home residents, lacked self-efficacy.

The focus groups were conducted with participants belonging to one stakeholder group which is also a limitation. This meant that the co-creation activity was done with one stakeholder group at a time and that these different groups did not interact with each other. Which means that this research is not able to indicate what the results would be if different groups with different types of knowledge interact with each other in product development. Additionally, the participants were given no limitations. When this kind of activity would be done in a real product development process than all the different stakeholder groups would be faced by limitations as time, money and existing technologies.

An additional limitation is that not all participants were randomly selected. This means that it cannot be said for certain that enough factors as for instance cultural background, educational levels, etc. that can influence how participants perceive social robots and co-creation are taken into account.

Another limitation was the lack of knowledge by the researcher of the elderly retirement home resident participant group. This resulted in semi-structured interviews that went quite strenuous. In other words, the questions that were formed were often not understood correctly by the participant group. This resulted in brief answers and sometimes a little irritation by the participant.

The last limitation of this research is the time participants had to participate in this research. A few interviews were done by telephone applications. Meaning that external factors as for instance incoming phone calls or colleague disturbances could not be avoided. Additionally, most participants had other appointments directly after the interviews or focus groups. This became sometimes clear when asked if the interview or focus group would still take long.

5.4. Future Research

There are different future research directions. First of all, this research should be repeated with other groups. The participant groups used in this research lacked diversity. All the participants from the semi-structured interviews and the elderly retirement home resident focus group came from the same organisation and were acquainted with each other. Although, the focus group with the healthcare professionals was done at another healthcare organisation, this organisation was still located in the eastern part of the Netherlands. In other words, it cannot be said for certain that the same results will be found in other parts of the Netherlands. Especially, the feelings, thoughts and opinions different individuals have regarding co-creation might differ when more diversity in participant groups is established. Therefore, this provides a future research direction.

This research points out that modular systems might be a future design principle in social robotics. Such a design principle would mean that users can assemble their own social robot that is able to answer their needs. Therefore, future research can try to indicate if this is a valid design principle for social robotics. It will also be important to keep focusing on the ethical aspects of social robotics. As the results show it is expected that social robots will not be able to resemble humans. Thus, it will be important to gain knowledge on how an innovation that needs to be able to take over and/or support patients in activities normally done by humans is going to affect these users.

5.5. Conclusion

This research shows that co-creation is a possibility to consider in social robot development. It shows the importance of inputs of different stakeholder groups in the development of social robots. A challenge in social robot development is that a lot of individuals do not have any experience with this product yet. Therefore, to boost the development of this product it should be important to get as much individuals acquainted with social robots as soon as possible. This would result in individuals that will start to understand the added value of social robots and how they can benefit from them. Co-creation then in time might provide organisations with the opportunity to quicker produce products that are easily accepted. This is important since this research showed that there is a difference in how the different participant groups were thinking about the added value of social robots.

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Appendix A – Interview Guide Robotic Researchers

2 minuten

1. Waarom heeft u ervoor gekozen om een robot onderzoeker te worden?

Individuele Context

10 minuten

2. Hoe merkt u dat mensen reageren op robotten?
3. Hoe zou u de toekomst van robotten in de gezondheidszorg voorspellen?
4. Wat ziet u als de grootste verandering op rookontwikkelingen gebied?

Sociale Robotten

10-15 minuten

5. Hoe zou u sociale robotten beschrijven?
6. In hoeverre sluit de huidige koers van ontwikkelingen in sociale robotten volgens u aan op de behoeften in de ouderenzorg?
    a. Hoe staat u tegenover sociale robotten in de ouderenzorg?
7. Wat zijn voor u voorwaarden voor goede sociale robotten in de ouderenzorg?

Co-creatie

8-10 minuten

8. Wat zou de toegevoegde waarde zijn van de gezamenlijke ontwikkeling van sociale robotten met ouderen en verpleegkundigen?
9. Welke omstandigheden zouden er gecreëerd moeten worden om de verschillende groepen te laten samenwerken?
10. Welke mogelijke obstakels voorziet u als deze verschillende groepen met elkaar samenwerken?

Afsluitende vragen

3 minuten

11. Wanneer denkt u dat sociale robotten geïmplementeerd worden in de ouderenzorg?
12. Wilt u nog iets bespreken of benoemen wat nog niet besproken is?

Appendix B – Interview Guide Healthcare Professionals

2 minuten

1. Kunt u kort uitleggen waarom u ervoor heeft gekozen om verpleegkundige te worden?

Individuele Context

10 minuten

2. Wat vind u van het gebruik van technologie in uw werk?
3. Wat is volgens u de grootste verandering die de laatste tijd heeft plaatsgevonden in uw beroep?

Sociale Robotten

10-15 minuten

4. In hoeverre bent u bekend met het gebruik van robotten in de gezondheidszorg?

Show: https://www.youtube.com/watch?v=bra0PBl7m2U&t

5. In hoeverre zou de inzet van deze robotten u kunnen ondersteunen in uw werkzaamheden?
6. In hoeverre zouden deze robotten de kwaliteit van de ouderenzorg kunnen verbeteren?

