A robot for the elderly?

A qualitative research on the acceptance of NAO robots in elderly care

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Abstract

Research on the acceptance of assistive robots in elderly care is still a novel field and no clear research methodology has been developed yet. Nevertheless, acceptance levels of people for new technology form an important basis for development in robots that are intended to interact with humans. Therefore, the current study investigated what factors contribute to or work against acceptance of the humanoid robot NAO in elderly care, considering two groups – caregivers (staff) and elders (residents). Qualitative analysis with semi-structured interviews based on a SWOT-Approach was conducted with 20 participants in an elderly care facility in Aachen, Germany. Participants had to interact with the NAO robot in two short demonstrations. First, the NAO robot functioned as a memory assistant by reminding participants to take their medication. In a second part, participants played a short game with the NAO robot. The interviews afterwards were transcribed and a codebook was designed to evaluate the most important or most frequently named factors. Seven main factors could be established: pro-acceptance: fun, playing and contra-acceptance: physical care, losing work, communication, espionage and stigmatization. Conclusions drawn from the qualitative analysis suggest that present models about technology acceptance should be adjusted in terms of applicability in real-life settings. It appears worthwhile to invest research into long-term effects of robots like NAO in elderly care for mentally healthy elders to investigate acceptance in a broader context.

Keywords: technology acceptance, NAO robot, elderly care, qualitative research, robotics

"It occurs to me with all this animus existing against mechas today it isn't just a question of creating a robot that can love. Isn't the real conundrum, can you get a human to love them back?" (Female colleague to Professor Hobby, A.I – artificial intelligence, Steven Spielberg, 2001)

Introduction

The movie "A.I. Artificial Intelligence" by Stephen Spielberg (2001) is about a robot-boy, a so called "Mecha", named David that is given to a family whose real son fell into coma. After David's new mother Monica has spoken the "imprinting code" unconditional love from David for his new mother is activated. Nevertheless, the real son awakens from his coma eventually and Monica considers whether she really loves her surrogate son as much as she loves her real son. In the course of the movie, the question arises whether a human can actually love a robot. Today, technology plays an important role in many different aspects of our life. Robots are being used in various industries, for example to manufacture our cars. There is even progress in the employment of robots in healthcare. Nevertheless, it forms a big difference whether a robot is used to build a car or whether it is used to be a social companion for people. In particular, love and attachment play an important role in the acceptance of such technologies - thus posing the question whether people really can love or form close attachments with technologies like robots.

In the face of the ever growing elder population and the shortage of healthcare professionals, the need for technological assistive aids and alternative methods for treatment or occupation in elderly care become appearant (Bouma, Forzard, Bouwhuis, & Taipale, 2007; Lesnoff-Caravaglia, 2007). Consequently, a recent review on the emergence of robotics in care by Goeldner, Herstatt, and Tietze (2015) shows that care robotics research and development is on a constant rise since the 1970s.

The probably most famous example for robotics in elderly care is PARO, a robot emulating a little seal. The robot is specifically applied in settings where elderly people are suffering from dementia. A study conducted about PARO's use in assisted living facilities has shown that people with dementia react positively on PARO, begin to open up socially and are thus able to relax and enjoy their time with the robot (Gelderblom, Bemelmans, Spierts, Jonker, & de Witte, 2010). Moreover, it was discovered that PARO can function as an intermediator in terms of facilitating daily care and supporting social visits from family (Gelderblom et. al, 2010). However, since PARO is a robot that was originally designed for

elders with dementia, research about the application of this specific robot has been restricted to this field. Elderly not suffering from dementia and/or other cognitive impairments will probably need a robot not like PARO, but one with more complex capabilities like to walk around, talk and a robot which can take part in social interactions as for example playing games.

The most important aspect of the application of robots in elderly care is, however, the acceptance by the people who are intended to interact or use the robot. Different studies have shown that certain aspects of appearance play an essential role in the acceptance of a robot by elderly people (Körtner et. al, 2012; Wu, Fassert, & Rigaud, 2012). Körtner et. al (2012) established that elder users prefer a certain structure to a robot that includes at least arms, a body and a head to which they can talk, in turn ruling out robots with less humanoid features in terms of body proportion. However, Wu, Fassert, & Rigaud (2012) come to a different conclusion. In their study, assessing acceptance of appearance features and levels of comfort being exposed to several robots, elderly users were shown to prefer something that is discrete and small that does not look too human (Wu, Fassert, & Rigaud, 2012). With regard to the evaluation of how comfortable elders felt with the present robots, it came forward that cute and humanlike robots were preferred as long as they did not look too human (Wu, Fassert, & Rigaud, 2012). This aspect is related to the assumption of "the uncanny valley", a theory of Masahiro Mori (2012) that presumes that we are uncomfortable with robots that look too much like humans, until they reach the point where they are not distinguishable from real humans anymore. However, despite appearances, there are also emotional and practical aspects considered important with regard to the acceptance of a humanoid robot in elderly care.

A review by Broekens, Heerink, and Rosendal (2009) evaluated assistive social robots in elderly care. They found that elderly people become less lonely when exposed to companion robots. Additionally, companion robots were found to ease stress and even increased immune system response. These observations were further confirmed by a systematic literature review from Kachouie, Sedighadeli, Khosla, and Chu (2014), who assessed eighty-six studies in 37 study groups. They observed positive effects of social assistive robots on elderly well-being as well as a decrease of workload for the caregivers in elderly care facilities.

In terms of practical aspects regarding the acceptance of robotic assistance in elderly care, recent findings by Smarr et. al (2014), show that elders were open to robot assistance in general, but distinguished among different tasks. That is, elders wanted robot assistance

mainly for tasks related to domestic work, manipulation of objects and information management. With regard to personal care and leisure activities, they preferred human assistance.

However, not all studies confirm such a positive attitude towards a robot in elderly care. A study by Wu et. al (2014) assessing the acceptance of an assistive robot in older adults with and without cognitive impairment over a period of one month found that there was a generally low intention to use the robot and negative attitudes toward the robot. Furthermore elders in this study did not perceive the robot as useful for their daily life even though they found it easy to use, amusing and not threatening (Wu et. al, 2014). The authors emphasized that it is important to destigmatize the image of assistive robots to enhance acceptance. Additionally, a study on the views of staff of a disability service organization by Wolbring and Yumakulov (2014), found that staff members thought that a robot cannot replace human touch, interaction or companionship and that a robot should not replace a worker in the field of disability settings. Moreover, concerns about safety and normality for disabled people were voiced with regard to a robot companion (Wolbring & Yumakulov, 2014).

Taken together, it is evident that multiple factors ranging from appearance over practical and emotional aspects seem to play a role in the acceptance of technology in elderly users. However, comprehensive theoretical models aiming at prioritizing the underlying factors are few and afar. The most acknowledged theory about the concept of technology acceptance is the "Technology Acceptance Model" (TAM) developed by Fred Davis (Davis, 1986). This theory designs how users attain acceptance and how they perceive the usefulness of a new technology. According to the technology acceptance model, there are two main factors which influence the user's decision about whether they will use a new technology, namely: Perceived usefulness (PU) and Perceived ease-of-use (PEOU). People will use or not use an application or technology based on their belief whether it will help them perform their job in a better way (performance expectancy), and a person's conviction about the fact that the use of that particular application or technology is free of effort (effort expectancy; Davis, 1986). A conceptual design of the model can be found in Figure 1.

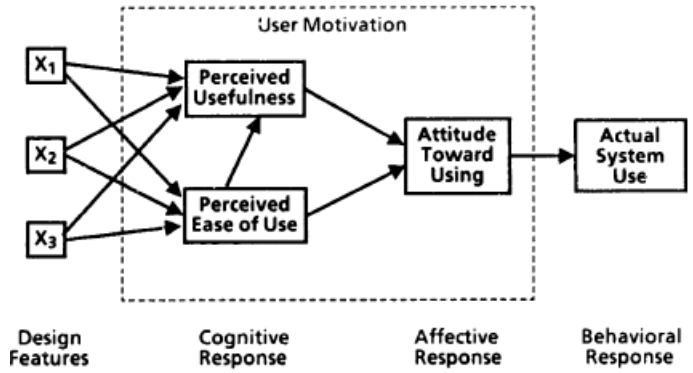


Figure 1 – Model of technology acceptance. Arrows present causal relationships in this model. Adapted from Davis (1986).

