



Aalborg Universitet

AALBORG UNIVERSITY
DENMARK

Humanoid Robots for Health and Welfare

on humanoid robots as a welfare technology used in interaction with persons with dementia

Strandbech, Jens Dinesen

DOI (link to publication from Publisher):
[10.5278/vbn.phd.hum.00092](https://doi.org/10.5278/vbn.phd.hum.00092)

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):

Strandbech, J. D. (2018). *Humanoid Robots for Health and Welfare: on humanoid robots as a welfare technology used in interaction with persons with dementia*. Aalborg Universitetsforlag.
<https://doi.org/10.5278/vbn.phd.hum.00092>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal -

Take down policy

If you believe that this document breaches copyright please contact us at vbn@aub.aau.dk providing details, and we will remove access to the work immediately and investigate your claim.



HUMANOID ROBOTS FOR HEALTH AND WELFARE

ON HUMANOID ROBOTS AS A WELFARE TECHNOLOGY USED
IN INTERACTION WITH PERSONS WITH DEMENTIA

**BY
JENS DINESEN STRANDBECH**

DISSERTATION SUBMITTED 2018



AALBORG UNIVERSITY
DENMARK

HUMANOID ROBOTS FOR HEALTH AND WELFARE

**ON HUMANOID ROBOTS AS A WELFARE TECHNOLOGY
USED IN INTERACTION WITH PERSONS WITH
DEMENTIA**

by

Jens Dinesen Strandbech



AALBORG UNIVERSITY
DENMARK

Dissertation submitted January 2018

Dissertation submitted: January 2018

PhD supervisor: Professor Ann Bygholm
Aalborg University

PhD committee: Professor w.s.r. Anne Marie Kanstrup
Aalborg University

Associate Professor Anne Gerdes
University of Southern Denmark

Professor Charles Melvin Ess
University of Oslo

PhD Series: Faculty of Humanities, Aalborg University

ISSN (online): 2246-123X
ISBN (online): 978-87-7112-993-9

Published by:
Aalborg University Press
Langagervej 2
DK – 9220 Aalborg Ø
Phone: +45 99407140
aauf@forlag.aau.dk
forlag.aau.dk

© Copyright: Jens Dinesen Strandbech

Printed in Denmark by Rosendahls, 2018



CV

Jens Dinesen Strandbech received his Master in Information Architecture and Persuasive Design from Aalborg University in 2012, specialising in the interplay between motivation and learning with a focus on the application of Persuasive Design in e-learning. He continued branches of this work at SOSU Nord Future Lab in a position as Project Manager and scientific counsel to Health and Welfare oriented projects. In conjunction, he entered a Ph.D. Fellowship with The Department of Communication and Psychology at Aalborg University, focusing on the present dissertation.

Jens Dinesen Strandbech is affiliated with the Aalborg University eLearning Lab (eLL) – Center for User Driven Innovation, Learning and Design as well as the Aalborg U Robotics (AUR) and Human Centred Health Informatics & Participation (CHIP) at the University of Aalborg, Denmark. His research interests peak in the fields of Human-Robot-Interaction, Health- and Welfare-technology and technological implementation. Since submitting his dissertation, Jens has been in a position as Project Manager at the Health Innovation Centre of Southern Denmark focussing on Robot interaction and automation as well as open innovation methods for researching, developing and implementing Health- and Welfare- technology.

In his Ph.D. thesis, Jens Dinesen Strandbech characterises the interaction between the Functionally Designed Humanoid Socially Assistive Robot Telenoid and persons with severe dementia.

ENGLISH SUMMARY

This dissertation takes an exploratory approach to investigating the interactions between the Functionally Designed Socially Assistive Robot *Telenoid* in interaction with elderly persons with severe dementia.

Initially, the dissertation presents, frames and relates relevant core concepts and distinctions at the intersection of robotics and dementia, to which this dissertation aims to add. Then the dissertation reviews the current state of research into Humanoid Socially Assistive Robots in the domain of Health and Welfare. Here it is found that the sub-domain of *Elderly with dementia* is by far the most researched domain in the domain of Health and Welfare. Primary findings include the need for a qualitative approach to investigating the application of robotics in the domain, the formulation of a coherent methodology, and the need to move beyond pilot studies.

After presenting the Pilot and Main studies of this dissertation, a chapter on the analytical approach reviews the methods applied in the elements of the previous review, which emphasises the need for a qualitative approach to understand the application of Humanoid Robots for Health and Welfare. Then a chapter details the path of arriving at the applied analytical approach, as well as insights into the Constructivist Grounded Theory Method.

Applying the Constructivist Grounded Theory Method provides a characterisation and explication of interactions between six Participants with severe dementia and *Telenoid*. The following qualitative analysis of interactions reveals both specific and general Participant interaction scripts, appropriations and points of improvement. In addition, the conclusions and discussions add to the body of knowledge on the application of these robots by revealing some of the roles, challenges and opportunities Humanoid Socially Assistive Robots can adopt to, create and fulfil in the Health and Welfare system of tomorrow.

This dissertation is funded in part by SOSU Nord and The European Regional Development Fund (ERDFN 13-136) and was made possible due to the collaboration between eLearning Lab at Aalborg University, SOSU Nord Future Lab and the Hiroshi Ishiguro Laboratories at the Advanced Telecommunications Research Institute International (ATR) of Nara, Japan.

DANSK RESUME

Formålet med denne afhandling er at foretage en eksplorativ undersøgelse af interaktionen mellem den Funktionelt Designede Sociale Robot *Telenoid* og personer med svær demens.

Indledningsvis præsenteres, indrammes og relateres centrale relevante koncepter og distinktioner i krydsfeltet mellem robotvidenskab og demens, hvor denne afhandling placerer sig. Dernæst vil et litteraturstudie fremlægge relevant forskning ift. menneskelignende Sociale Robotter brugt i domænet Sundhed og Velfærd. Her lægges fundamentet for afhandlingens primærstudie, og der redegøres for, hvordan under-domænet *Ældre med demens* er det absolut mest undersøgte indenfor Sundhed og Velfærd, og at der er brug for kvalitative undersøgelser, der går ud over pilotprojekt stadiet samt formuleringen af en sammenhængende metodik i undersøgelsen i dette krydsfelt. Litteraturstudiet understøtter formuleringen af det senere studie.

Efter at have præsenteret afhandlingens pilot- og primærstudier præsenteres et litteraturstudie over de metodiske tilgange, der er benyttet i anden relevant forskning samt afhandlingens analytiske tilgang. Her understreges nødvendigheden af en kvalitativ tilgang til undersøgelsen af Menneskelignende Robotter i Sundhed og Velfærd. Dernæst præsenteres den proces, der har ledt til brugen af en Constructivist Grounded Theory Method.

Ved at benytte en Constructivist Grounded Theory Method er det muligt at præsentere en karakteristik og eksplication af interaktionen mellem primærstudiets seks deltagere med svær demens og den menneskelignende robot *Telenoid*. Den følgende kvalitative analyse af interaktionerne undersøger og afdækker både specifikke og generelle resultater ift. interaktionsscript, tilegnelse og forbedringspunkter. Konklusionen tilføjer viden om de roller, udfordringer og muligheder som Menneskelignende Sociale Robotter kan indtræde i, skabe og løse i fremtidens sundheds og velfærdssystem.

Afhandlingen er delvist støttet af SOSU Nord og Den Europæiske Regionalfond (ERDFN 13-0136) og blev gjort muligt af samarbejde mellem Aalborg Universitets eLearning Lab, SOSU Nord Future Lab og Hiroshi Ishiguro Laboratories ved Advanced Telecommunications Research Institute International (ATR) i Nara, Japan.

ACKNOWLEDGEMENTS

Writing this dissertation has been an incredible journey of personal and professional development, which has plunged me into the cross-section of Health and Welfare and Robotics. Both domains were new to me, and while the journey has had its bumps I have been fortunate enough to collaborate with brilliant and passionate people from around the world, as well as to receive support from friends and family.

To my mentors and contributors...

My principal supervisor Professor Ann Bygholm has provided me with the right measures of encouragement and scepticism; forcing me downward into the data or back to the drawing board to improve, refine or expand on ideas or paragraphs. Through our time together she has forced me to rethink, reframe and rework things both big and small, and she has encouraged me to investigate paths I mistakenly thought irrelevant. Looking back, I am humbled by your patience and thank you deeply for your commitment, insight and support.

The project on which this dissertation is built was not of my original design. That foresight falls to Anja Hald, the former CEO of SOSU Nord. Her determination and commitment to expanding the best frames for educating the best possible health care worker of the future through establishing SOSU Nord Future Lab laid the foundation for this dissertation, and her continuing support throughout its creation has been of tremendous importance and value both scientifically and professionally.

Bent Fuglsbjerg, my supervisor at SOSU Nord Future Lab, has been a continuing source of passion, energy and support throughout our time together. His continuing support and input has helped to refine and strengthen the project through new insights and perspectives and for that I am forever grateful.

A special thanks to the study team of Anna-Mette Nedergaard Boch, Rikke Krogsgaard and Birgitte Rysgaard. The three of you are without a doubt some of the kindest and most compassionate people I've ever met. As a newcomer in the field of Health and Welfare you offered me your tremendous range of knowledge and I am confident that this end result is improved from having you as advisors.

Likewise, a special thank you to Gerda Hold Christensen for the courage to welcome as strange a thing as Telenoid, the team and myself to Ådalscenteret to conduct our study. Without the continued support and encouragement from both you and your staff this dissertation would not have come to be. Also, special thanks to the family members of all Participants of the studies for agreeing to join in and allow us to spend time with your loved ones.

To my colleagues at the Hiroshi Ishiguro Laboratories who harboured me during the writing of the dissertation, taught me to use Telenoid properly and have acted as inspiration and support throughout the project, I thank you. Thank you to Professor Hisroshi Ishiguro and Professor Shuichi Nishio for your support, encouragement, insight and discussions about issues big and small. Thank you to Tasashi Minato and Kaikou Kuwamura for helping me understand the engineering side of Telenoid in detail. Lastly, thank you to Phoebe Liu, Dylan Glass and everyone at ATR HIL for welcoming me to Osaka and showing me the town.