Co-creatie

8-10 minuten

7. Nu heb ik u net het filmpje over de social robotten laten zien, zou u betrokken willen worden bij het ontwikkelen van deze robotten?
8. Welke omstandigheden zouden er volgens u gecreëerd moeten worden als verschillende groepen zouden meewerken aan het ontwikkelen van de robotten?
9. In hoeverre vind u dat uw feedback wordt meegenomen op dit moment in de verbeteringen van de ouderenzorg?
    a. Hoe zou dit moeten veranderen in de toekomst?

Afsluitende vragen

3 minuten

10. Wanneer denkt u dat sociale robotten geïmplementeerd worden in de ouderenzorg?
11. Wilt u nog iets bespreken of benoemen wat nog niet besproken is?

Appendix C – Interview Guide Elderly Retirement Home Residents

2 minuten

1. Hoe lang woont u al in het verpleegtehuis?

Individuele Context

10 minuten

2. Kunt u mij beschrijven welke grote veranderingen u de laatste tijd heeft gezien hier in het verpleegtehuis?
3. In hoeverre merkt u dat er verschillende technologieën als computers in uw zorg worden gebruikt?

Sociale Robotten

10-15 minuten

4. Heeft u ooit gehoord van robotten die taakjes over kunnen nemen van verpleegkundigen en hen kunnen helpen in uw zorg?

Nee = Wat stelt u zich voor bij zo een robot?

Ja = Kunt u mij daarover vertellen?

Show: https://www.youtube.com/watch?v=bra0PBl7m2U&t

5. Waarom zouden deze robotten uw zorg verbeteren?
6. Als u kijkt naar uw eigen situatie, denkt u dat deze robotten uw zorg gaan verbeteren?
7. Wat zou u ervan vinden als robotten toegevoegd worden aan uw zorgteam?

Co-creatie

8-10 minuten

8. Vind u dat u mee kan besluiten over uw zorg?

Waarom wel/Waarom niet?

9. Denkt u dat verpleegkundigen en robotontwikkelaars naar uw luisteren als u zou aangeven hoe de robot eruit zou moeten zien?
10. In hoeverre denkt u dat u verpleegkundigen en robotontwikkelaars zou kunnen helpen in het maken van bruikbare robotten?

Afsluitende vragen

3 minuten

11. Wanneer denkt u dat sociale robotten geïmplementeerd worden in de ouderenzorg?
12. Wilt u nog iets bespreken of benoemen wat nog niet besproken is?

Appendix D – Protocol Focus Groups

Introductie

Dank u wel dat u vandaag deelneemt aan deze focusgroep. Ik kan mij voorstellen dat u zich afvraagt waar wij het vandaag over gaan hebben. U heeft misschien nog niet eerder een sociale robot gezien maar zij worden steeds vaker ingezet in verzorgingstehuizen en in menig huishouden. Deze robotten worden voor verschillende zaken ingezet. Om u een beeld te geven van wat sociale robotten zijn zal ik u zo een filmpje laten zien van een nieuwsitem van RTL nieuws. Maar eerst zal ik nog even verder uitleggen wat de bedoeling is van vandaag.

Graag wil ik u vandaag meerdere vragen voor gaan leggen over uw gevoelens, gedachtes, meningen en ingevingen die bij u opkomen als u met elkaar bespreekt wat sociale robotten voor u kunnen betekenen. Technische kennis is hiervoor niet nodig. Mijn rol vandaag is om jullie allen de kans te geven om uw verhaal kwijt te kunnen en ervoor te zorgen dat het gesprek zo soepel mogelijk verloopt. Ik zal niet aan de discussie deelnemen, omdat het vandaag om jullie gaat. Omdat het vandaag om meningen, gevoelens, gedachtes en ingevingen gaat is het ook niet belangrijk dat we een akkoord bereiken over wat het meest belangrijk is. Het is vooral belangrijk om u vrij te voelen om alles te zeggen wat u wilt en dat er met elkaar respectvol gediscussieerd kan worden over de inbreng.

Zijn er nog vragen naar aanleiding van de uitleg over wat u vandaag gaat doen?

Dan wil ik u graag nu het RTL nieuwsitem laten zien https://www.youtube.com/watch?v=bra0PBl7m2U&t

10 minuten

1. Wat is uw eerste reactie op dit filmpje?

Triggervragen:

   a. Wat vind u van de verschillende robotten die u zag in het nieuwsitem?
   b. In hoeverre denkt u na het zien van dit filmpje dat u zelf sociale robotten zou willen gebruiken?