Davis (1986) describes that the determinant for a user to actually use a new technology is defined by the users' overall attitude towards this new technology or system. These attitudes consist of the earlier mentioned perceived usefulness (PU) and perceived ease of use (PEOU). Thereby, perceived ease of use is assumed to have a causal effect on perceived usefulness. The "design features" in his model consist of external variables which are interpreted by Davis as not having any direct effect on attitude or behavior but rather fuel the intensity and direction of the perceived ease of use and, in turn, the perceived usefulness which will then influence the valence of attitude towards use and eventually the actual system use (Davis, 1986).

In line with the theorized importance of perceived usefulness and perceived ease of use by Davis (1986), a study by Jaschinski (2014) reached a similar conclusion assessing technology adaption in an elderly care facility surveying residents and staff. While aspects like health and safety, social involvement and support for the activities of daily living are important for the elders, certain aspects that form a barrier for acceptance of new technologies came forward, most prominently lack of perceived need and perceived usefulness. Additionally, control, fear of social stigma and lack of human interaction have been denoted (Jaschinski, 2014). All of those variables together form the basis for acceptance of a new technology.

In summary, it is evident that a multitude of factors influencing acceptance of new technologies in elderly care have been identified already. These factors range from appearance over practical, as well as emotional issues. Owing to these aspects and aiming at gaining deeper insight into the acceptance of a specific robot in an assistive setting, the present study focuses on factors that influence the acceptance of a humanoid robot, NAO, in elderly care. Since the NAO robot is capable of communication, playing games, walking and

moving similar to humans, NAO is probably more appropriate for fitter elderly without mental constraints but who are nevertheless at risk of social isolation as opposed to the aforementioned PARO robot designed specifically for elderly with mental impairments.

The focus of this study lies especially on the use of NAO robots as a memory assistant (reminder help for taking the medications) and social companion (playing a game) to achieve a clear overview of the factors that might contribute to the acceptance of the NAO robot. Additionally, residents as well as staff members in elderly care were included in the experiment to gain insights from all parties affected by interactions with NAO. After the interactions with the NAO robot, interviews were conducted based on a SWOT-Approach by asking for Strengths, Weaknesses, Opportunities, and Threats (SWOT) the elderly people or caregivers might see regarding the robot in their work or living environment.

Method

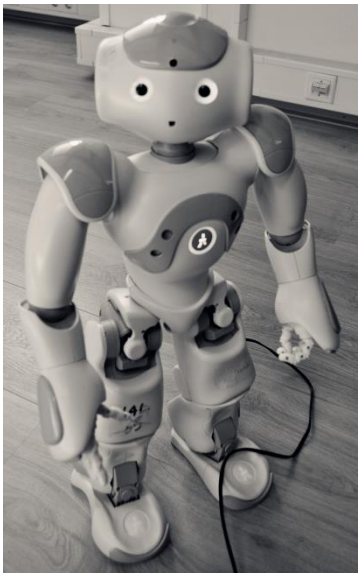
Participants

In total, 20 participants attended the experiment. All participants were either caregivers or residents of the elderly care center "CMS Pflegewohnstift Laurensberg" in Aachen, Germany. Ten of the participants were caregivers (7 female, 3 male) and ten were residents (6 female, 4 male) of the facility. All participants in the resident-group were mentally healthy elders without diagnosed dementia or other mental health issues. Participants were recruited by directly being asked from the head of the facility whether they would like to participate on a voluntary basis. The age of the participants ranged from 25 to 58 years in the caregiver-group (staff) and from 82 to 92 years in the resident-group. The mean age in the caregiver-group was 33,4 years and the mean age of the resident group was 87 years. All participants were German. The experiment was approbated by the standing ethical committee of the FPN, Maastricht (ECPMARBLE_2014_113).

Materials

NAO-Robot (Aldebaran, Edition: 4)

A NAO Robot (Edition 4) of the French company Aldebaran was used. The robot was provided by the Department of Knowledge Engineering, Maastricht. The NAO Robot is 57.3cm tall and weighs 5.2-kilogram. Inside its head are one 1.6 GHz Intel ATOM Z530 Processor and two high definition cameras. The robot spoke German



during the experiment. In order to program the robot for the experiment, the software "Choregraphe" ([2.1.2] Choregraphe Suite) from Aldebaran was used. For the first part of the demonstration (NAO as memory-assistant), an independently programmed procedure was created using the visual user interface of Choregraphe (a screencapture can be found in appendix A). For the second part of the demonstration, a finished free application ('guess-which-sport-it-is-game') was downloaded from the website of Aldebaran. A laptop (Lenovo ThinkPad) with OS Win 7 was used to run Choregraphe and to operate the NAO robot.

Oral instructions, written information and informed consent

Participants were provided with written information about the experiment beforehand. Furthermore, they were provided with an informed consent. Additionally, a waiver for taking photographs during the conduction of the experiment was presented (not obligatory). At the end of the experiment, participants also received written information about the goals and intentions of the study. Since the study was conducted in Aachen, Germany all written materials were provided in German.

Demographic questionnaire

After signing the informed consent, prior to the experimental parts, all participants had to fill in a short questionnaire (Appendix B). Through the questionnaire, basic information about the participants was collected (e.g. date of birth, nationality, gender).

Interview Questions

The interview consisted of seven questions, of which the first four were based on the SWOT-approach (Appendix C) investigating participant's perception of strengths, weaknesses, opportunities and threats posed by the NAO robot. The remaining three questions concerned what NAO should be able to do in order for participants to use it, what NAO should not be able to do and what elders in general often forget in daily life. All questions were face validated by a group of peers (mainly students, various backgrounds, age: 19-25).

Sound recordings

Interviews were recorded with an iPhone 4S. All sound recordings were later transcribed and coded with a code book.

Procedure

The study was conducted at the elderly care center "CMS Pflegewohnstift Laurensberg" in Aachen, Germany. A meetingroom in the elderly care center was used for the experiment. Participants were picked up by the experimenter in front of the room or at the entrance area of

the facility and were guided to the meetingroom. After receiving written and oral information about the experiment, they had the chance to ask questions and look at the robot to get used to it. Thereafter, participants signed the informed consent and were asked by the experimenter whether they would approve that pictures were going to be taken during the experiment. If participants approved, they had to sign an additional waiver for the photographs. Participants were then asked to fill in a short demographic questionnaire. The two interactive parts with the NAO Robot were explained to the participants. It was emphazised how and when participants had to interact verbally or nonverbally (e.g., touching the robot on the head) with the NAO robot. Furthermore, the communication-pattern of the robot was explained and how participants had to speak when giving an answer to a question of the robot.

Demonstration Part 1: In the first part of the interactive demonstration, the NAO robot functioned as a memory assistant reminding participants to take in their (imaginary) medicine. First, the NAO sits down. When the robot is seated, the participants were told that they could caress its head if they wanted to. When being caressed, the NAO robot reacted to that by standing up. After that it began to track the face of the participant in front of it with its two inbuild cameras in its head. When it tracked a face, NAO turned its head in the direction of the face and waves. Then, it says in German "Hello my name is Deniro. It is nice to meet you. What is your name?". Participants had been told beforehand how they could answer to that. After receiving an answer from the participant, the NAO robot says "Oh, that's a really pretty name. I hope you had a good day today." and sits down after finishing the sentence. A few seconds later, the NAO robot starts to play classical music out of his speakers on the sides of the head (song: *Bach Cello Suite No.1*). Again, the participants were told before how they could react on that. They could either listen to the song until the end or they could touch NAOs head again to skip the song. After they touched the head of the robot, it says "Hey! Nice that you are here! Please do not forget to take your medicine now. Yes?". Participants had to answer affirmative. After receiving the answer from participants, the NAO Robot reacts by saying "You did great! I will always look out for you, so that you do not forget anything!". A screencapture of the first part of the demonstration can be found in Appendix A.