Finally, thank you to; Associate Professor Marco Nørskov and the Research Unit for Robophilosophy from Aarhus University, Claus Risager and John Erland Østergaard from Blue Ocean Robotics, Martin Jørgensen and the team from Xtel, Byung Kwang Yoo from University of California (UC) Davis, Antonia Krummheuer, Lotte N. S. Andreasen Struijk and Matthias Rehm from the University of Aalborg. You have all contributed to my understanding of the domain of robotics in Health and Welfare, strengthened my determination and improved my work.

And a sort of special mention to someone who I shall call *the unknown academic* who I met at the 2014 RO-MAN conference in Edinburgh. Somewhere between sessions on the first day we started chatting and found common ground in robotics for Health and Welfare. You studied stroke-rehabilitation and were fascinated with my thought on using Telenoid as presented in this dissertation. I never got your name, but your insights and enthusiasm for the prospects of my work has stayed with me to this day.

To my colleagues...

Thank you to all of my colleagues at SOSU Nord for inviting me to speak and share my insights at meetings, during teaching and at lunch. Thank you for your contributions to the design of my studies, discussions and interpretations. A special thank you to Anders Nielsen, Dorthe Thybo Kudsk, Gitte Jensen, Heidi Hansen, Jytte Solhøj, Lene Moselund, Mette Gram and Trine Strandridder for coffee, laughs and insights.

Thank you to the AAU Department of Communications and Psychology and particularly my colleagues at eLearning Lab for encouragement, improvement and support. Especially so to Lykke Brogaard Bertel, Sandra and Lasse Burri Gram-Hansen and Evgenios Vlachos for the years of insights, coffee and encouragements you have given me. Also a thank you to Jacob Davidsen, Jacob Madsen, Maria Dolores Castro Rojas, Pernille Viktoria Kathja Andersen, Susanne Hjorth Hansen, Tanja Svarre Jonassen for your support and insights from other fields of study.

To my family...

I am eternally grateful for the unwavering support and encouragement I have received from my family and friends in every possible aspect of this journey, from the very first time I uttered the words *I am thinking of pursuing a Ph.D.* to the morning of writing these final words before submitting.

To Jens and Kirsten. You have always supported me and encouraged me to strive for more and claimed that I could do almost whatever I put my mind to. Thank you for giving me the courage to go off the deep end and for lending an ear, offering thought and reviewing early ideas.

To my grandparents Connie and Ole. I vividly remember our weekly sessions on the intricacies of the German language when I was in elementary school. For better and worse. Through it all I remember how you stood by me and tempered the notion that I can do whatever I put my mind to.

To Jørgen, Ruxi and Olivia. In Bertilstorp or Vejers you have always offered a place to discuss, reflect or escape the dissertation. This is a central part of the writing process and your reflections have been a valuable part. Thank you.

To Yvonne and Jeppe. Living with you has given my life perspective and substance. Thank you for your kindness, encouragement and patience. More than anyone you have provided a harbour for me to set out from, leaving Christina and Maya on shore. Without you, the process of writing this dissertation would have been very different, and much harder.

To Mie and Martin, Anne-Mette and Mikkel. With friends like you, whose doors are always open, and who always carry champagne on ice, I cannot ask for more. Thank you for distractions, support and encouragements. I hope to repay.

Lastly, the most important acknowledgement of them all; to my wife Christina and our Maya. Being side by side with you through this has been a tremendous strength. You buy the Christmas presents I forget; you bring me lunch when I get lost in thought. You pull me back to reality and remind me what is truly important in life. It is easy for me to become lost in the depths of analysis, and despite having often growled at you for interrupting me; I am ever so thankful that you have endured. You have sacrificed greatly for my benefit, provided me with freedom to go off on study trips and writing-sessions and done so, mostly, with a smile. Had it not been for you and Maya, I would not have completed this journey. You provide me with a cause to better myself and you provide the perspective.

Much of what I am, I owe to you.

TABLE OF CONTENTS

CHAPTER 1. INTRODUCTION	13
1.1. CONTEXT AND SCOPE	14
1.2. FORMAT OF THE DISSERTATION	17
1.3. SUMMARY FINDINGS	19
CHAPTER 2. OUTLINES AND FOCAL POINTS	21
2.1. ABOUT ROBOTS	22
2.2. ABOUT DEMENTIA	33
2.3. REVIEWING HUMANOID AND ZOOMORPHIC ROBOTS IN HEALTH AND WELFARE	36
2.4. RELEVANT DEMENTIA INITIATIVES TODAY	56
2.5. BROADER QUESTIONS IN RESEARCH INTO SOCIALLY ASSISTIVE ROBOTS	59
CHAPTER 3. STUDY OVERVIEW	65
3.1. SETUP, CONSIDERATIONS AND SCRIPT	66
3.2. PILOT STUDY	83
3.3. MAIN STUDY	86
CHAPTER 4. ANALYTICAL APPROACH	103
4.1. METHODS USED IN HUMAN-ROBOT-INTERACTION-RESEARCH IN THE DOMAIN OF ELDERLY PERSONS WITH DEMENTIA	104
4.2. METHODOLOGICAL EXPLORATIONS AND REFLECTIONS	108
4.3. GROUNDED THEORY	110
CHAPTER 5. EXPLICATING THE USE OF TELENOID IN DEMENTIA-CARE	119
5.1. ANALYTICAL PROCESS AND STRUCTURE	120
5.2. EXPLICATION OF PARTICIPANT INTERACTION	128
5.3. EXPLICATION OF TELENOID INTERACTION	207
CHAPTER 6. CONCLUSIONS AND FUTURE DIRECTIONS	215
6.1. CONCLUDING ON EXPLICATIONS OF INTERACTION	216
6.2. EVALUATING THE GROUNDED THEORY	219
6.3. FINAL REMARKS AND FUTURE DIRECTIONS	220
REFERENCES	224
APPENDICES	238

CHAPTER 1. INTRODUCTION

The purpose of this chapter is to provide a short introduction and outline of this dissertation. This is done in three separate sections.

First, I present the context and scope of the dissertation, outlining its motivation, context and scope.

Next, I present the format of the dissertation by presenting the overall goal of each chapter.

Lastly, I present a light summary of the findings of the dissertation.

1.1. CONTEXT AND SCOPE

During my master's degree studies in Information Technology in 2010-12 I was able to pursue studies of how novel technologies change human interaction. The programme focused on understanding Human Computer Interaction (HCI), and placed focus on how technologies can change attitudes and behaviours through acting as Persuasive agents (Fogg, 2002). Among the technologies I became familiar with was the Geminoid-DK humanoid robot from the (ATR Hiroshi Ishiguro Laboratory, 2017), and while I was not directly involved in robotics research, it laid the foundation for a budding interest in robotics.

In the final year of my studies, SOSU Nord (sosunord.dk, 2017) approached me regarding a position focused on researching the implications of using humanoid robots as a Health and Welfare-technology. As a vocational healthcare college, SOSU Nord has been engaged in educating the healthcare support staff of the future for more than 25 years. With the influx of technology SOSU Nord Future Lab was founded as a praxis-oriented test centre for Health and Welfare Technology focusing on teaching students new technologies, theories and methods required in their future profession.

This dissertation is partly funded by SOSU Nord as well as The European Regional Development Fund (europa.eu, 2017) with grant ERDFN 13-0136. With it, robotics became an addition to the centre, which already focused on new lift systems, automatic toilets, pill dispensers as well as various information display systems. My knowledge of the workings of the healthcare sector was limited, and arguing the study and possible implementation of a technology that I had mostly read about to a company full of extensively trained healthcare professionals was somewhat unnerving.

While many of my new colleagues found Telenoid to be an interesting addition to the portfolio of Future Lab, some were more than apprehensive at the prospect of *contributing to the deterioration of the welfare system*, as one co-worker told me in my first week. I am glad that this position was far from prevalent, and that over the course of the project, most of my colleagues came to see Telenoid as I do: as a tool for better understanding persons with dementia, and for developing future Health and Welfare Technologies. The initial reaction is however somewhat understandable as the term Health and Welfare-technology is liberally applied, and is said to often not meet the desired or promised results.

Nevertheless, the term Health and Welfare-technology plays a central part in the political discussions about the future of health-services, both in our homes, hospitals and at care facilities. While the term is not defined as such, its use covers all manner of technology applied either within the domain of, or with the purpose of enhancing, Health and Welfare. The term is often associated with great

expectations to a rise in the quality of care as well as a lowered cost and naturally the discourse reflects this duality. Health and Welfare-technology is often framed as a tool for providing better care, as well as a collection of tools for quality improvements as well as tools for lowering budgets. There is a vast range of examples of technologies described as Health and Welfare-technologies. This is done with various degrees of success and new sub-domains, problems and solutions are explored continuously with the aid of funding agencies such as The European Regional Development Fund (ERDF) or similar national, regional or local initiatives. Examples cover the full range of technological development from low-tech pill dispensers to high-tech remote-operation equipment and covers applications such as toilets, lift systems and bed-equipment, vacuum cleaners, tele-care solutions as well as embedded sensors in clothing, plates and floors which monitor respiration, nutritional intake and night-time behaviour. There are plenty of examples, but for many developments tailored to newer sub-domains or problems, the level of technological maturity is understandably often at the Pilot study stage. Thus it remains to be seen what roles, challenges and opportunities these technological developments can adopt to, create and fulfil in the Health and Welfare system of tomorrow.