Co-creatie (30 minuten)

Op dit moment wil ik u de mogelijkheid geven om zelf een sociale robot te bedenken waarvan u vind dat die toegevoegd mag worden aan uw zorgteam. Daarvoor doorlopen we verschillende stappen. De eerste 20 minuten wil ik u de mogelijkheid geven om uit te leggen wat een sociale robot moet kunnen. Daarna zou ik het 10 minuten met u willen hebben over het uiterlijk van de sociale robot. Allereerst wil ik u vragen om het volgende A4tje erbij te pakken. Zoals u kunt zien staan hier drie categorieën van vaardigheden op van sociale robotten. Deze drie zijn de bewegingen die de robot kan maken, de verzorgende taken die sociale robotten kunnen overnemen en de sociale vaardigheden die de sociale robot kan hebben. Ikzelf heb ook dit A4'tje ingevuld voor mijn huidige situatie om aan te geven wat voor een vaardigheden ik zou waarderen in een sociale robot. Ik wil u dan ook vragen als u

kijkt naar uw huidige situatie om na te gaan wat voor een soort sociale robot u kunt gebruiken. Alles is hierin mogelijk en u hoeft niet te denken in restricties. Ik zou u willen vragen bij elke vaardigheid drie dingen te bedenken die u zou willen dat u sociale robot zou kunnen. U heeft ongeveer 5 minuten om die negen post-its in te vullen. Daarna gaan wij dit met elkaar bespreken.

15 minuten

2. Wie zou als eerste zijn opmerkingen bij bewegingen van de sociale robot willen bespreken?

Triggervraag:

   a. Wil iemand hierop reageren?

3. Wie wil er wat over zijn/haar punten zeggen die u heeft opgeschreven bij zorgvaardigheden?

` Triggervraag:

   a. Wil iemand hierop reageren?

4. Zou iemand iets willen vertellen over de punten die hij/zij opgeschreven heeft bij sociale vaardigheden?

Triggervraag:

   a. Wil iemand hierop reageren?

Nu we besproken hebben wat een sociale robot zou moeten kunnen, wil ik het ook graag hebben over hoe een sociale robot eruit zou moeten zien. Ook heb ik een voorbeeld gemaakt van hoe het uiterlijk van mijn sociale robot eruit zou moeten zien. Hetzelfde wil ik ook aan u vragen om te doen, om het uiterlijk te bepalen van uw ideale social robot. Hiervoor heb ik een aantal onderdelen voor u geprint. U heeft 10 minuten om met elkaar uw ideale robot te ontwerpen.

Follow-up vragen aan de hand van de gemaakte robot

15 minuten

5. Zou u mij kunnen uitleggen waarom jullie deze sociale robot hebben gemaakt?
6. Zou u de robot die u allen nu gezamenlijk heeft gemaakt willen gebruiken?

Triggervraag:

   a. Waarom wel/waarom niet?

7. Wat vond u van dat u hier gezamenlijk een sociale robot mocht maken?
8. Vind u wat wij hier vandaag hebben gedaan kan helpen met het maken van sociale robotten waar u wat aan heeft?
9. Zou u vaker aan dit soort sessie mee willen doen?

Triggervraag:

   a. Waarom wel/waarom niet?

Afsluiting

Ik zou u graag nog twee afrondende vragen willen stellen.

5 minuten

10. Na alles dat wij vandaag besproken hebben, zou u graag een sociale robot hebben die uw zorgteam versterkt?

Triggervraag:

a. Waarom wel/waarom niet?

11. Wilt u nog iets bespreken of benoemen wat nog niet besproken is?

Appendix E – Social Rules during the Focus Group

Regels voor een goede dialog zijn als volgt:

- Het gaat om uw opvattingen, meningen, gevoelens en gedachten.
- Opvattingen, meningen, gevoelens en gedachten mogen verschillen van elkaar.
- Elke mening telt.
- Er zijn geen goede of foute antwoorden.
- U hoeft geen kennis van sociale robotten te hebben.
- Respecteer elkaar, laat elkaar uitpraten en luister naar elkaar.
- Geef elkaar de kans om te vertellen.