Demonstration Part 2: In the second part of the interactive demonstration, the NAO robot functioned as a social companion by playing a game with participants. The game is called the 'guess-which-sport-it-is-game' which was downloaded as a finished application from Aldebaran. In this game, the NAO robot mimics eight different kinds of sports (skiing, boxing, horse riding, golf, volleyball, tennis, bowling, soccer and bodybuilding) with his whole body

posture and asks the participants afterwards whether they knew which sport it was. The second part of the demonstration began with the robot explaining the game to the participant. Participants could skip the explanation by touching the head of the robot if they desired. After explaining the procedure to the participants the robot mimics a kind of sport. When the robot is done it asks "And? Could you guess it?" on which participants had to answer after a beep. When the participant had guessed correctly, the NAO robot reacted by repeating what participants had guessed and saying "Well done!". If participants gave the wrong answer, the robot reacted by repeating the answer and stating "No, this is not the right answer". Thereafter, it asked whether participants wanted to play again to which the participants could either answer affirmative or decline. Participants were told beforehand that they could play as long as they wished to. When participants wanted to stop the game by either holding the head sensors for three seconds or by declining another round, the NAO robot sums up the game score by saying for example: "Congratulations you have 2 out of 4 answers correct".

Example pictures of the participants interacting with the NAO robot during the demonstration can be found in the appendix D.

Interviews: After finishing the two sessions with the NAO robot, participants were told that they were going to be asked seven questions and that they were going to be recorded on a device for later transcription. It was emphasized that all recordings will be deleted after the study is completed and that the recordings could not be traced back to their person.

Post-Demonstration: After finishing the interview questions, participants were given the debriefing in verbal as well as in written form and they had the chance to ask questions or discuss the experiment with the experimenter. Finally, participants could write down their names and addresses in order to receive the results of the study. All in all, the whole experiment lasted approximately 20-30 minutes per participant.

Data Reduction and Analyses

Goal of this qualitative study was to establish factors that might have an influence on the acceptance of the NAO robot in elderly care. Interviews were conducted with the participants after completing both interactive sessions with the robot. A codebook was made with the most important and most frequent factors participants mentioned in the interviews.

Codebook

The Codebook was developed by first reading all interviews and marking important or frequent factors mentioned by the participants. First, an overview of all factors was created in

a table. Secondly, the most important, frequent or surprising factors were chosen from this list to make the codebook. The column named "Code / Nr. of responses" shows the frequency of responses in terms of a participant code. The column "Factor" describes the factor which was referred to by the participant/s. The column "Brief Definition" gives a brief description of the factor in general and the columns "inclusion criteria" and "exclusion criteria" define the boundaries of the factors. Finally, the last column "Example Passages" gives one or more examples from the interviews.

Overall, the Codebook was sorted into two categories (first column); namely "Pro Acceptance" and "Contra Acceptance" for each group (staff and resident). With regard to the SWOT-approach, which was used to develop the interview questions, strengths and opportunities can mainly be seen in the category "Pro Acceptance". Weaknesses and threats can be seen in the category "Contra Acceptance". It is, however, important to mention that many factors can be equally "Pro Acceptance" and "Contra Acceptance". For example the factor "Companion" was perceived positively (to not be alone, to talk to someone) and negatively (doubts about a robot being capable of real companionship) in terms of acceptance. That is to say, those factors were either more positively or negatively attributed by the participants or that this factor is mentioned in terms of contributing to acceptance at one time by one participant, but working against acceptance from another at another time. In case a factor is mentioned in pro acceptance and in contra acceptance, it shows up in both categories but with different examples from the interviews. Pro acceptance thus means that a factor contributes to acceptance and a contra acceptance factor makes acceptance harder.

Taken together, the codebook thus consists of seven columns and four rows for the category "pro acceptance staff", two rows for the category "pro acceptance resident", seven rows for the category "contra acceptance staff" and five rows for the category "contra acceptance resident." The complete codebook with all factors can be found in Appendix E.

Results

Results in the staff group

Pro acceptance

Fun is one of the most frequent factors contributing to acceptance in this group. Out of ten caregivers it was mentioned by three different members of this group. One member emphasized this by saying:

"Elderly people need a lot of fun and joy… elderly people like to play as much as children or adults around 40 like to play. And because of that I can imagine that he (the robot) will be fun for the residents." (Code: SR)

The staff member further conveyed that the robot could fulfill this job in terms of entertaining the elderly. In addition to that another staff member said that she/he could imagine a certain resident to have fun with the robot:

„And well also as an occupation… because I can imagine that… I am not going to say a name now… but a certain resident would have fun with it (the robot)." (Code: MC)

This implies that she/he thinks at least some elderly would enjoy interacting with the robot even though this is maybe not the case for every resident.

Support was mentioned three times by three different members of staff as well. The term "support" describes all support except for physical care or memory assistance. Members of this group saw support as a valuable addition the robot could offer to ease workload in elderly care facilities. Nevertheless, they did not want to let the robot do the physical care - the majority said that this should still be done by humans. An example for support a robot could give in an elderly care facility besides physical care was given by one out of the ten staff member:

"Yes, I would say that he (the robot) could pass on information (to the staff) like blood-pressure values or from blood-sugar controls. This kind of stuff - which has to be done on a daily basis with certain residents. If something like this could be passed on, that would be not bad!"(Code: HG)

Another staff member gave the example of brain training with the robot:

"…or even conducting memory-training with the lightly demented elderly. I think this is a good thing." (Code: NB)

Appearance refers to the pure outer appearance of the NAO robot. It was mentioned by two different members of staff.

"*I could imagine that the Robot would be fun for the elderly – because he is funny. (…I like the blinking of his eyes, I like the way he talks.) He has something babyish, worth protecting."* (Code: SP)

Here the blinking of the eyes of the NAO robot and his childlike appearance (relatively big head, big eyes) is meant. This was perceived as positively cute and somewhat human-like.

Companion refers to the robot functioning as a social comrade of sorts for the elderly. This factor was brought up two times by two different members of staff. Again, this factor is mentioned in terms of lessening workload and giving support while working with the elders. One member of the group mentions occupation for the elderly as aspect of companionship:

> *"Hmm… that's varying… on the one hand the care of the dementia patients. Especially when they are sitting at the table, that you can put something in front of them so that they can communicate with it (the robot) while we are still busy with fostering the elderly. At least at times when you do not have so much time for the resident or patient."* (Code: NB).

Nevertheless that the robot will just be used for this purpose was emphasized – only when members of staff are busy fostering the elders. This means elders having some distraction while the caregiver nurses the next resident.

Contra acceptance

Physical care is definitely seen as a negative attribute by at least three different members of staff.

> *"Hmm… the general fostering… well the fostering has to be done by humans. And I mean from human to human. Otherwise we would be like a car or an object of utility. Human fostering should always be a task for humans."(*Code: MW).

This example clearly illustrates the uneasiness most of the caregivers feel concerning the robot performing intimate tasks like washing people.

> *"No! Definitely not. I mean you could probably bring a machine so far as to foster a simple resident in bed. But I think… you should not do this to people… that they are being washed by some machine… seriously!"*(Code: BE).

The majority of the members of staff perceive fostering as something really intimate and sensitive which should not be done by any machine as it would degrade humans to things.

Fear is another concern expressed by caregivers. This factor was mentioned by two different caregivers. In general, it describes the concern or anxiety which is related to the robot in the elderly care facility.

> *„Hmmm… I think for the elderly it is interesting. But I do think the elderly nowadays will have difficulties with it. But in a later generation it would be easier. I think about the elderly residents which live here now. Especially in the dementia sector upstairs… I think they would be afraid!"* (Code: SR).

This example demonstrates the uncertainty of staff regarding the usefulness-tradeoff. On the one hand the caregiver in this example thinks that the robot could be interesting but on the other hand it could also be frightening especially for the elders with dementia.