One such Health and Welfare-technology is the tele-operated android robot *Telenoid*, which has been evaluated as a tool for testing if new forms of media and presence can contribute to the alleviation of symptoms of dementia, improvement in Quality of Life and overall social skills. This dissertation does not attempt to clarify or answer all these questions, but contributes by addressing the open questions above by providing a series of qualitative explications of the interactions between the tele-operated Functionally Designed Humanoid Socially Assistive Robot *Telenoid* and several elderly persons with severe dementia. This adds to the body of knowledge on the application of Humanoid Socially Assistive Robots in general and specifically as a tool within the domain of Health and Welfare.

Specifically this dissertation's research question is as follows:

Research question
How can interaction between Telenoid and elderly persons with dementia be characterised and to what degree can interaction with Telenoid alleviate symptoms of dementia in these persons?

Table 1: Research question

To understand the reasoning and framing of this research question I offer the below sections which are greatly expanded in the coming chapters.

1.1.1. FRAMING THE RESEARCH QUESTION

The choice to research the application of Telenoid in interaction with elderly persons with dementia stems from previous research (Ryuji Yamazaki, Nishio, Ishiguro, et al., 2012; Ryuji Yamazaki, Nishio, Ogawa, et al., 2012; Ryuji Yamazaki et al., 2013) focusing on the use of Telenoid in dementia-settings and as a means of enabling tele-presence between long term ill children and their schools. The results surrounding the dementia-case were interesting and offered anecdotal indications of improvement in the Participants as well as a change in overall demeanour.

Overall, persons with dementia suffer from a wide range of symptoms, which cluster into five overall types of dementia with Alzheimer's being the prevalent. Combined, these symptoms effect memory, reasoning and communication skills, in addition to a gradual loss of the skills needed to carry out simple daily activities (Alzheimer's Society, 2007, p. 2) with individual symptoms in various forms, levels of severity and combinations. Not surprisingly, most persons with dementia react with frustration and aggression to the loss of skill, ability and memory, which in popular terms is dubbed *regressing slowly into infancy*. Perhaps especially so in regard to the loss of verbal and social skills, which causes isolation from peers due to a feeling of being overwhelmed in social settings. As a result, no two persons with dementia are alike, and while specialised treatment is advancing, the prognosis can seem disheartening; *permanent degenerative*, meaning a steady and incurable decline of affected skills leading to eventual death.

Treatment is successful at decreasing the speed of degeneration and research indicates that in addition to medication one of the best ways to keep the mind from degenerating is to activate it. As such, non-pharmacological initiatives of conversation, music and interaction-activities or goal-oriented tasks related to memory or logic have been tested for many years with positive results. The present research focuses on conversation, and ways to engage persons with dementia in activities that help them use these abilities. However, with persons being easily overwhelmed in social interaction, it is natural to investigate other avenues of nurturing social skills or lowering the level of social signals in the setting. Building on initiatives with animals, the use of e.g. the robotic seal PARO has been applied with interesting results in the field of dementia and have in some cases helped silent elderly become verbally engaged in conversations with the seal, which is however not able to speak. A natural next step down this avenue of reasoning is to evaluate if the same indications are present *if the seal could talk*, or more precisely, *if the seal was not a seal, but a humanoid robot*, which does not elicit the same level of social signals as humans do and would thus seem more approachable than humans. One candidate for this research is the Telenoid, which mediates human interaction and presents as a simplistically designed Socially Assistive Robot.

1.2. FORMAT OF THE DISSERTATION

The purpose of this short section is to present the structure and format of the dissertation.

1.2.1. A NOTE ON STRUCTURE

Due to the exploratory nature of this dissertation, the only fix point, which has remained throughout the entire process, is that of the overall nature of the research-question presented above. As a result, the theories, methods and setups were not clear from the outset. Due to this exploratory nature, this dissertation does not conform to typical standards of presentation since e.g. the methods of analysis were decided upon after the data was obtained. The below structure is chosen as a result of my working as a newcomer to the field of dementia and robotics-research, and thus I structured the dissertation in a way, which hopefully introduces novices to the field to the required knowledge at the right time, as well as remaining true to the process of analysis.

It should be noted that this dissertation draws on my own paper (Strandbech, 2015) in matters of framing and definitions as the paper presents an early concept for analysis of the data as well as outlines the reasoning for the studies. I have been asked by the University to include both this paragraph as well as a general reference to the relevant paragraphs and citations when appropriate so as to not appear to be plagiarising myself. Total use covers approximately five pages used on pages 22, 23, 26-28, 33-35, 57-59, 79, 87, and 127.

1.2.2. CHAPTER OVERVIEW

The first chapter, ‘Introduction’ provides an introduction, outline of this dissertation and its findings.

The second chapter, ‘Outlines and Focal points’ from page 21 provides an overall basis for understanding the different issues involved in this dissertation. As such, the chapter provides an initial frame for understanding the field of robotics and the Socially Assistive Robots (SAR) that this dissertation revolves around. From there I present key points in regard to dementia before reviewing the use of Humanoid and Zoomorphic robots in Health and Welfare. Beyond this review I present relevant initiatives used today aimed at dementia as well as a synthesis of the critique on the current state of research in Socially Assistive Robots within Health and Welfare.

The third chapter, ‘Study Overview’, provides insight into the technical setup of the studies that formed the basis for the collected data used in the dissertation. Initially, I will further outline the reasoning for conducting studies focused on Functionally Designed Socially Assistive Humanoid Robots in interaction with persons with dementia. Then I will present all relevant aspects of both the Pilot study and the Main study.

The fourth chapter, ‘Analytical Approach’, details the analytical approach used in this thesis. This is done by first elaborating on the established methods for analysing the interaction between elderly persons with dementia and Humanoid and Zoomorphic Robots before presenting the Constructivist Grounded Theory Method chosen.

The fifth chapter, ‘Explicating the use of Telenoid in dementia-care’, explicates the process of using Telenoid in the Main study. This is done by first presenting the precise Grounded Theory Method detailing the process of arriving at the format. The main part of the chapter consists of six Explications of Participant Interaction, which provide the analysis and conclusion on interaction found for each Participant as well as a section, which covers all six Participants as one dataset.

The sixth chapter, ‘Conclusions and Future Directions’, details the conclusions found in this dissertation as well as my recommendations for the future directions of the research and application of Humanoid and Zoomorphic Robots in the domain of Health and Welfare.

After this, Appendix A contains an Overview of elements in the literature review. The data pertaining to the dissertation is deemed confidential and using encryption was made available only to the Ph.D. committee, supervisor and relevant staff.

1.3. SUMMARY FINDINGS

The findings of this dissertation are presented in Chapter 6 and offered here in summary.

With respect to the characterisation of interaction between Telenoid and elderly persons with dementia it is found that Telenoid has the possibility to function as a Health and Welfare-technology, which is appropriated by the Participants and functions in diverse roles which they, staff and family members, can help to define. Telenoid can hopefully serve as a tool for training or possibly maintaining or maybe improving social and verbal abilities or competencies through singing and conversation. Telenoid is often described and handled by Participants as *childlike*, but conversations with Telenoid are increasingly personal and at times touch on deeply private memories not fitting a childlike view of Telenoid. Moreover, the design of Telenoid appears to support the notion that Functionally Designed Humanoid Socially Assistive Robots can perform in the role of conversational partner for persons with severe dementia, but within the limited population of the study, it appears that persons who retain the ability and initiative to engage socially with peers do not view Telenoid as a relevant conversational partner. In addition, the technical difficulties and verbal distortions in the use of Telenoid amount to significant disruptions to the interaction and cause deterioration in the relationships and limit otherwise positive interactions.

With respect to the evaluation of to what degree this interaction can alleviate symptoms of dementia in these persons it is overall found that while a multitude of quantitative methods were applied there was no coherent pattern of decrease or increase of symptoms of dementia. While some tools such as the MMSE show an increase in e.g. the sub-section of Language or similar sub-categories, this dissertation finds more value in the analysis of the qualitative data and forming the Explication of Participant interaction based on this.

With respect to future directions of research and application of Humanoid and Zoomorphic Robots in the domain of Health and Welfare I argue for the further need for qualitative long-term studies on the interaction, as well as studies specifically on Functionally Designed Humanoid Socially Assistive Robots. While it is argued that the degree of positive effects found in this dissertation at present can be achieved by other means, it is my distinct conviction that this should not discourage further research into the application of Humanoid and Zoomorphic Socially Assistive Robots in the domain of Health and Welfare. The technical difficulties and limitations to Telenoid and his kin will be alleviated soon, and this dissertation finds that, even despite these, he, in some cases, is better than his human counterparts. Telenoid is thus a specialised tool capable of engaging persons with severe dementia in activities they did not engage in before.

CHAPTER 2. OUTLINES AND FOCAL POINTS

The purpose of this chapter is to provide a basis for understanding the different issues involved in this dissertation. As such, this chapter will provide the reader with information on robotics as a general concept as well as Socially Assistive Robots, dementia and relevant dementia initiatives in particular.

First, I will provide a frame for understanding the field of robotics as well as some of the different categories of robotics with particular emphasis on Socially Assistive Robots (SAR) that this dissertation revolves around.

From there I will present an overview of key points with regard to dementia, so as to provide a frame of reference for understanding the implications of working with persons within this particular range of special needs.

Next I will present a synthesis of findings formulated from reviewing studies where Humanoid and Zoomorphic robots have been used in the fields of health and welfare.

Finally, I will present relevant initiatives beyond robotics that are aimed at archiving alleviation of the symptoms commonly associated with Dementia.

From the review and supporting literature, I will finally present a synthesised critique of the current state of research into Socially Assistive Robots within Health and Welfare.

2.1. ABOUT ROBOTS

As mentioned, the purpose of this subsection is to provide a basis for understanding the basis of robotics and the class of Socially Assistive Robots that this dissertation focuses on. As such, I will start by introducing the history of Socially Assistive Robots and from there I move on to different sub-classes of Socially Assistive Robots. This section is not exhaustive, as a complete overview of the field of robotics is not possible. Instead it serves as an adequate frame of reference in which to place Telenoid and the work of this dissertation.