Appendix F – Characteristics Social Robots

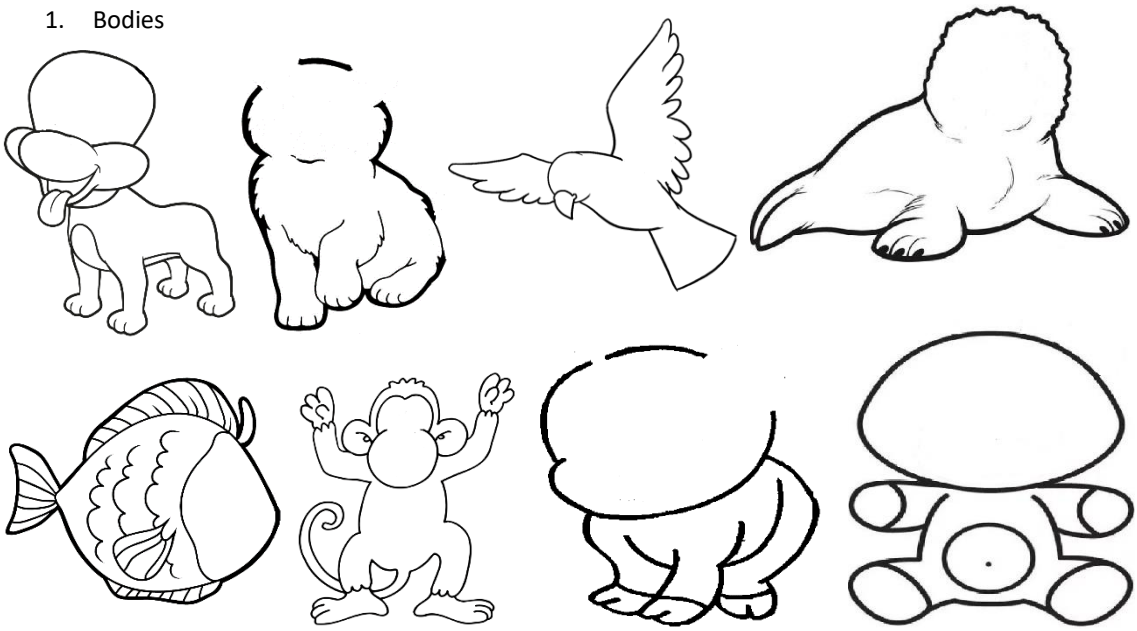
Bewegingen

Zorgtaken

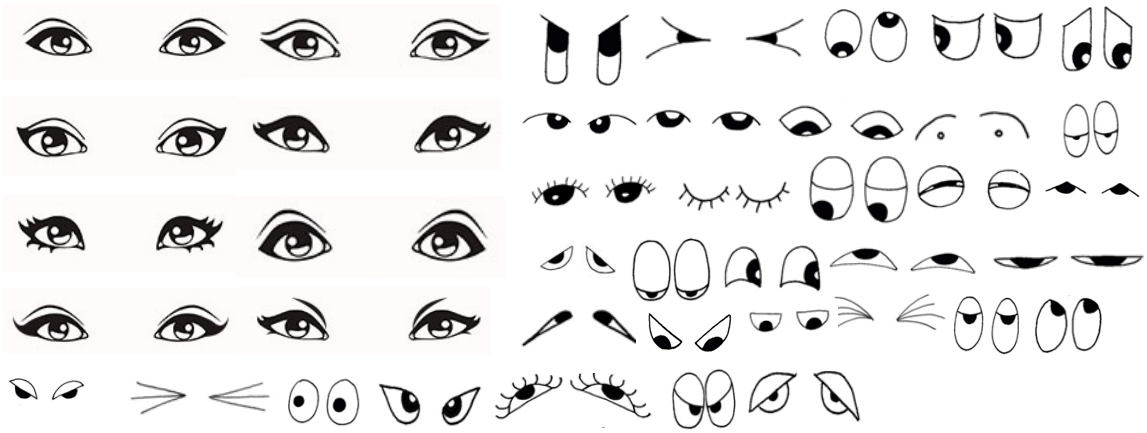
Sociale vaardigheden

Appendix G – Visual Cues Social Robots