Substitution is a generally negatively attributed word and it came up in this context in one interview.

> *"… better would be a pet, a dog – therapeutic walking. Or that the dog is there so that people can feel it. But a robot… well of course you can touch it's head… we did that earlier… but I think it's just not it. He (the robot) also couldn't give the love and affection to the one you actually need."* (Code: EJ)

This answer refers to the aspect of love and affection – feelings a robot cannot communicate as for example an animal like a dog could. Since the NAO is a robot and not an animal, giving a substitution for those real feelings is what participants mainly perceived. Moreover, the caregiver emphasized that elders really need to receive real love and affection which a robot is not capable of.

Losing work is a factor which was mentioned by three different caregivers and is related to the fear of losing work because of the robot. When asked about possible future threats regarding the robot, one member of staff said:

> *"That's a good question… well hmm… the only thing I could see there right now is the threat that workplaces could be taken away."* (Code: SR).

As illustrated by this example, caregivers see the robot more as some kind of rival than a viable option to ease workload.

Memory Assistant is a factor which was also perceived more negatively. This factor refers to action the robot performs to remember their users to not forget things. It was mentioned by one caregiver.

> *"Yes, for example, that the elderly say that they took their medication but in fact they did not. There are frequently people who say 'yes' although they did not understand the question at all. And I also said yes although I did not take any medication!"* (Code: SP)

Here the danger a robotic memory assistant can hold, by not being able to detect a lie or by not being able to detect the action of having taken the medication is mentioned. The robot is not deemed reliable enough to be trusted with such an important task as reminding elders to take their daily medications. Moreover, the question about responsibility arises here: Who is responsible for the consequences when the resident has not taken the medicine?

Appearance is a factor which was not only attributed positively by the caregivers but also negatively. It was mentioned by two caregivers. When asked the question what a NAO should do so that the participant would use it, one said

> *"(it has to) look more human!"* (Code: EJ)

This refers to the NAO not looking human enough to be completely comfortable with.

Human-Human interaction means interactions which are pure between two human beings. It was mentioned by two different caregivers in this context.

> *„Well… we work with human beings and I think from human to human it is better to work then robot to human. Well, I think it would even be a deficit if the robot would be there too."* (Code: EJ)

It was not further explained why the robot would be a deficit. Nevertheless this answer demonstrates that work with a robot is perceived as a deficit which could maybe derive from the robot not having enough competencies in comparison with humans regarding social skills or motoric capabilities.

Results in the resident group

Pro acceptance

Playing is a factor which was mentioned by three different residents and could be described as joyful, voluntary interaction between human and robot.

> *„Well there are interests you might have which he could ask about…like reading or something like that. Whether you would like to join… reading or playing games maybe. Or in general, what interests we still have in life. I assume that this will be kind of successful sometimes."* (Code: CS)

As one resident mentioned, to have someone ask you or invite you to play games sometimes is perceived as important and valuable. Being asked by someone about interests and hobbies is mentioned. This example emphasizes the wish of elderly to be engaged more in daily live. This need could maybe be fulfilled by a robot somehow.

Memory Assistance In contrast to the caregivers, who saw memory assistance as a too dangerous procedure for being done by a robot, elderly perceived it as a useful task a NAO robot could perform.

> "*Well… when I forget to take my medicine… when I am so far that I am not able to do this… then this would be a good arrangement, I would say. Then it would be appropriate that he could remind me and so on. This would be good."* (Code: GV)

Nevertheless, this is only an option when the user is not able to do such tasks by her- or himself anymore.

Contra acceptance

Communication is one of the most frequent named negatively attributed factors in the group of the elders. It was mentioned in this context by six different residents.

> *"Well, the tone… this has to change. More naturally, you see? Well I guess this is a device which has to be tested first… but this has to be changed to be more natural. This is like the speaking-dolls, right?"* (Code: ME)

Not only was the manner of speech (tone) of the robot criticized but also the aspect of difficulties in understanding the robot clearly. One participant mentioned when asked about the weaknesses of the robot:

"Yes, that I am just not able to understand him. This is going to be lost" (as in "a lost cause", editor's note). (Code: GR)

Nevertheless, this aspect was mainly mentioned by the group of elders – so the reason for the difficulty in understanding could be due to hearing impairments in old age.

Espionage is a factor which evoked concerns in the elders and was mentioned by four different residents.

> *"I don't know exactly if there is something saved (on the robot)… when you for example say things you wish you did not say… those things are maybe saved. But I cannot estimate how this works. "* (Code: IR)

This example clearly illustrates the uncertainty about new technologies regarding being watched or the capabilities of the robot to do so. This of course, could again be reinforced by the development in media and the reports in newspapers about cases such as countries saving data of their internet users.

Physical care was not only uttered negatively by caregivers but also by three residents.

> *"Yes, I have read about it… also in…uhm… lack of care (personnel) and that robots are being used… I mean big ones, which can serve people. This would be awful!... That is cold…"* (Code: ME)

This again shows that the elders do not want to be fostered by a machine – this opinion is consistent throughout the interviews.

Substitution was again named in both groups. One elder mentioned the concern about the robot taking away or substituting the natural contact in the family:

> "*He (the robot) takes away the natural contact in the family – he takes it away. We leave it here to a robot. And this is a thing which is more or less inappropriate in a family. Since in a family, the correspondence between old and young and between the couple has to work. And this is something no robot can do."* (Code: GR)

Again, this example seems to refer to a lack of social competences from the robot. A robot should not be used as a substitution for the normal communication between members of a family.

Companion was attributed more positively by the group of caregivers than by the group of elders. Here it was associated more negatively.

> *"Yes that's it… when I am desolate. Lonely. Then I would like to talk to someone. But this someone is not there anymore. You know… just not there anymore. What can I talk to him then? What? That is not possible… he can't react on my questions. You have to ask a certain kind of question so that he can answer."* (Code: GS)

This example shows the need or wish, to have someone to talk to when being lonely but it also shows the doubts about robots ever being able to do communicate as fluent and intelligent as humans. This is perceived as a big disadvantage.

Factor frequencies and additional outcomes

Overall the pro acceptance factors that were mentioned most frequent in the group staff are support and fun (named by 3 participants each) followed by companion and appearance (named by 2 participants each). The contra acceptance factors mentioned most in the group staff are physical care and losing work (named by 3 participants each) followed by fear, appearance and human-human interaction (named by 2 participants each) and finally, substitution and memory assistance (names by 1 participant each). An overview of the results can be found in figure 2.

The pro acceptance factors which were mentioned most in the group resident are playing (named by 3 participants) and memory assistance (named by 2 participants). The contra acceptance factors which were mentioned most in the group resident are communication (named by 6 participants), espionage (named by 4 participants) followed by physical care (named by 3 participants) and substitution and companion (named each by 1 participant). An overview of these results can be seen in figure 3.