2.1.1. A BREIF HISTORY OF THE TERM

“Historically the term robot is coined in the play R.U.R. or Rossum's Universal Robots by Karel Capek (1890-1938) in 1923 (Capek, K & Playfair, N, 1961), where humanoid robots are created as a workforce, which then rises to take control. While this depiction has fascinated pop culture for almost a century as seen countless times in literature (Asimov, 1995) as well as in movies, plays, games and other forms of media, the term is much older. “The perhaps earliest example of a humanoid design is in the Jewish Talmud where a ‘Golem’ is used to describe both Adam in the first 12 hours of his existence when he did not have a soul, and the mythical creation bearing the literal name, formed from clay” (Oreck, 2015)” (Strandbech, 2015, p. 3).

It would seem that although humanoid robots are just one of several categories of robots, they are the first to emerge historically. As we have luckily moved far from these first gloomy depictions of humanoid creations, so has the concept of a humanoid companion begun to take a foothold in the general public, advanced by such developments as the commercially available *Pepper* (Aldebaran Robotics, 2015), *Buddy* (Bluefrogrobotics.com, 2016) and *Jibo* (Jibo.com, 2016) as well as the research-oriented but far more humanoid Geminoids by Hiroshi Ishiguro’s team (Ishiguro & Nishio, 2007) (Strandbech, 2015, p. 3).

2.1.2. CORE DEFINITIONS

According to the (ISO, 2012), Robots are technically classified broadly as either Industrial- or Service- robots, based on their *“intended application”* with several sub-classifications that all hinge on the *“robot”* having autonomy, several degrees of freedom and a manipulator. Here, a service robot *“performs useful tasks for humans or equipment excluding industrial automation applications”*. In research-contexts, there is no one universally recognised definition of what a *robot* or indeed what a *social robot* is, which is noted in almost every review on the subject.

While *Social Robots* are said to have been first created in the 1940s, having an insect-like shape and behaviour (Fong, Nourbakhsh, & Dautenhahn, 2003), the term *Socially Assistive Robot* has become more common, although not universally accepted when describing the very same field of robotics.

As an illustration I have chosen the description found in the review (Mordoch, Osterreicher, Guse, Roger, & Thompson, 2013, p. 15) on *Social Commitment Robots*, a term that either closely or fully overlaps *Socially Assistive Robots*, depending which definitions are applied.

“There are a confusing array of terms used to describe robots that may fall under a general category of human interactive robots for psychological enrichment and are then further sub-classified as interactive autonomous robots which provide personal interactions, pleasure and relaxation. Other literature identifies the classification of social assistive robots. The social assistive robot bridges the assistive robot functions, which provide physical assistance with the social interactive robot functions of providing social and non-physical interaction. In our reading of the literature, a multitude of terms, i.e. social commitment robot, social robot, therapeutic robot, caring robot, mental health robot, entertainment robot, interactive autonomous robot, interactive engaging robot and mental commitment robot appear to refer to similar types of robots. In addition, several terms may be used within the same article, terms are not consistently used within the literature and often lack clear operational definitions”.

Following the confusing array of terms and categorical issues with defining the term Robot and Socially Assistive Robot, there is also no clear consensus on when the first Humanoid robot was created. This might be due to the fact that the trait of looking like a human is categorically of family resemblance (Lakoff, 1990, p. 12), and thus a humanoid can have both some human-like-traits and some distinctly not human-like, but still be human-like overall (Strandbech, 2015). *“As such, it falls to the individual to decide if and when a robot looks enough like a human to be a humanoid, and when it does not. This again is influenced by the context in which the robot is placed, making the problem of defining Robot, Social Robot and Humanoid an even bigger problem”* (Strandbech, 2015, p. 3).

In attempting to define what sub-class of robot Telenoid is, I begin with the definition of Socially Interactive Robots (SIR) as defined by (Fong et al., 2003, p. 145) where SIR is defined as those *“... robots for which social interaction plays a key role”*. This term is introduced with the expressed intension of *“...distinguish[ing] these robots from other robots that involve “conventional” human–robot interaction, such as those used in teleoperation scenarios”* (Fong et al., 2003, p. 145). This definition is used again by (Feil-Seifer & Mataric, 2005, p. 465) who state that *“...Socially assistive robotics (SAR) [are found at] the*

intersection of Assistive Robotics (AR) and Socially Interactive Robots (SIR)“. Here, Assistive Robots are defined as a robot “...that gives aid or support to a human user. Research into assistive robotics includes rehabilitation robots, wheelchair robots and other mobility aides, companion robots, manipulator arms for the physically disabled, and educational robots” (Feil-Seifer & Mataric, 2005, p. 465). Thus the reach of Socially Assistive Robots is an extension of Assistive Robots, which focuses on physical assistance, with the Social aspects found in the notions of Social Interaction Robots. (Feil-Seifer & Mataric, 2005, p. 465) offers the below definition of the term:

“SAR shares with assistive robotics the goal to provide assistance to human users, but it specifies that the assistance is through social interaction. Because of the emphasis on social interaction, SAR has a similar focus as SIR. In SIR, the robot’s goal is to develop close and effective interactions with the human for the sake of interaction itself. In contrast, in SAR, the robot’s goal is to create close and effective interaction with a human user for the purpose of giving assistance and achieving measurable progress in convalescence, rehabilitation, learning, etc”.

On face value this definition is appealing to apply to Telenoid, as it is comprised of three elements that Telenoid in its present use does: Social, Assistive and Robot. Applying this definition to Telenoid is however in contrast with the definition of SIR, which carries the constraint that it is used specifically to contrast “teleoperation” robots (Fong et al., 2003, p. 145). As Telenoid is teleoperated, the definition of SIR and SAR does technically not apply.

I apply this definition to Telenoid in recognition of this fact, as I also apply the below on Social Robot by (Breazeal, 2003). This widely used definition of a Social Robot by Cynthia Breazeal in (Breazeal, 2003, p. 168) is but one of many, but it emphasises the human observer’s perspective, which is very much synchronous with the above categorical notions on family resemblance in humanoids as well as my own views. Breazeal’s book with the below definition is not only fitting in this context, as it is often cited and used, it is also one that I adhere to in general:

“Autonomous robots perceive their world, make decisions on their own, and perform coordinated actions to carry out their tasks. As with living things, their behavior is a product of its internal state as well as physical laws. Augmenting such self-directed, creature-like behavior with the ability to communicate with, cooperate with, and learn from people makes it almost impossible for one to not anthropomorphize them (i.e., attribute human or animal-like qualities). We refer to this class of autonomous robots as social robots, i.e., those that people apply a social model to in order to interact with and to understand. This definition is based on the human observer’s perspective”.

Because this definition is subject-dependent and not object-dependent, any design that is perceived as an autonomous social robot is an autonomous social robot, without having to actually be autonomous or fit a specific definition. This entails that any robot, if perceived by someone as having a social model, is a social robot. While this might seem as a convenient escape from having to define actual traits common to or defining of the term Robot, Social Robot or Socially Assistive Robots, it acknowledges the importance of the perception by the user. This in turn relates well when noting that Socially Assistive Robots are often, if not predominantly used in relation to persons with special needs such as dementia, and that some of these persons have a distorted view of reality, being prone to delusions and hallucinations.

In line with the ISO-definition used above, Breazeal's definition calls for sensors, computational power and actuators and thereby eliminates all robots that are tele-operated in that they are inherently not autonomous and thus not even robots. I would argue that this point in the definition is in contrast to the subject-dependant focus and not in line with the notion of social model described later in the definition.

While the mechanical elements included in the definition are central and understandable to focus and clarify the scope of the definition, I argue that it makes little sense to allow the human observer to be the judge of whether or not a robot is a social robot, based on whether or not he or she applies a social model, and then exclude the robot in question if no sensors, computation or actuators are present. As exemplified later in this dissertation, Ethel who is an elderly woman with severe dementia, views Telenoid as a social presence, and clearly develops a relationship with *him* over time. As such she applies a social model to the interaction, making Telenoid fit the strict definition of Social Robot, were it not for the lack of computation. The woman is however blissfully unaware of this point, and it in no way influences the relationship with Telenoid, ultimately making the need for autonomy a mute point. This is however only true for as long as the user feels the need to *apply a* social model to [it] in order to interact with and to understand [it], to paraphrase Breazeal.

Thus I suggest, that the notions of subject-dependency and description of the nature of behaviour of Social Robots in Breazeal's definition are the defining factors, and that the autonomy-clause, as it were, should be kept but made secondary and non-binding. This can be exemplified by the present case of Telenoid and other tele-operated robots, as they are perceived as autonomous and interacted with in much the same way people interact with actual autonomous Socially Assistive Robots.

In my view, Telenoid and other Socially Assistive Robots are on the very fringe of the suitable definitions. Indeed, applying a strict view of the definitions could banish tele-operated robots to the same class as remote controlled cars as they may

have a form of locomotion, but ultimately rely on input from an Operator to function. This I do not believe is descriptive of the nature of Telenoid and other Socially Assistive Robots as they, despite the ill-defined term of Robot, are more robot than remote-controlled.

Thus I will not apply this stringent view but instead use the definition of Socially Assistive Robot as presented by (Feil-Seifer & Mataric, 2005, p. 465) and define the purpose of Telenoid as a Socially Assistive Robot to be “...to create close and effective interaction with a human user for the purpose of giving assistance and achieving measurable progress in convalescence, rehabilitation, learning, etc”.. In addition I apply my modified notions of (Breazeal, 2003, p. 163) in claiming that identifying, which robot belongs to this class of robots, which we “...apply a social model to in order to interact with and to understand” is ultimately in the eye of the beholder in that humans tend to apply social models of behaviour to both artefacts and agents, and that any one person’s reaction is personal and while a third party may argue that a particular artefact is not worthy of the social model I apply, it may still provide me with value.