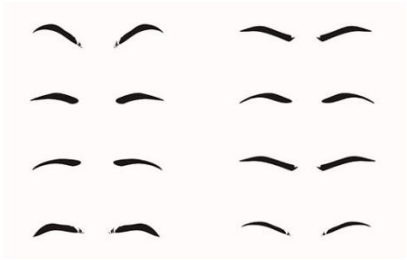
1. Bodies



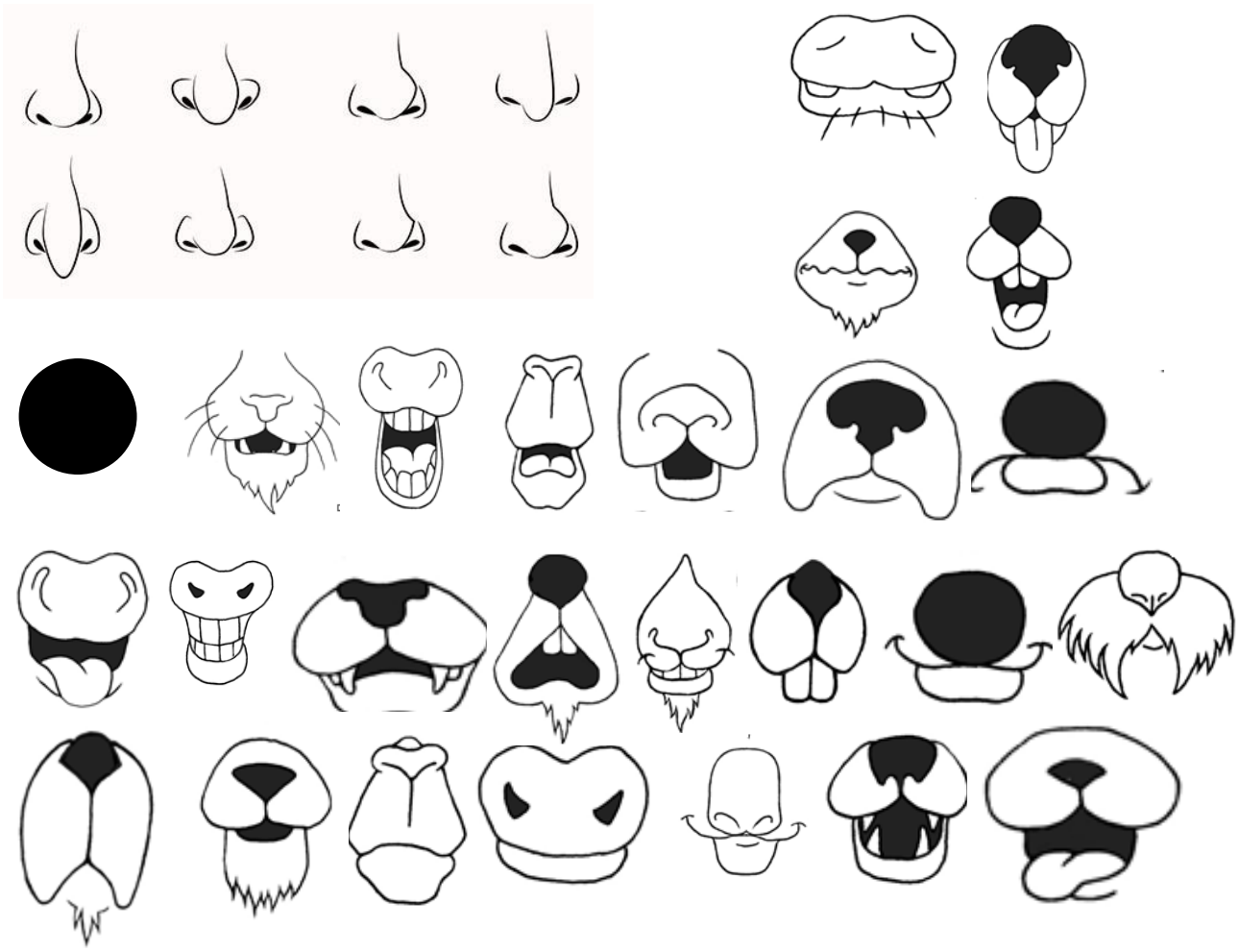
2. Eyes



3. Eyebrow



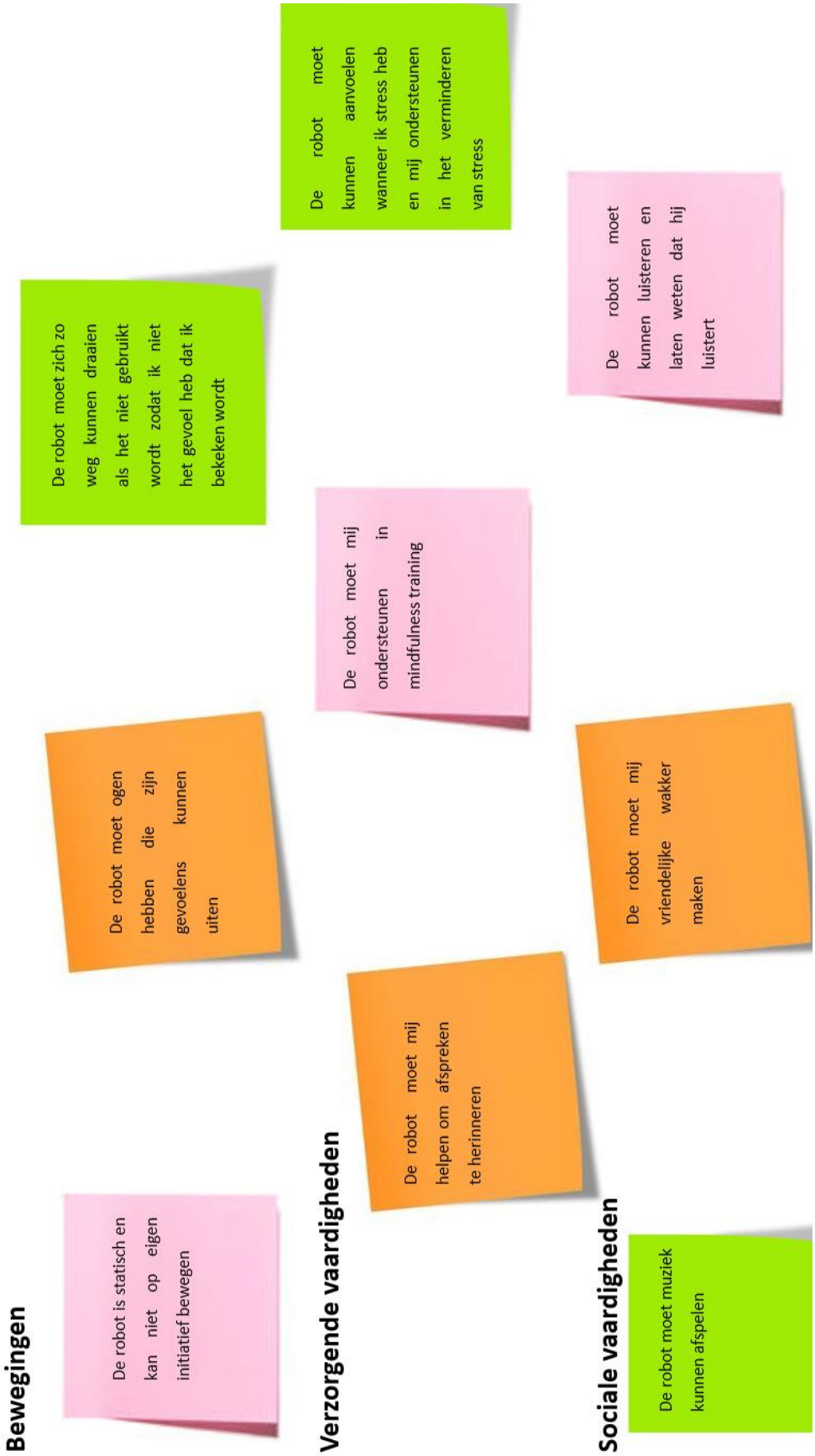
4. Noses