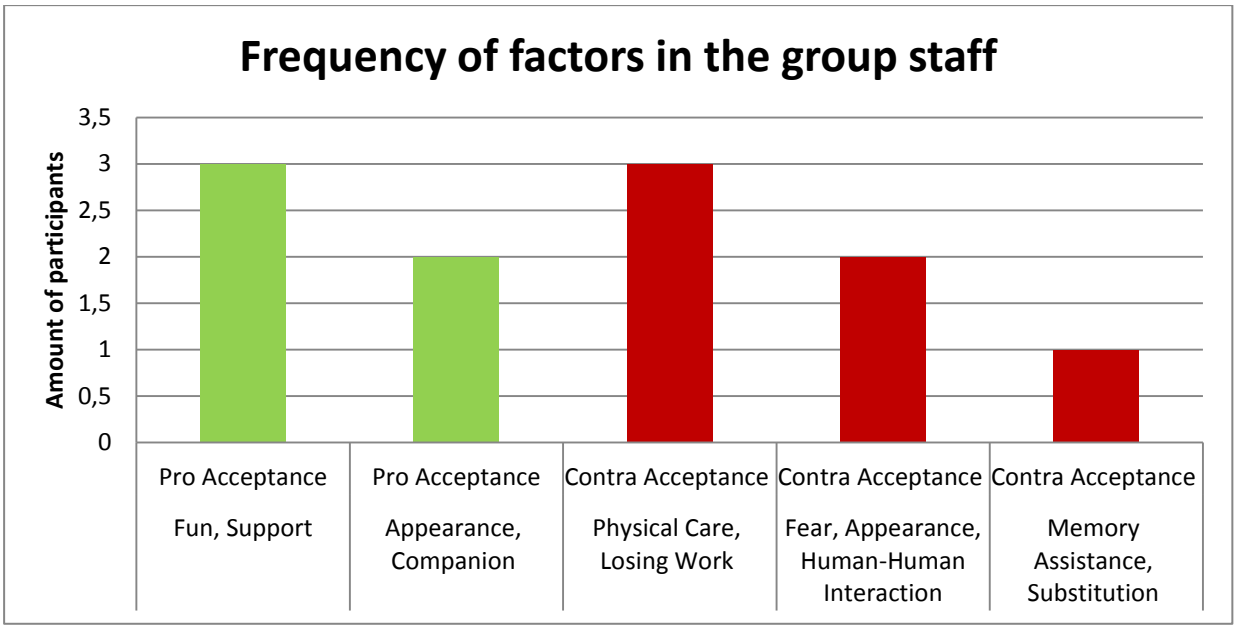


Figure 2 – Overview of factor frequency in the staff sub-sample

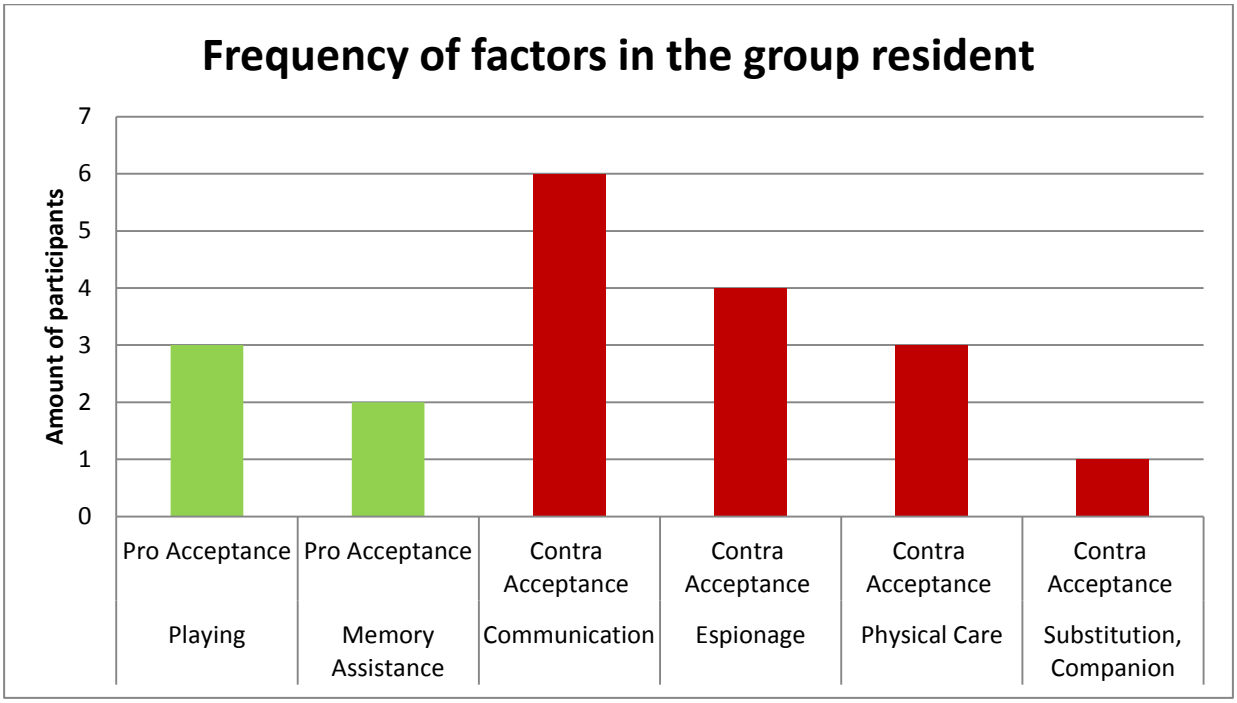


Figure 3 – Overview of factor frequencies in the resident sub-sample

Stigmatization by the use of robots such as PARO in care for dementia forms an additional factor which was obtained from the interviews. Supplementary to the questions which were based on the SWOT-approach, another general question was added in the interview, namely "Are there any things you or the residents frequently forget?" Many participants reacted defensively on this question, especially in the group of elders. One example from an interview with a resident illustrates this aspect clearly:

Participant: *"Yes I think mostly for dementia patients this would be good. I could imagine this. Someone else might feel mucked… definitely."*
Researcher: *"Yes okay. So you are saying that the robot is rather intended for dementia patients than for…"*
Participant*: "As I said… this needs getting used to… this as entertainment… but anyways… you need to not be able to cope with things anymore… right?"*
Researcher: *"Yes okay. So you would say that this would rather be for…"*
Participant: *"There I could imagine this as entertainment. But well when you are still able to read and write and… hmm yes… and when you are not having any defects in your head then… (laughs)."* (Code: ME)

Or another example from a resident:

"I don't know… well when you are still mentally fit or something… then it is… I would not see anything good in it for me." (Code: AK)

These examples extracted from the interviews demonstrate the perceived stigmatisation which is present since for example robots like PARO are used especially in care for dementia patients. Robots in regular elderly care with mentally healthy elders are not yet as established and thus not easily accepted by the elders. Stigmatization is thus an important factor which has to be considered while creating robots for the mentally healthy population of elders.

Discussion

Using semi-structured interviews based on a SWOT approach, the present study investigated factors that influence the acceptance of the NAO robot in elderly care among residents and caregivers. Before the interviews were conducted, participants performed two interactive operations with the robot (memory assistance and playing a game). The aim of this study was to narrow down factors which could possibly play a role in the acceptance for each group: caregivers who are essential for the operation of the robot in elderly care and the elders who are ultimately the population group which is intended to be the end-users.

The results found in the group staff which contribute positively to the acceptance of the NAO robot are: Fun, Support, Appearance, and Companion. The factors found in the same group but contributing negatively to the acceptance of the NAO robot, are: Physical care, Fear, Substitution, Losing Work, Memory Assistant, Appearance, and Human-Human interaction.

Factors found in the group resident which contribute positively to the acceptance of the NAO robot are: Playing and Memory Assistant. The factors found in the same group but yielding negative impact on the acceptance of the NAO robot are: Communication, Espionage, Physical Care, Substitution and Companion. All factors coming forward in the analysis can be once more roughly ordered in three overarching categories: appearance, practical aspects, and emotional aspects. Overall, more factors "contra-acceptance", meaning contributing negatively to acceptance were found for both groups. Additionally, for both groups alike, especially practical and emotional aspects rather than appearance came forward contributing negatively to acceptance. Physical care in particular was mentioned as a factor where a robot should simply not be used. This finding confirms the distinction found by Smarr et. al (2014) that elders prefer human interaction in certain kind of activities such as physical care and leisure activities.

In line with prior research by Wolbring and Yumakulov (2014), who surveyed acceptance of robots in assistive care amongst caregivers for disabled residents, worries about substitution (and in turn fear of losing work) and the lack of human-human interaction were prominently featured in the staff member group. For the group of residents, the findings of the present study are similar to Wu et. al's (2014) findings of a rather negative stance participants took towards the employment of robots in assistive care, particularly with regard to perceived usefulness.