The definition of Socially Assistive Robots thus focuses on the needs and progress in the life of the user and aims to define the class of robots that assist in this task, which aligns somewhat with the purpose of this dissertation in that we presently do not seek to rehabilitate, but to some extent are focused on the Participants re-learning social skills. In addition to this, as reported above, the definitions are often without clear definitions and applied inconsistently, overlapping or interchangeably with other definition.. In my reading the use of the term Socially Interaction Robots is less frequently used than that of Socially Assistive Robot, which serves as a more recognised term for the types of robotic platform Telenoid is in the journals and texts, which represent the core of my review and understanding of the field. As such, I have chosen a term that to a large extent is still used interchangeably with other similar definitions, but which in its denotation fits the overall parameters as well a follows in line with at least some of the scholars working in related fields with related approaches.

2.1.3. CLASSIFYING SOCIALLY ASSISTIVE ROBOTS

When using the definition above, with the limitations that I provided, there is however still a need for further sub-classification of the different types of Socially Assistive Robots. Here, a central source by any means is the often used (Fong et al., 2003). “*When classifying Social Robots, we should, according to (Fong et al., 2003), classify them into four major groups: Anthropomorphic, for those looking like humans; Zoomorphic, for those looking like creatures; Caricatured, for those who do not have to appear realistic in the first place, and finally the Functional, describing those robots whose design first and foremost reflect the task for which they are designed*” (Strandbech, 2015, p. 4).

This classification deals only with Social Robots and the categories defined by Fong et al. are, in contrast to the ISO definition, based not on the intended application but on the physical appearance of the robot, indicating that the determining factors are how users relate to the robot. The categories are:

“Anthropomorphic robots are defined as those robots that are designed to look like or at least, to some extent, are perceived as having human-like features. The function of these human-like features are according to (Fong et al., 2003, p. 150):”

“...to present an appropriate balance of illusion (to lead the user to believe that the robot is sophisticated in areas where the user will not encounter its failings) and functionality (to provide capabilities necessary for supporting human-like interaction). (Strandbech, 2015, p. 4)”

It is worth noting that this balance between illusion and functionality is based on the robot's *perceived* capabilities and not its *actual* capabilities. This relates to the idea of providing the robot with enough human-like features so as to convince the user that the robot is competent in performing its range tasks, while still avoiding that users perceive this range to be larger than it actually is, and thus not have their expectations met.

“Zoomorphic robots are defined as those robots designed with the intent to replicate an animal or creature to some degree of perfection. These robots are not central to the development of humanoid robots, but they are important when distinguishing between types of Socially Assistive Robots. Fong notes that, avoiding the creation of robots that do not fulfil our expectations, what is also known as the Uncanny Valley (Mori, 1970), may be easier with zoomorphic robots” (Strandbech, 2015, p. 4). This is due to our expectations as to what constitutes normal behaviour is not so finely tuned with animal behaviour as it is with human behaviour, due to few first hand experiences. A prime example here is Paro as presumably only few people have had first-hand close-proximity interaction with harp seals.

Caricatured robots are defined as robots “designed in accordance with the above categories, but in an unrealistic fashion, so as to place emphasis on implied abilities or to moderate attention to specific features. Herein is a central point not to confuse a non-realistic/simplistically designed robot with a caricatured. As a prime example, NAO, while being humanoid, is more caricatured than realistic (Aldebaran Robotics, 2015)” (Strandbech, 2015, p. 5).

“Functional robots are those robots whose design is first and foremost governed by a purpose of task. One example of a functional robot is Baxter (Fitzgerald, 2013), designed to serve as an industrial robot to aid in or fully overtake simple operations. While it is not important for Baxter to look or behave humanlike ‘he’ has been outfitted with a LCD-screen showing a face, so workers can better relate

to the robot” (Strandbech, 2015, p. 5). Adhering to the above definitions, Baxter is not a Socially Assistive Robot, but presumably benefits from a social design-component.

In addition to these four categories, there are two categories of inspiration that should be noted: *The Functionally Designed* and *The Biologically Designed*. “While both types of inspiration can lead to the design of Socially Assistive Robots, the biologically inspired robots are born from the notion that humans are better at understanding a robot that looks and behaves like something they know, which builds on the same notions as Mori’s paradigm of the Uncanny Valley. The functionally designed robots are, like the category of Functional robots, designed for a specific purpose or rather, as presented in (Fong et al., 2003, p. 148):”. (Strandbech, 2015, p. 5).

“The objective is to design a robot that outwardly appears to be socially intelligent, even if the internal design does not have a basis in science or nature. “[...] These “engineered” robots may need only to generate certain effects and experiences with the user, rather than having to withstand deep scrutiny for “life-like” capabilities. [...] The robot may only need to be superficially socially competent. This is particularly true when only short-term interaction or limited quality of interaction is required. The robot may have limited embodiment, capability for interaction, or may be constrained by the environment. Even limited social expression can help improve the affordances and usability of a robot. In some applications, recorded or scripted speech may be sufficient for human–robot dialogue” (Fong et al., 2003, p. 148)”. (Strandbech, 2015, p. 5).

At its core, what Fong et al. describes as the functionally inspired robots, are robots that aim to serve a specific range of uses or tasks while being within the bounds of Socially Assistive Robots. Now, these robots can be Anthropomorphic, Zoomorphic, Caricatured or even Functional, but as presented, the design is purposely not very life-like. This does not entail that robots that are Functionally Designed are mostly Caricatured or Functional Robots; only that the purpose is to create a simplistically designed Socially Assistive Robot, and accepting that this design with its non-realistic features may be fitting for a range of tasks.

2.1.4. A NOTE ON CULTURAL PERCEPTION OF ARTIFICIALITY

While it is difficult to establish how and to what extent cultural identity has influenced the use and development of robotics over the years, it is a source of great interest and speculation. In this short section I present resumes of two fictional stories – one from the Shinto-religion of Asia and one from the Danish author H.C Andersen – as examples of how technology and especially replications

are viewed and perceived in different cultures. I include them, not as sources of definitive explanations for development and uses, but as inspiration and background information on robotics. I've also included the popular *Uncanny Valley*, which is sometimes used to explain why humans perceive some replications as eerie.

2.1.4.1 Stories of artificiality

As described in both (Kaplan, 2004, p. 469), the pan-Asian Shinto-religion holds a central myth on the use of deception for the greater good:

“One of the best well-known episodes among Shinto myths is the tale of the vanishing of Amaterasu O-mi Kami, the sun goddess. The goddess, offended by her brother’s provocations, decided to withdraw to a cave. As a result, the world was turned into darkness. To convince her to come back, the other deities decided to set up a spectacle with music, theatre and dance. The party was not a real one, but all the guests pretended to have fun, laughed and made a great amount of noise. Driven by curiosity, Amaterasu O-mi Kami decided to take a look at what was going on and came out of her cave. As soon as she was out, the other gods blocked the entrance: the sun was back for good. The world was saved by a simple masquerade, a fake party and forced laughter, set up to fool a goddess. In the Shinto tradition, artificiality is licit: it saved the world”.

In the Shinto-myth, the use of deception is, while not lasting, extensive and a sound course of action. The contrast to Western culture is shown by (Shaw-Garlock, 2009, pp. 256–257) by citing Frankenstein; the well know tale of the artificial monster created by science, which is hunted and feared. As a Dane, I prefer contrasting this pan-Asian Shinto-myth to the 1844 fairy-tale *The Nightingale* by H.C. Andersen (Andersen, 2016) which I paraphrase below.

In the *Nightingale*, travellers would come from all countries of the world to see the palace of the Emperor of China that was made entirely out of expensive porcelain that was so delicate that it could only be touched with the greatest of care. The palace had the most beautiful garden imaginable and at the far end was a mighty forest where a Nightingale would sing. Everyone who heard it agreed, that of all the wonders in the land, the Nightingale’s singing was *“the best of all”*. When the Emperor heard of this he ordered the Nightingale to be brought before the court and upon hearing its singing the Emperor began to cry in joy over the beauty of the Nightingale. He then ordered the Nightingale to stay at court and permitted it short walks with armed guards, in fear that anything should happen to it. One day an artificial nightingale arrived, with the message *“The Emperor of Japan’s*

nightingale is a poor thing compared with that of the Emperor of China". Made from gold and silver and encrusted with diamonds, rubies and sapphires the contraption could be wound up and be made to sing all of the Nightingale's songs. Being prettier and more reliable, the contraption was favoured, and the Nightingale ultimately banished from the land in disgrace. After some time, a public concert was given and despite much work to the contrary by learned men of music, those who had heard the Nightingale's songs agreed that the contraption was lacking something. In time the contraption broke, its tunes became distorted, and then the Emperor fell ill. In his final moments, at Death's door, the disgraced Nightingale appeared and drove away Death with its song. The Emperor regained his strength and invited the Nightingale to stay at court as a free bird with no obligations, and although it declined, the Nightingale promised to come by his window to sing and tell stories from the land.

In the Nightingale, artificiality may be licit, but the natural world offers virtues that are either impossible to replicate or flawed in their artificial replication.

In both stories, the theme of copying nature is present and in both stories the artificiality is licit, although they bring about different results. Interestingly, H.C. Andersen presumably thought it relevant to include the suspense-building note from the anonymous sender of the contraption, that hints at a Shinto-inspired view of technology in that the Emperor is warned that the contraption is but a poor substitute. As mentioned, this contrast in views and its implications are beyond the scope of this thesis, but they remain interesting, or at least personally inspiring, when confronted with different cultural views on robotics. (Kaplan, 2004, p. 469) describes this by paraphrasing (Berque, 1986) in a passage on the views on garden fountains:

"...Japanese people do not oppose the natural and the artificial but on the contrary very often use the artificial to recreate nature. The difference between Western fountains and small Japanese cascades illustrates this point well. In the west, fountains throw water high in the air. As it is a completely unnatural movement, the Western man hopes to demonstrate his mastery over nature. On the contrary, small Japanese cascades mimic as closely as possible the way water naturally flows. They look much more modest than their Western counterparts but often the hydraulic mechanisms underlying them turn out to be technically superior. The artist-engineer shows his art by transferring the elements that really count from the natural cascade to an artificial one. In this respect, to be able to copy means to understand and to pay homage to nature".