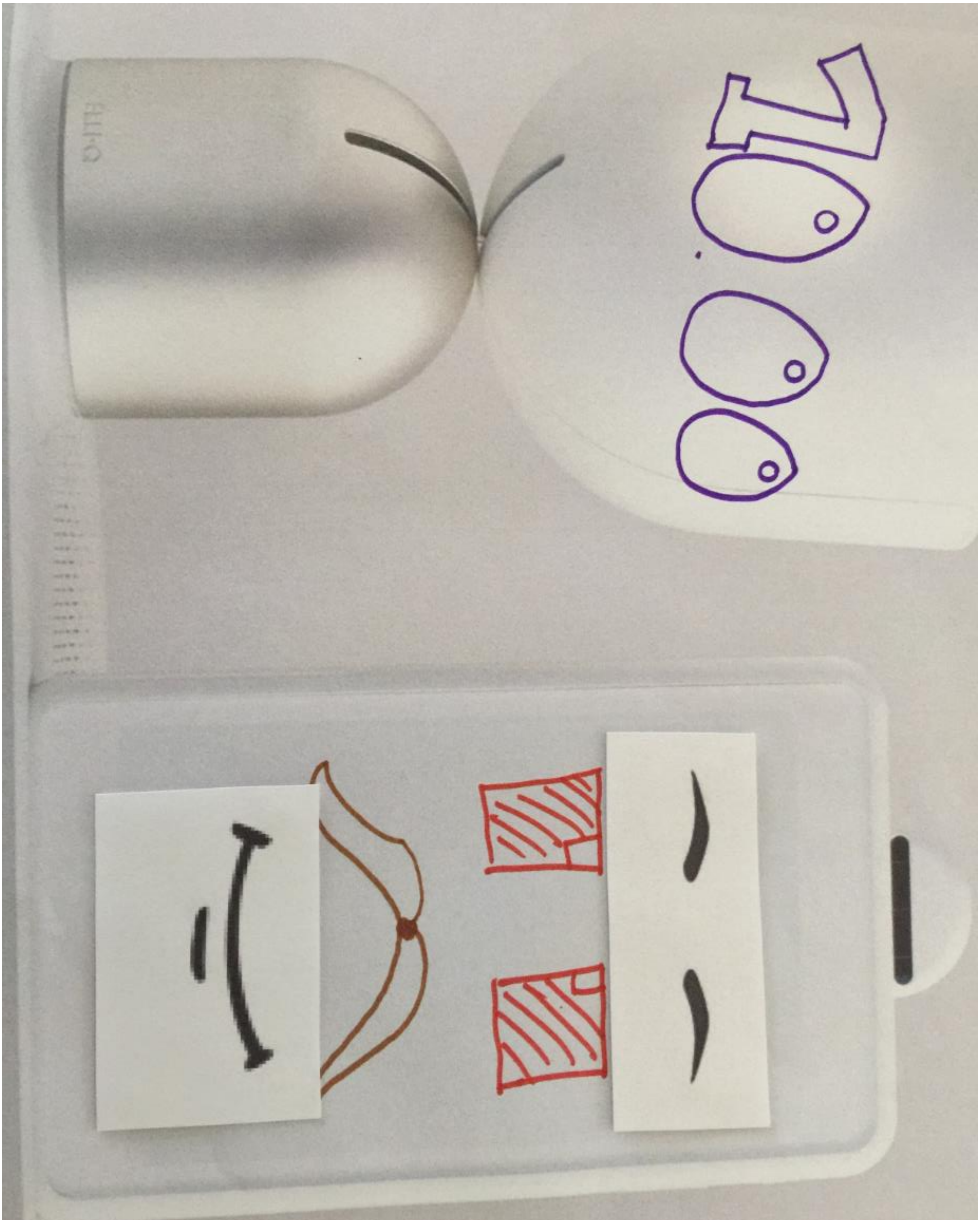
5. Mouth

6. Ears

Appendix H – Example Characteristics Social Robots



Appendix I – Constructed Social Robots for Support Elderly Retirement Home Residents