For both groups it seems to be the case that even though NAO's added value as (short-term) entertainment/social companion is recognized and appreciated, which confirms earlier findings that assistive robots can have a positive impact on resident's well-being and relief some of the work load of caregivers (Broekens, Heerink, & Rosendal, 2009; Gelderbloem et. al, 2010; Kachouie et. al, 2014), the perceived usefulness in practical an emotional regards is considered rather low. A notable exception is the discrepancy between the two surveyed groups with regard to NAO's memory assistance feature. While caregivers perceive this feature as dangerous, being aware of the adverse effects wrong medication and/or deceit of the robot (as in pretending to have taken the medication) can have, residents seem to view this feature as a playful reminder they would welcome.

With regard to the factor "Appearance" which was mentioned in both categories "pro-acceptance" and "contra-acceptance" by the group staff, it is not so clear anymore what is being preferred: A robot which looks somewhat like a human in terms of possessing a body similar to ours (head, torso, arms, legs, walking upright) as Körtner et. al (2012) established (and which is the case for NAO), or a robot who completely looks like a human (i.e.

possessing mimics, facial features, skin, hair, etc.). Since it was mentioned by both sub-samples, it seems to be an ambiguous factor. According to the model of "Uncanny valley" by Mori (2012), robots which are supposed to look human are evoking repelling and uncomfortable feelings in us until robotics eventually reaches the moment where it is no longer possible to even distinguish a robot from a real human. To summarize, some participants liked the outer appearance of the NAO robot as it is and some other wished it to look more like a human since he evoked some feeling of repulsion.

By using three extra questions in addition to the aforementioned factors that were assessed based on the SWOT-approach, an additional factor was found: fear of stigmatization. Induced by reports and news in television and newspapers about robots like the mental commitment robot PARO that is mainly used in care for dementia, participants worried the use of a robot for any kind of assistance would stigmatize them in terms of *needing* assistance rather than *choosing* assistance. This finding of the factor "stigmatization" is in accordance with the findings of Jaschinski (2014), who examined the acceptance and adoption of so called "AAL technologies" (Ambient Assisted Living) in elders. AALs have the intention of making it possible for elders to live more independently for a longer amount of time for example in their own homes.

Jaschinski (2014) described AALs as following: "AAL is a term for a new generation of information and communication technology (ICT) products, services and systems which promote and support healthy and active aging at home, the community and at work." (p.320). One example for such a technology is unobtrusive sensors instead of the use of an emergency button. In general, Jaschinski (2014) discovered that aspects which can form a barrier for the acceptance of such new technologies are: lack of perceived need and perceived usefulness, privacy, obtrusiveness and control, lack of experience, technology anxiety and self-efficacy, fear of a social stigma, reliability, lack of human interaction, cost, and health concerns. But not only "stigmatization" can be found in her findings. Also the factor "Espionage" found in the present study is incorporated in the factor "privacy" of Jaschinski's (2014) study. The factor "Substitution" found in the present study draws back on "lack of human interaction". Furthermore, robots as for example PARO are mainly used in care for dementia patients with positive outcomes on their wellbeing and openness to social interactions (Gelderblom et. al, 2010). Nevertheless, robots are not yet as common in the life of elders. This could form an explanation for elders in this study reacting in a biased way.

Findings of the recent study have shown that participants expressed themselves indeed positively towards using the NAO robot in the future if it would fulfill criteria for "perceived usefulness":

> Researcher*: "And what should a NAO in general be able to do so that you would use or possess it? I mean except for what you have seen in the two presentations?"*
> Participant: *"Yes, I would say, to pass on information for example blood-pressure measurements or blood-sugar controls. The things, that has to be done on a daily basis for some residents. And when something like this would be passed on – that would be not bad." (*Code: HG)

And that they would consider using the NAO robot if it would fulfill criteria of "perceived ease of use":

> Researcher: "*What should a NAO robot be able to do, so that you would use it?"*
> Participant: *"It has to be easy to operate and handle. It should look funny and not be too heavy, because it has to be transported often. And well… maybe a bit more colour for the outer appearance." (*Code: MS)

Nevertheless, findings of this recent study have also shown that especially negatively attributed factors as for example "fear" or "substitution" can have a significant impact on whether participants would even consider using a NAO robot.

> *"… better would be a pet, a dog – therapeutic walking. Or that the dog is there so that people can feel it. But a robot… well of course you can touch it's head… we did that earlier… but I think it's just not it. He (the robot) also couldn't give the love and affection to the one you actually need."* (Code: EJ)

In this example, the NAO robot is seen as a substitute for giving love – which is not possible. A dog is preferred by the participant since a dog is able to express feelings. This example demonstrates the importance of variables or factors which influence the user's attitude or acceptance towards technologies and by it also the usefulness or actual usage.

Subsequently a positive factor as for example "fun", "appearance" or "playing" can enhance the acceptance of the NAO robot and by it enhancing the probability of the robot being actually used.

> *„Well there are interests you might have which he could ask about…like reading or something like that. Whether you would like to join… reading or playing games*

maybe. Or in general, what interests we still have in life. I assume that this will be kind of successful sometimes." (Code: CS)

To sum this up, the factors which were found in this recent study offering important information about variables which can contribute to the acceptance of the NAO robot in elderly care and, in turn, also higher probability of ambition to use the robot. Considering the Technology Acceptance Model of Davis, however, it becomes clear that the relationship between the user's motivation and "design features" or variables/factors has to be considered anew. While the initial model breaks down all external factors to mere determinants of the expression of perceived ease of use (which influences the perceived usefulness), the present study highlights the importance of those external factors as direct determinants for acceptance and hence, attitude towards use. With reference to the factors found in this study, this would imply to change the concept of "design features" from having no direct influence on the user's motivation towards a new concept of design features and user's motivation being considered as working together and/or the possibility of former "design features" a direct determinants of attitudes towards technology use. The Technology Acceptance Model should therefore possibly be extended to include more direct factors which might account equally well for change processes in acceptance or actual use of such technologies as perceived usefulness only.

Limitations

The findings presented in this study suffer from several limitations. First, the director of the care facility chose the participants for the experiment. This might have led to a biased participant population in terms of attitude towards new technologies. Additionally, it remains unclear which criteria the director used to determine "mentally sound" residents of his facility. Secondly, the experiment was conducted at only one retirement home which means that the general pool of participants was limited due to exclusion criteria like mental impairments. Thirdly, the sports depicted by the NAO robot in the "guess-which-sport-it-is-game" were not always the same for every participant. Out of the limited number of sports, the NAO robot thus, depicted them randomly for every participant. Furthermore, the robot did not work perfectly at all times – there were incidents were the robot either lost its balance or the speech of the robot was not properly understandable due to technical errors (staccato voice).

Next, there may have been a bias through the way the interview questions were asked, since participants sometimes had difficulties in hearing (hearing impairment) or general

difficulties in understanding the question. Therefore, the researcher had to repeat or reformulate the question which led to a non-consistent question pattern among different participants. Occasionally questions had to be further explained which in turn might have influenced the participant in her or his own answer by just agreeing (the tendency to just say yes to a question).

Furthermore, while exploring the factors in the analysis, it became apparent that it was not always clear where to define the boundary of a factor. For example, it is not completely clear if communication and companion actually form two distinct factors. Lastly, not all participants of the group staff belonged to the same job classification (caregiver, occupational therapists and social worker). Nevertheless, all participants from the group staff had ample personal contact to the elderly to sufficiently evaluate the needs of the residents regarding the use of the NAO robot. Finally, the recent study is limited due to the fact that only one researcher has analysed the qualitative results (interviews) therefore making calculations of inter-rater reliability impossible.

Applications

Even though there has been increasing development in socially assistive robots for the elderly, this line of research is still in its infancy, both with respect to development of the robots itself but also regarding investigation about what factors influence acceptance of such new technologies in elderly care for mentally healthy elders. It is not yet clear why the group staff mainly named specific factors in comparison with the group residents. Or why they mentioned more negatively focused factors than positive factors in general. Given the pioneering, rather exploratory nature of this study the reasons as for why those factors have been mentioned remain to be uncovered in future research.