Without drawing conclusions, I find it interesting that while both the East and West develop artificial representations of the natural world, the expectations to them, are different. While the West operates with expectations of mastering the East appears to operate with expectations of coexistence.

2.1.4.2 The Uncanny Valley

It could be argued that the field of robotics has incorporated this notion in the form of *The Uncanny Valley* as presented by (Mori, 1970, 2012). With practical implementations of humanoids being sparse and development costly, the results often fall short of public expectation. With the examples above as well as other developments, we are continuously seeing attempts to design robots that are sufficiently realistic and familiar to something we know, but still do not fall into the *Uncanny Valley* (Mori, 1970, 2012).

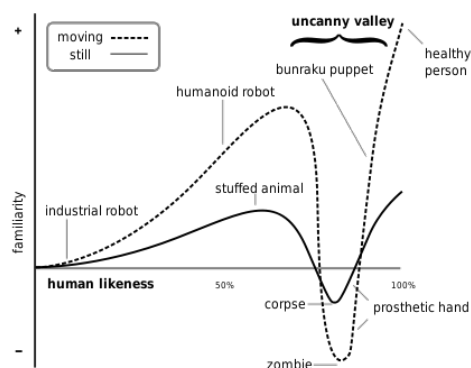


Image 1: Mori's "The Uncanny Valley". Adapted from (Mori, 1970).

This mental model exists, according to Mori and others, as the relationship between familiarity with a phenomenon and its human likeness is not a proportional one. Instead, as (Mori, 1970) states it “...as robots appear more humanlike, our sense of their familiarity increases until we come to a valley. I call this relation the ‘Uncanny Valley’”. This familiarity concept is perhaps better understood if thought of in terms of expectations, as the concept of *Familiarity* bears the notion of what we believe the phenomenon is capable of. Mori moves on to provide an example using prosthetic hands:

“Some prosthetic hands attempt to simulate veins, muscles, tendons, finger nails, and finger prints, and their color resembles human pigmentation. [...] But this kind of prosthetic hand is too real and when we notice it is prosthetic, we have a sense of strangeness. So if we shake the hand, we are surprised by the lack of soft tissue and cold temperature. In this case, there is no longer a sense of familiarity. It is uncanny. In mathematical terms, strangeness can be represented by

negative familiarity, so the prosthetic hand is at the bottom of the valley. So in this case, the appearance is quite human like, but the familiarity is negative. This is the uncanny valley”.

Essentially, the placement of the valley on the graph is subjective and will therefore vary in distance from the point (0,0) indicating no human likeness and no familiarity. In other words, it is subjective how much human likeness any one person will tolerate before the familiarity drops, how fast this happens, and to what extent.

In essence, a non-realistic/simplistically designed robot will be given more leniency in terms of imperfections and odd behaviour than a realistic one, and the expectations of a realistic robot will be higher than those of the simplistic. In (Pollick, 2009, p. 69) the author surmises that “...*there is a dearth of empirical evidence on [the effect of the model] and certainly no study that outlines essential properties that can be manipulated to navigate into and out of the uncanny valley. Thus, it would seem some care is needed in the evaluation of claims about the uncanny valley until a more rigorous understanding is reached”.*

Despite the review by Pollick and the critique listed therein, it would seem that the notions forming the model remains central to the development and goals for development of most Socially Assistive Robots and especially so for humanoid ones.

2.1.5. CONCLUDING REMARKS ABOUT ROBOTS

In summary, and “*without addressing the need for a more universally adopted terminology in the field of social robotics, it is clear that a view of social robotics in line with if Breazel’s observer-dependant definition of Social Robot and Fong’s definition of the Functionally Designed and Anthropomorphic Robots, lead to an understanding of Socially Assistive Robots; Teleoperated, Humanoid, Zoomorphic or otherwise, that accept an intentionally non-realistic design as the best solution for certain contexts and user groups”* (Strandbech, 2015, p. 18).

These “*Functionally Designed Socially Assistive Robots thus aim to be sufficiently realistic for a given context or task, and as a category they seem ideally suited to engage with persons with e.g. cognitive impairments such as dementia, who, as I will describe in the following, are often placed in overwhelming social interaction situations when engaging face-to-face”* (Strandbech, 2015, p. 18) with other humans. If we choose to apply the notions from the Shinto-myth of Amaterasu O-mi kami to this view, we are left with a view of especially *Functionally Designed Socially Assistive Robots* as purposely designed as artificial representations of real world beings, but not made with the purpose of matching the object they are made to represent.

The difference is of course a theoretical one. The tale of Amaterasu will not change the views of frightened children or persons finding a robot eerie, but the cultural understanding of the use of robotics may prove vital in reframing the use of both Functionally Designed and extensively anthropomorphic Socially Assistive Robots. This reframing may be vital, as many find that we are on the precipice of a transformation that will bring about massive changes in development in robotics and, inevitably, their application.

2.2. ABOUT DEMENTIA

The purpose of this section is to provide an overview of dementia in general. This is meant only as a means of providing a preliminary basis for understanding the changes in the participants as described later. Again, this section is inspired by my own previous work found in (Strandbech, 2015).

“In short, the term ‘dementia’ is used to describe not a single illness or disease, but “a collection of symptoms, including a decline in memory, reasoning and communication skills, in addition to a gradual loss of the skills needed to carry out simple daily activities” (Alzheimer’s Society, 2007, p. 2). These symptoms are caused by structural and chemical changes in the brain as a result of physical diseases such as Alzheimer’s disease” (Strandbech, 2015, p. 6). The five primary symptoms of dementia are often surmised into ‘The five A’s” (Gulmann, 2001, p. 73) as seen in Table 2 below. However, as “it is estimated that some 200 different illnesses lead to dementia, there are many different symptoms as well as types and subtypes of dementia. It is believed that dementia is a permanent degenerative state, and as such persons with dementia cannot be cured and whatever initiatives are deployed, serve only to alleviate symptoms (World Health Organization, 2007; Alzheimer’s Society, 2007)” (Strandbech, 2015, p. 7).

Symptom	Oxford Dictionary Definition
Apathy	The feeling of not being interested in or enthusiastic about something, or things in general
Aphasia	Inability (or impaired ability) to understand or produce speech
Apraxia	Inability to perform particular purposive actions
Agnosia	Inability to interpret sensations and hence to recognise things
Amnesia	A partial or total loss of memory

Table 2: The Five A's describing the primary types of symptoms of dementia

“A common denominator in most persons with dementia is the loss of verbal activity and ability to comprehend social interaction. Not surprisingly, many feel overwhelmed when in social interaction; leading to further isolation and a degeneration of mental capabilities” (Strandbech, 2015, p. 7). It should be noted that there is some discussion as to the prevalence of BPSD in Dementia, with reviews of studies on the matter suggesting ranges from 50 to 100% (Devshi et al., 2015). *“The BPSD’s include apathy (27%), depression (24%), and agitation/aggression (24%), and are four times as likely to be found in persons with dementia, over persons without dementia (Alzheimer’s Disease International, 2009, p. 15)”* (Strandbech, 2015, p. 7). While many research-papers on Socially Assistive Robots in relations to persons with dementia do not list the use of BPSD evaluation specifically, most results are, for good reason, related to the factors described here. *The overall diagnosis of dementia “... is defined with one or more of the several categories and subtypes as well as a stage of severity. While the WHO adheres to three levels of severity – mild, moderate, severe - it is common practice for other organisations as well as healthcare professionals in Denmark and other countries to use five stages, adding ‘mild-moderate’ and ‘moderate-severe’ in the overlap between the existing categories. For our present purposes, it should be noted that (World Health Organization, 2007, p. 45) defines moderate and severe dementia as:”* (Strandbech, 2015, p. 7).

Moderate dementia is defined as *“a degree of memory loss, which represents a serious handicap to independent living. Only highly learned or very familiar material is retained. New information is retained only occasionally and very briefly. The individual is unable to recall basic information about where he lives, what he has recently been doing, or the names of familiar persons.* (World Health Organization, 2007, p. 45).

Severe dementia is defined as *“a degree of memory loss characterised by the complete inability to retain new information”* where *“only fragments of previously learned information remain”* and thus *“the subject fails to recognise even close relatives”* (World Health Organization, 2007, p. 45).

“It is currently estimated that 11% of persons aged 65 or more have dementia if living in a developed country, and likely greater in developing countries (The Alzheimer’s Association, 2014, p. 16). Due to a coming sharp increase in persons 65 or older, which is cordially referred to as the rise of “The Silver Economy”, the EU currently projects that 117 million (25%) of Europeans will be 65+ in 2050. As a result, 14,5 million Europeans are projected to have dementia in 2050, compared to the current 10,3 million (European Commission, 2005, 2014, EUROSTAT, 2015a, 2015b)” (Strandbech, 2015, p. 7). With extreme uncertainty (Brodaty & Arasaratnam, 2012) estimated 115 million globally, if all projections hold true.

2.2.1. INTERACTING WITH DEMENTIA

Due to the common core of symptoms found especially in the later stages of dementia, interaction takes special skill but shows some commonalities between persons. In this short section I will outline some of the major disruptions to interaction caused by dementia symptoms. Specifically, I will focus on the prevalent issues regarding loss of memory, verbal skills and ability to comprehend social interaction, as well as apathy, aggression, hallucinations and delusions that are all present in the later explications of interaction.