70.00

Appendix J – Informed Consent Form Robotic Researchers

Geachte meneer/mevrouw,

Dit interview wordt uitgevoerd voor een masteronderzoek aan de Universiteit Twente. Het doel van dit onderzoek is te onderzoeken of co-creatie in de ontwikkeling van sociale robotten de ontwikkeling van deze robotten kan ondersteunen waardoor zij sneller geaccepteerd zullen worden door ouderen en verpleegkundigen. Het interview zal tussen de 30 minuten en 60 minuten duren en zal opgenomen worden. Na afloop zal het interview getranscribeerd worden om te kunnen analyseren. Met de opname van de getranscribeerde tekst zal vertrouwelijk omgegaan worden den deze worden niet verstrekt aan derden. Tijdens het interview heeft u op elk moment het recht om aan te geven niet verder te willen participeren in het onderzoek.

Graag wil ik u verzoeken dit formulier te ondertekenen als u akkoord gaat met de bovenstaande informatie.

Naam:

Datum:

Handtekening:

Met vriendelijke groet,
Madelynn Wanschers

Heeft u nog vragen of zou u graan nog extra informatie willen ontvangen dan kunt u een e-mail sturen naar m.e.a.wanschers@student.utwente.nl of naar dr. Anne Dijkstra via a.m.dijkstra@utwente.nl

Appendix K – Informed Consent Form Healthcare Professionals

Geachte meneer/mevrouw,

Dit interview wordt uitgevoerd voor een masteronderzoek aan de Universiteit Twente. Het doel van dit onderzoek is te onderzoeken of co-creatie in de ontwikkeling van sociale robotten de ontwikkeling van deze robotten kan ondersteunen waardoor zij sneller geaccepteerd zullen worden door ouderen en verpleegkundigen. Het interview zal tussen de 30 minuten en de 60 minuten duren en zal opgenomen worden. Na afloop zal het interview uitgeschreven worden om te kunnen analyseren. Met de opname en de uitgeschreven tekst zal vertrouwelijk omgegaan worden en deze worden niet verstrekt aan derden. Tijdens het interview heeft u op elk moment het recht om aan te geven niet verder te willen participeren aan het onderzoek.

Graag wil ik u verzoeken dit formulier te ondertekenen als u akkoord gaat met de bovenstaand informatie.

Naam:

Datum:

Handtekening:

Met vriendelijke groet,
Madelynn Wanschers

Heeft u nog vragen of zou u graag nog extra informatie willen ontvangen dan kunt u een e-mail sturen naar m.e.a.wanschers@student.utwente.nl of naar dr. Anne Dijkstra via a.m.dijkstra@utwente.nl

Appendix L – Informed Consent Form Elderly Retirement Home Residents

Geachte meneer/mevrouw,

Dit interview wordt uitgevoerd voor een masteronderzoek aan de Universiteit Twente. Het doel van dit onderzoek is te onderzoeken of co-creatie in de ontwikkeling van sociale robotten de ontwikkeling van deze robotten kan ondersteunen waardoor zij sneller geaccepteerd zullen worden door ouderen en verpleegkundigen. Het interview zou tussen de 30 minuten en de 60 minuten duren en zal opgenomen worden. Na afloop zal het interview uitgeschreven worden om te kunnen analyseren. Met de opname en de uitgeschreven tekst zal vertrouwelijk omgegaan worden en deze worden niet verstrekt aan derden. Tijdens het interview heeft u op elk moment het recht om aan te geven niet verder te willen participeren aan het onderzoek.

Graag wil ik u verzoeken dit formulier te ondertekenen als u akkoord gaat met de bovenstaande informatie.

Naam:

Datum:

Handtekening:

Met vriendelijke groet,
Madelynn Wanschers

Heeft u no vragen of zou u graag nog extra informatie willen ontvangen dan kunt u een e-mail sturen naar m.e.a.wanschers@student.utwente.nl of naar dr. Anne Dijkstra via a.m.dijkstra@utwente.nl.

Appendix M – Informed Consent Form Focus Groups

Geachte meneer/mevrouw,

Deze focusgroep is een onderdeel van een afstudeeronderzoek aan de Universiteit Twente. Het doel van dit onderzoek is een verdieping naar het gebruik van sociale robotten in de zorg. De focusgroep zal gericht zijn op het creëren van een situatie waarin u gevraagd wordt mee te denken en mee te praten over uw ideale sociale robot in uw huidige situatie. De informatie die u geeft heeft als doel om te onderzoeken hoe wetenschappers samen met ouderen en verpleegkundigen sociale robotten voor de zorg kunnen ontwikkelen.

De focusgroep zal ongeveer een uur duren en zal opgenomen worden. Na afloop zal de focusgroep uitgeschreven worden om deze te kunnen analyseren. Met de opname en de uitgeschreven tekst zal vertrouwelijk omgegaan worden deze worden niet verstrekt aan derden. Tijdens de focusgroep heeft u op elk moment recht om aan te geven niet verder te willen deelnemen aan het onderzoek.