Furthermore it is also not clear to what extent the external factors or variables (called "design features" in the TAM) are influencing the user's motivation (PEOU and PU) or whether that influence is also reciprocally active, meaning whether users' motivation can change the factors/variables itself. Future studies should investigate these aspects more closely and should consider taking more external variables into account as for example input from family while conducting interviews in a focus-group setting. Further, it is highly advised to address the methodological problems since these studies are relatively novel and it is not yet established how to measure acceptance in terms of a robot as the NAO. Moreover, it could be considered whether this study might be replicated in a longitudinal design in order to fully evaluate the process of acceptance on a broader context.

Conclusion

Undoubtedly, it is still a long way ahead until robots are being accepted in elderly care. Nevertheless, this study has highlighted several factors which are essential for this step to be accomplished. The most frequent named factors contributing positively to acceptance are: fun which means that being able to play games with the robot and to be able to have fun with it is considered important. That the robot serves as an interactive activity is highly valued. The most frequent named factors contributing negatively to acceptance, making acceptance harder are: physical care which was mentioned frequently by concerned staff about humans being nursed by machines. Losing work was another negative factor named by staff in terms of being afraid to lose their jobs in the future because a robot has taken their place. Communication and espionage form negative factors which were mentioned by the residents since they often had difficulties understanding the robot properly and mentioned the fear of being observed by the robot.

In general, both groups mentioned more negatively attributed factors (12 contra-acceptance factors) in comparison to positively attributed factors (6 pro-acceptance factors). Surprisingly, another factor manifested while conducting the interviews: stigmatization for the use of robots like PARO in elderly care for dementia patients. Elders repeatedly mentioned that they do not see any use in the NAO robot since they are still able to do everything mentally. This makes clear that elders are being biased by news about such robots which can be seen in television or read in newspapers. Stigmatization forms another barrier for acceptance which has to be overcome in the future by slowly getting the elders used to robots (long-term studies) not only being deployed in dementia care.

Lastly, with regard to present models about technology acceptance as the "technology acceptance model" by Davis, it becomes clear that this model might have to be adjusted in terms of applicability in real-life settings, since user's motivation - at least in this study, seems not to be completely independent from variables or factors from outside. The current study has only begun to shed light on the emerging field of technology such as robots in elderly care. Additional research is needed to investigate long-term effects of such robots like NAO in elderly care for mentally healthy elders that go beyond purely exploratory research. By investigating acceptance for assisting technology on a broader context, fears and worries might be reduced and NAO (or any other assisting technology for that matter) might be seen and accepted as for what it is: Assistance to make life easier, no more, no less.

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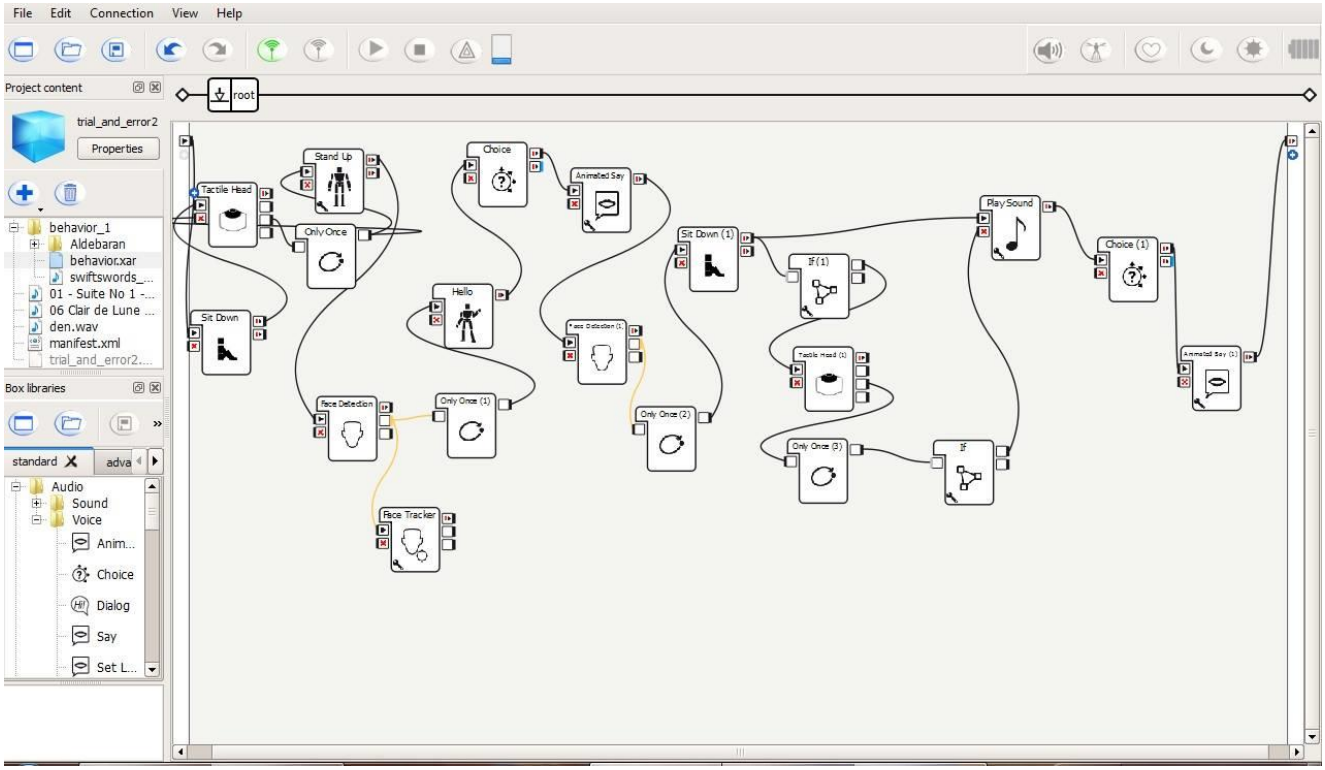
Appendices

Appendix A: Screenshot of the first procedure with the NAO robot



Appendix B: Demographic questionnaire for participants

Questionnaire

For participation in the academic research study:

"A robot for the elderly? - A qualitative research on the acceptance of NAO robots in elderly care."

Participant Number:	
Name:	
Date of Birth:	
Nationality:	
Gender:	male female
Resident or Caregiver/Staff?	

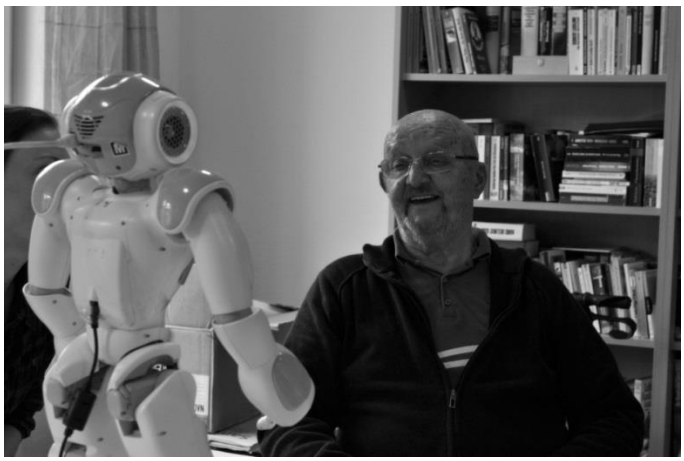
Appendix C: Interview protocol for the semi-structured interview

I. Please tell me about the strengths you perceive regarding presence of NAO robots in your living/work environment?
II. Please tell me about the weaknesses you perceive regarding presence of NAO robots in your living/work environment?
III. Please tell me about the opportunities you perceive regarding presence of NAO robots in your living/work environment in the future?'
IV. Please tell me about threats you perceive regarding presence of NAO robots in your living/work environment in the future?'
V. Can you imagine possessing or using a NAO robot in the future? Why?
VI. What should a NAO robot be able to do for you to really use/possess one?
VII. What should a NAO robot NOT be able to do for you to really use/possess one?