Memory loss is often wrongly seen as the most significant symptom of dementia, as it presents first and progresses steadily as described above. From an interaction-perspective, interlocutors can find great value in using open questions such as *Did you like living there?* in favour of *When did you live there?* By avoiding closed questions which can cause the person to try and fail to identify e.g. a year, in favour of exploratory ones, which can include the same information the persons are given the opportunity to focus the conversation and not be forced into confronting their memory deficit. The loss of verbal skills and ability to comprehend social interaction decrease along the same lines, as persons with dementia experience both the direct effect of the structural and biological changes in their brain, as well as the side-effects of increased isolation due to seeing their own declining abilities to function normally. This is seen as a steady decrease in active vocabulary used and understood with nouns being affected as early as in the first stages of the disease. Naturally, this loss is compounded by the BPSD known as apathy that causes a feeling of not being interested in or enthusiastic about something or things in general. The result is often physical and social isolation as persons with dementia isolate themselves and don't participate in interactions when physically present. In addition, the aggression found in many persons with dementia causes them to e.g. become physically or verbally resistant to help, to shout or start tapping, to slam doors or throw objects. In addition, some persons with dementia suffer from hallucinations and delusions, causing them to experience things that are not there, and e.g. believe that people around them are not sincere, steal from them or hurt them.

With these symptoms, the impairment to the interaction in persons with dementia is severe and extremely varied. As hinted, questions should be open, verbal skills stimulated and social interaction encouraged.

There are several questions of ethics when working with persons with dementia. These reflections are presented below on page 74 in connection to the ethical approval process, ethical guidelines for research and ethics in dementia research.

2.3. REVIEWING HUMANOID AND ZOOMORPHIC ROBOTS IN HEALTH AND WELFARE

As mentioned above, this section presents a review of the use of Socially Assistive Robots within the field of health and welfare. The section will first elaborate on the specifications of the review in terms of search-methods and evaluation criteria before providing an overview of the elements and their distribution into relevant domains of application. Following a short description of all presented robots, I will elaborate on the results found within each of the domains of application and the field as a whole. Lastly, I will summarise discussions found in other reviews so as to provide as detailed an overview of field as possible.

2.3.1. REVIEW SPECIFICATIONS

The purpose of the review was to identify domains of application and current state of knowledge with regard to the use of Socially Assistive Robots in health and welfare, and with regard to dementia-care in particular. This was done to ensure that the research conducted in this thesis does in fact address relevant issues. Specifically, the two following questions were posed:

- a) From previous research, in what health-related contexts of application have zoomorphic or humanoid robots been placed?
- b) From previous research, what is the health/welfare related effect of interacting with a zoomorphic or humanoid robot for persons with dementia?

Using the methods of (Randolph, 2009) for the structure of this review, coverage of the above questions is representative for a) and exhaustive for b), within the below limitations.

Using Web of Science (Thomson Reuters, 2016), a review with the following search-string was conducted in the autumn of 2015.

TOPIC: (((Humanoid OR social OR emotional) Robot OR PARO)
AND (Health* OR Dementia)) **NOT TOPIC:** (SURGICAL)
Refined by: LANGUAGES: (ENGLISH)

This string returns all elements with either “*Humanoid robot*”, “*Social robot*” “*Emotional robot*”, “*Robot*” or “*Paro*” present in the title, abstract or keywords if the term “*health*” or “*dementia*” is also present and the language is “*English*”. Elements with “*Surgical*” in title abstract, or keywords are excluded, as the field of surgical robots is not of interest to this review.

As seen in the figure below, the initial search provided 212 elements. In addition to these, 66 elements from the lists of references were considered relevant, leaving 278 elements in the review. From this, 240 were excluded for the below reasons.

- a) Not reporting on interaction (e.g. presenting results and data relevant only for the improvement of the software, with little regard to effects on end-user).
- b) Not reporting results from conducted studies (e.g. only discussing others' results, implications of use or deployment, or presenting frameworks),
- c) Reports on interaction outside a health setting (e.g. Evaluating reactions to Nao in persons with no special needs)

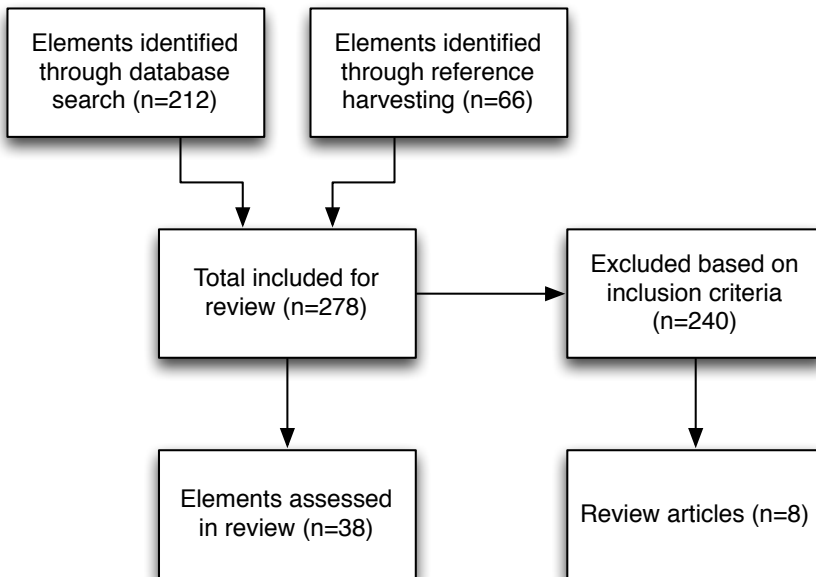


Figure 1: Schematic flow diagram of the review process

The vast majority of the excluded papers deal with the design and implementation of e.g. the Artificial Intelligence that govern the behaviour of the robot in which it is employed and thus fall to the “a” clause. Another large portion deals primarily with ethical evaluation, hypothetical deployment, investigations into previous research-claims or other forms of meta-evaluation that does not include either new data or evaluations being presented in the element. As a result, these fall to the “b” clause. 11 such elements deal with Paro, and were evaluated as relevant, but found to present already included data and as such excluded for not adding new data or perspectives.

After exclusions, 38 elements remain and are included in the review, all of which report original data or new perspectives on interaction between persons and a Humanoid or Zoomorphic robot in a health-related context. The full list of references, their domain, used robotic platform, synthesis of results and other data can be found in Appendix A on page 238. The results are conceptually structured, providing insights into the different domains and subsequent robot used within the field. The matrix below provides an overview of the use of robots in their respective domains.

Robot Summary	Name of robot	Elderly with Dementia	Adults and Elderly With No Special Needs	Adults With PDD	Children with No Special Needs	Children with PDD
4	AIBO	3	1			
1	Autom		1			
1	Brian 2.0		1			
(1)	Giraff	(1)				
(1)	Guide	(1)				
2	IROMECC					2
1	JustoCat	1				
1	Kabochan		1			
1	KASPAR					1
1	Keepon					1
2 (1)	Nao	(1)			1	1
1	NeCoRo	1				
18	Paro	14	2	1	1	
2	[No name]	2				
3	Telenoid	2			1	
38 (3)	Domain summary	23 (3)	6	1	3	5

Table 3: Matrix combining robots in the review with their domain of use.

2.3.2. ROBOTS FOR HEALTH AND WELFARE

Before moving on to a presentation of the syntheses of the results in the specific domains, this section will provide a description of the different robots. They are mostly cited from one of the elements, but have on occasion been adapted or imported from external references when included elements gave too vague a description of the robot used. I have omitted a section on the non-specific robots, labelled [No Name] in the previous sections.

2.3.2.1 AIBO



Image 2: Sony AIBO ERS7-M2

AIBO is a robotic dog made by SONY in several different versions. This version is the ERS7-M2 and is fitted with several sensors such as temperature and accelerometer, as well as an infrared camera. It is able to perform common doglike-tasks and behaviours such as fetching toys, walking around and rolling around and indicates its mental state by way of sound and LEDs in its face (Sony, 2015).

2.3.2.2 Autom



Image 3: The robot AUTOM

“Autom is a humanoid robot based on easily available PC components, motors and motor controllers. It has a moving head and eyes, a camera for vision, and a full-colour touch screen display for user input. The robot is designed to have a once- or twice- daily interaction with the user with each interaction lasting approximately five minutes. The nature of the interaction is helping individuals track information related to their weight loss program. The robot talks to the person and guides them through the interaction,

making small talk along the way. The discussion is varied, changing with each interaction based on variables including time of day, estimated state of the relationship between the robot and person, time since last interaction and data that the user has provided in recent days” (Kidd & Breazeal, 2008, p. 2). Interaction with Autom is based on the touchscreen on the robots front with verbal responses based on input and several parameters in the controlling software.

2.3.2.3 Brian 2.0



Image 4: Brian 2.0

Brian 2.0 is a human-like shape with “similar functionalities to a human from the waist up. Brian has been designed to incorporate five design parameters that are pertinent in social settings: embodiment, emotions, verbal/nonverbal communication, social learning and perception. The robot is able to communicate via: (a) verbal means using speech and vocal intonation, (b) a unique human-like face capable of displaying facial expressions, (c) a 3 degrees-of-freedom (DOF) neck capable of expressing head gestures, and (d) an upper torso consisting of a 2 DOF waist and two 4 DOF arms designed to mimic human-like body language. Brian is capable of encouraging natural interactions between an individual and itself through social learning and its physical expressive capabilities” (Chan & Nejat, 2010, p. 534).

2.3.2.4 Giraff

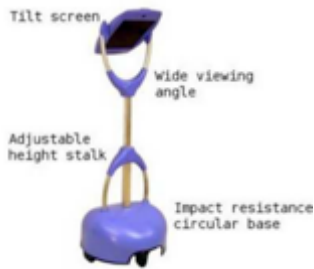


Image 5: The Giraff

“The Giraff provides a means for achieving remote communication between two parties. A mobile robotic base equipped with a web camera, a microphone and a screen is placed at the local user site. The local user interacts in a natural way through the robotic device with a remote peer who connects through a client interface. The client interface is on the remote user site and allows this user to teleoperate the Giraff and navigate around while speaking through a microphone and a web camera. [...] The camera and screen are mounted on a tilt unit allowing the remote user to control the field of view. [...] Navigation is done by pointing with the mouse cursor on the real-time video image received from the Giraff while pushing the left button of the mouse. [...] The Giraff can move both forwards and backwards”. (Kristoffersson, Coradeschi, & Loutfi, 2011).