Graag zou ik willen verzoeken dit formulier te ondertekenen als u akkoord gaat met de bovenstaande informatie.

Naam:

Datum:

Handtekening:

Met vriendelijke groet,
Madelynn Wanschers

Heeft u nog vragen of zou u graag nog extra informatie willen ontvangen dan kunt u een e-mail sturen naar m.e.a.wanschers@student.utwente.nl of naar dr. Anne Dijkstra via a.m.dijkstra@utwente.nl.

Appendix N – Cronbach's Alpha

Reliability Statistics	
Cronbach's Alpha	N of Items
,876	2

Appendix O – Translation Quotes Participants NL-EN

Table 4

Translation of quotes.

Dutch quotes	English quotes
Na een/twee jaar is dat bedrijf vaak failliet omdat de toepassing die die robot biedt gewoon niet iets is waar mensen massaal hun geld aan gaan uitgeven	After one/two year(s), an organisation is bankrupt, because the social robot application is not something people want to spend their money on
Op Somatiek maak je niet veel gebruik van die zorgrobots. Dat doe je nu vooral op PG	In regular elderly care social robots are not often used. Currently, they are most often used in dementia care
Ik weet nog niet precies wat bijvoorbeeld zo een robot gaat doen voor mij. Kijk als ik dat dan weet dan kan ik straks zeggen van dat heeft me wat opgeleverd	I do not yet know what such a robot is going to do for me. Look, when I know I will be able to say what the added value of the robot is
Ja, ja nou open. Als het niet anders kan dan vind ik dat heel logische ontwikkeling	Yes, yes, well open, if there is no other way, it is a logical development
Kun je dat wat specifieker maken, want ik vind het nog vooral een verschil qua contexten, van wie is, wie is mensen, welke toepassingen heb je het. Ik, ik zie daar wel in wat verschil zeg maar	Can you make it more specific, because I think it makes a difference in context, ownership, related individuals, which applications. I, I see a difference
Ja, nee ik denk niet dat je echt een sociaal kunt zijn met robots. Ondanks dat je zeg maar wel reageert en alles, ik denk dat dat heel leeg zou voelen	Yes, no, I do not think that you can be really social with a robot. Despite that the robot will be able to react and stuff, I think it will feel empty
Ik vind, het lijkt me wel heel leuk om zoiets uit te gaan proberen. Om te kijken hoe het werkt in de zorg en hoe de mensen erop reageren en hebben wij er voordelen van en wat voordelen hebben. Waar lopen we wel tegen aan en waar lopen we niet tegenaan	I think, it seems fun to try out such a thing. To see how it works in the care environment and how people will react to it and which benefits we will experience. What problems we will encounter or not encounter
Weet ik niet. Zou ik eerst moeten ondervinden en dan misschien dat ik dan zeg van. Ik kan me zo niet zeggen dat zou ik wel leuk vinden. Nee, ik moet het eerst ondervinden.	I do not know. I first have to work with such a robot and then maybe I can say something about this innovation. I cannot just say that I like them. No, I first need to have worked with the robot
Ja ik weet niet als je een robot wil hebben die en kan koken en jou naar school of naar je weet ik veel wat, en met je therapie kan doen en die je gras kan maaien. Dat, dan moet die, weet je well. Dan wordt een soort Swiss Army Knife van een robot. Nou ja, dat zie ik niet makkelijk passen in een bejaarden flatje"	Yes, I do not know. If you want a robot that can cook and can bring you to school or I do not know therapy and mow the grass. That, then he has to. Than it will be a kind of a Swiss Army Knife of a robot. And yes, I do not see that easily fit in an elderly apartment
Je hoort vaak van ja robots komen en die gaan ons vervangen. Ik denk dat dat never nooit gaat gebeuren. Dat vind ik eigenlijk overschatting van robotica en onderschatting van wat mensen kunnen	You often hear that, yes, that robots will replace us. I think that this will never happen. I think that it is an overestimation of robotics and a underestimation of the abilities of humans
Ik ben altijd een beetje bang dat ik het dan, dat ik, ja. Ik word er altijd een beetje onzeker van zeg maar van dit soort dingen. Ik weet namelijk niet of ik daar wel de geschikte persoon voor ben	I have always been a little afraid that I, that I, yes. I always become a little insecure of these kinds of things. I namely do not know if I am the right person for this
Ik luister naar de dokter-generatie	I listen to the doctor generation
Zo van nou we gaan gewoon vragen aan die mensen wat hebben ze nodig. Weten zij veel	So, we are just going to ask these people what they need. How do they know
Vaak vinden cliënten/patiënten het heel fijn om betrokken te worden en dat er niet over hen maar met hun gepraat wordt. En anderzijds ja de bedrijven en de ontwikkelaars die, die vinden vaak dat ze hun nodig hebben. Dat ze die input gewoon nodig hebben omdat het product er uiteindelijk beter van wordt	Often clients/patients think it is really nice to be involved and that they are consulted. On the other hand, yes, organisations and developers often think that they need these people. That they need the input to make an improved product