Appendix D: Photographs of participants while interacting with the NAO robot

Participant touching NAO's head in the first experimental part

Experimenter explaining the procedure with the NAO robot to an elderly



Elderly participant is laughing at the NAO robot


Left: resident & right: caregiver interacting with the NAO robot

Resident is critically watching the NAO robot

Appendix E: The codebook

Category	Code / Nr. Of responses	Factor	Brief Definition	Inclusion Criteria	Exclusion Criteria	Example Passages
Pro Acceptance Staff	MS, SR, MC,	Fun	- The robot eliciting fun by e.g. his appearance, playing games, his voice etc.	- participant uses the word fun - participant mentions enjoyable activities	- not enjoyable activities	(1, staff, female) *„Elderly people need a lot of fun and joy… elderly people like to play as much as children or adults around 40 like to play. And because of that I can imagine that he (the robot) will be fun for the residents."*
	HG, SP, NB	Support	- All support besides physical care or Memory Assistant (e.g. assistant in household, carrying things around)	- participant mentions supportive actions the robot could take to facilitate life	- physical care	(20, staff, male) "*Yes, I would say that he (the robot) could pass on information (to the staff) like blood-pressure values or from blood-sugar controls. This kind of stuff, which has to be done on a daily basis with certain residents. If something like this could be passed on, that would be not bad!"*
	MS, SP	Appearance	- The pure outer appearance of the robot.	- Participant talks about or refers to the Body of the robot	- communication - language -speech	(1, staff, female) "*I could imagine that the Robot would be fun for the elderly – because he is funny. (…I like the blinking of his eyes, I like the way he talks.) He has something babyish, protective."*
	NB, MC	Companion	- spending	- spending	- playing games	(19, staff, male)

			enjoyable time with the robot - to not be alone	time with the robot		"*hmm… that's varying… on the one hand the care of the dementia patients. Especially when they are sitting at the table, that you can put something in front of them so that they can communicate with it (the robot) while we are still busy with fostering the elderly. At least at times where you do not have so much time for the resident or patient.*"
Pro Acceptance Resident	CS, GV, AK	playing	- All activities in which the human and the robot play a game. (e.g. The guess-which-sport-it-is-game)	- participant uses the word playing - participant mentions games or other playful activities	- obligatory activities	(10, resident, female) *„Well there are interests you might have which he could ask about…like reading or something like that. Whether you would like to join… reading or playing games maybe. Or in general, what interests we still have in life. I assume that this will be kind of successful sometimes."*
	GV, WG	Memory Assistance	- The robot as pure memory assistant in terms of reminding people about things which they should not forget.	- Participant mentions robot in terms of assisting with reminding things	- Every other kind of assistance e.g. companionship, household help, serving/carrying things	(12, resident, female) *"Well… when I forget to take my medicine… when I am so far that I am not able to do this… then this would be a good arrangement I would say. Then it would be appropriate that he could remind me and so on. This would be good."*
Contra Acceptance Staff	MW, SP, BE	Physical care	- The pure physical care in terms of fostering elderly people	- Participant mentions fostering e.g. washing people, assisting with intimate	- Taking medications - Companionship - playing games	(18, staff, male) *"Ähm… the general fostering… well the fostering has to be done by humans. And I mean from human to human. Because otherwise we would be like a car or an object of utility. Human fostering should always be a task for humans."*

				actions like using the toilet		
	SR, HG	Fear	- a strong negative feeling of anxiety which is related to the robot	- participant mentions the word fear / being afraid	- positive feelings towards the robot	(6, staff, female) *„Hmmm… I think for the elderly it is interesting. But I do think the elderly nowadays will have difficulties with it. But in a later generation it would be easier. I think about the elderly residents which live here now. Especially in the dementia sector upstairs… I think they would be afraid!"*
	EJ	Substitution	- The robots takes in the place of the human and executes the action in place of the human. - Substitution for intimacies between humans (e.g. family-contact, love, affection)	- The robot takes something away - robot substitutes human emotions	- losing work because of substitution	(7, staff, female) „*Yes… well I think all the stuff I mentioned earlier… care, fostering, Daily-structure, to plan the residents for activities. I think this would not be possible (for the robot). Also not for the people upstairs. Better would be a pet, a dog – therapeutic walking. Or that the dog is there so that people can feel it. But a robot… well of course you can touch it's head… we did that earlier… but I think it's just not it. He (the robot) also couldn't give the love and affection to the one you actually need."*
	SR, SP, XR	Losing work	- Loosing ones workplace because of the robot. (e.g. Cars are now being built by robots instead of	- participant mentions concern about losing job because of robot	- substitution in other areas then work	(6, staff, female) *„That's a good question… well hmm… the only thing I could see there right now is the threat that workplaces could be taken away."*

			humans)			
	SP	Memory Assistant	- The robot as pure memory assistant in terms of reminding people about things which they should not forget.	- Participant mentions robot in terms of assisting with reminding things	- Every other kind of assistance e.g. companionship, household help, serving/carrying things	(5, staff, female) *"Yes, for example, that the elderly say that they took their medication but in fact they did not. There are frequently people who say yes although they did not understand the question at all. And I also said yes although I did not take any medication!"*
	EJ, SR	Appearance	- The pure outer appearance of the robot.	Participant talks about or refers to the Body of the robot	- communication - language -speech	(7, staff, female) *"- Researcher: Okay and what should a NAO Robot do, so that you would own or use it?* *- Participant: To look more human!"*
	EJ, HG	Human-Human interaction	- Interactions which are pure between two human-beings.	- participant mentions that activity is better between two humans than human-robot	- fostering - companionship - playing games - emotional substitute	(7, staff, female) *„Well… we work with human beings and I think from human to human it is better to work then robot to human. Well, I think it would be a deficit if the robot would be there too. "*
Contra Acceptance Resident	ME, GS, GR, WG, SP, IR	communication	- verbal & non-verbal communication (mimic, gesture) of the robot - difficulties with beep-schema - difficulties in understanding (too quiet,	- everything which has to do with the pure process of communication	- playing games - companionship	(15, resident, female) *"Well, the tone… this has to change. More naturally, you see? Well I guess this is a device which has to be tested first… but this has to be changed to be more natural. This is like the speaking-dolls, right?"*

			unclear)			
	IR, AK, GS, CS	Espionage	- the fear of being observed by the robot (e.g. the robot is recording what is happening around it)	- Participant mentions to be afraid of being watched by the robot. - Participant mentions recording, data saving	- everything else	(16, resident, female) *"I don't know exactly if there is something saved (on the robot)… when you for example say things you wish you did not say… those things are maybe saved. But I can not estimate how this functions"* (13, resident, female) *"- Researcher: Which threats do you see in the future?* *- Participant: Oh, that you are being spied on!"*
	ME, GR, CL	Physical care	- The pure physical care in terms of fostering elderly people	- Participant mentions fostering e.g. washing people, assisting with intimate actions like using the toilet	- Taking medications - Companionship - playing games	(15, resident, female) *„- Participant: Well I cannot imagine it. Yes, I have read about it… also in… äh… lack of care (personnel) and that robots are being used… I mean big ones, which can serve people.* *- Researcher: Yes, there are robots like this.* *- Participant: This would be awful!... That is cold… I mean you could bring a machine to nurse a resident in bed but I think… you should not do this to people. That they are being washed by a machine. Seriously!"*
	GR	Substitution	- The robots takes in the place of the human and executes the action in place	- The robot takes something away - robot	- losing work because of substitution	(3, resident, male) *"He (the robot) takes away the natural contact in the family – he takes it away. We leave it to a robot. And this is a thing which is more or less inappropriate in a*

			of the human. - Substitution for intimacies between humans (e.g. family-contact, love, affection)	substitutes human emotions		*family. Because in a family, the correspondence between old and young and between the couple has to work. And this is something no robot can do."*
	GS	Companion	- spending enjoyable time with the robot - to not be alone	- spending time with the robot	- playing games - communication	(2, resident, male) *„Yes that's it… when I am desolate. Alone. Then I would like to talk to someone. But this someone is not there anymore. You know… just not there anymore. What can I talk to him then? What? That is not possible… he can't react on my questions. You have to ask a certain kind of question so that he can answer."*

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