2.3.2.5 Guide



Image 6: The Guide

“Guide Robot is a 1,6 meter tall robot manufactured by ED Robotics Company in Seoul, Korea. [...] It has a head and a large touch screen for interaction. The robot interacts with the user by speaking, displaying messages/images/video/text on a touch screen and accepting user input on the touch screen. Guide can be programmed with software applications, which currently include: the ability to take vital signs (such as blood pressure) and store them in a database, entertainment (music videos, quotes, photographs), telephone calling to phone numbers using Skype, and brain fitness games” (Robinson, MacDonald, Kerse, & Broadbent, 2013, p. 36).

2.3.2.6 IROMEC



Image 7: The ICOMEC

From the elements included in the review and a websearch on IROMEC, the robot is presented simply as having the appearance of *“...a mix of humanoid and vehicle like, depending on the horizontal or vertical position”*. (Bernd, Gelderblom, Vanstipelen, & Witte, 2010, p. 260).

2.3.2.7 JustoCat



Image 8: The JustoCat

“JustoCat is an interactive robotic pet developed using reminiscence therapy as a framework; it is the result of considering the promising outcomes of the robotic seal, PARO). However, the inventors of JustoCat assumed that a seal would not appeal in reminiscence therapy, as few individuals in Sweden have memories related to seals. In Sweden, cats are a common domestic pet; therefore, a robotic cat was assumed to appeal to individuals’ memories of cats. There was also the idea of downscaled, advanced technology based on the hypothesis of a robotic cat’s functional reliability and lower cost”. (Gustafsson, Svanberg, & Müllersdorf, 2015, p. 48).

2.3.2.8 Kabochan Nodding Communication Robot



Image 9: The Kabochan

“The robots are 28 cm in height and 680 g in weight. The features of shape, voice, and motion resemble those of a 3-year-old boy. The robot was programmed to behave as if communicating with customers and to release affective behavior that could develop a friendly relationship, in particular with elderly people. Loaded with software developed by PIP Co., Ltd. (Osaka, Japan), this communication robot senses the situation and environmental surroundings using light, sound, and motion sensors, and is able to communicate by talking and nodding” Tanaka et al., 2012, p. CR551).

2.3.2.9 KASPAR

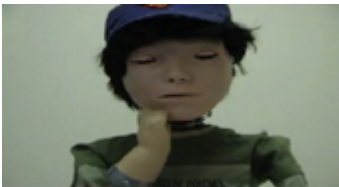


Image 10: The robot KASPAR

A child-sized robot platform inspired by work on comic design, which can exhibit bodily expressions with movements of the head, hand, arms, facial expressions and gestures. It has a static torso, legs and hands but 8 DOF in the head and two 3 DOF arms. Important features of KASPAR’s head are minimal design, emphasis on the features used for (non-verbal) communication such as facial feedback, moving the eyes and eyelids, and moving the arms. The design approximates important features, appearance and movements of a human, Reduction in detail depersonalises the face and allows the interaction partner to project own ideas on it and potentially make it what they want it to be. This section is adapted from (Robins, Dautenhahn, & Dickerson, 2009).

2.3.2.10 Keepon



Image 11: The Keepon

“The creature-like robot, Keepon (pronounced, key-pong) is designed to perform emotional and attention exchange with human interactants (especially, children) in the simplest and most comprehensive way. Keepon has a yellow snowmanlike body. The upper part (the head,) has two eyes, each of which is a colour CCD camera with a wide-angle lens (120 degrees horizontally), and a microphone-nose. The lower part (the belly) has a small gimbal and four wires, by which the body is manipulated like a marionette, as illustrated in Fig. 4. Four motors and two circuit boards [...] are installed in the black cylinder. Since the body is made of silicone rubber and its inside is relatively hollow, Keepon's head and belly deform whenever it changes posture and when people touch it” (Kozima, Nakagawa, & Yasuda, 2005, p. 342).

2.3.2.11 Nao



Image 12: The NAO Robot (Bertel, 2016, p.61)

“The NAO robot, developed by French Aldebaran Robotics in 2006, is a small humanoid, aiming to reflect the concept of a human being with human-like features and affordance, without attempting to ‘accurately’ resemble the human body (like android or geminoid robots). It is 58 cm tall and equipped with microphones, cameras, tactile and pressure sensors, allowing some simulation of perception (i.e. being “reactive” by “looking for” and responding to words and gestures). It communicates through movement (25 degrees of freedom) and speech (19 different languages) as well as coloured LED lights in its eyes. It is programmable in ‘Choregraphe’ (a visual drag-and-drop language) as well as Python and C++ for experienced programmers. Choregraphe consists of a series of easy to understand predefined modules (e.g. “Say,” “Stand Up,” “Go to” etc.) combined in sequences and executed in a virtual 3D environment or on the physical robot” (Bertel, 2016, p. 61).

2.3.2.12 NeCoRo

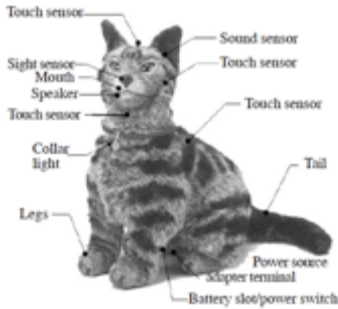


Image 13: NeCoRo (Libin & Cohen-Mansfield, 2004, p.113)

“NeCoRo is based upon the concept of an emotional communication robot. Enhanced artificial intelligence and built-in sensors allow for a variety of responses during interactions, which can be either verbal (meow, purr, or hiss) or nonverbal (stretching paws, wagging tail, opening and closing eyes, turning head and spreading ears, and sitting or lying down)” (Libin & Cohen-Mansfield, 2004, p. 112).

2.3.2.13 PARO



Image 14: PARO (Marti, Pollini, Rullo & Shibata, 2005, p.100)

“PARO’s appearance is from a baby of harp seal and its surface is covered with pure white and soft fur. ... PARO is equipped with the four primary senses: sight (light sensor), audition (determination of sound source direction and speech recognition), balance and the above-stated tactile sense. Its moving parts include vertical and horizontal neck movements, front and rear paddle movements and independent movement of each eyelid, which is important for creating facial expressions” (Marti, Pollini, Rullo, & Shibata, 2005, p. 100).

2.3.2.14 Telenoid



Image 15: The Telenoid.
Image courtesy of SOSU Nord

Telenoid is a tele-operated android developed by ATR in 2010 and since updated continuously. It is 50 cm tall, has no legs, and consists of a white torso with 20 cm long arm-stumps. It is equipped with one actuator in its shoulders, arms, and mouth and three in the neck. As the robot is tele-operated, it cannot do anything on its own and thus allows the Operator of Telenoid to transmit movements of the neck as well as the voice of the Operator. Telenoid's arms allow for a simplified but effective hug. The simplified face allows no movement at all, although the eyeballs are able to move naturally. The Operator can view and hear the interlocutor on a control computer with the help of a camera, placed somewhere in the setting and listen with the help of microphones placed in the ears (Geminoid.jp, 2015) (Strandbech, 2015, pp. 9–10). A more extensive description of Telenoid is presented from page 79.

2.3.3. DOMAINS OF APPLICATION

As seen in Table 3, page 39, there are five primary domains of application. In the following, I will present only these five largest domains, as results regarding the overlapping domains are founded on very few elements. I will later present common themes and findings across all relevant elements in the review.

2.3.3.1 Elderly with Dementia

With 23 included elements in this review, the domain of Elderly with Dementia is by far the most researched group in regard to the effects of Socially Assistive Robots. In this domain, three articles investigate the use of the humanoid robots Telenoid and Nao and two additional papers aim to compare the use of the somewhat humanoid Guide and Giraff to Paro as well as another unnamed humanoid. In the remaining articles, 14 investigate the use of Paro and the remaining six investigate other Zoomorphic robots.

As mentioned in section 2.3.1 from page 36, some elements were removed due to irrelevant data. These include the first papers on Paro (T. Shibata, Inoue, & Irie, 1996), indicating that the field has been developing well before 2004, but without much regard as to how the effect of the interaction is evaluated. The paper holds remarks on the possible effects of *Emotional Creatures* on persons such as those with dementia, and historically serve as the point of origin for much of the research that has been done in the field of Socially Assistive Robots.

The first included element in this domain is (Libin & Cohen-Mansfield, 2004) investigating NeCoRo's effect on elderly with dementia. The study aims to compare the use of a Zoomorphic cat to Animal Assisted Therapy. This view of comparison with AAT is general to the field, both now and then. Specifically, the study aims to investigate the benefits of interaction with a robotic cat and a plush toy cat as interventions for elderly persons with dementia. This point of origin is found either explicitly or implicit in the setup and context of most of the included papers.

In (Libin & Cohen-Mansfield, 2004) nine elderly persons with dementia were exposed to a plush-toy cat and NeCoRo for ten minutes each. Participants showed a small comparable increase in pleasure and interest when interacting with either cat, warranting further study (Libin & Cohen-Mansfield, 2004, p. 115).

From there, the field diversifies into the study of the effect of both Zoomorphic robots and the study of mostly autonomous, humanoid robots. I will present the below findings according to those two categories, starting with the Zoomorphic robots.

In (Sakairi, 2004) the effects of interaction with AIBO was investigated using a pre-post MMSE evaluation for eight participants over a one time 30 minute interaction. It was found that verbal activity and MMSE scores improved, but with comments with regard to the certainty that the source could not directly be identified as AIBO.

AIBO was also the subject of (Kramer, Friedmann, & Bernstein, 2009) that sought to compare the effects of visitation by a person, a person accompanied by a live dog, and a person accompanied by an AIBO, on behavioural indicators of social interaction among nursing home residents with dementia. The study was conducted with one visit of three minutes per week for three weeks. With the use of video, social behaviour in the interaction was documented according to initiator, type (Touching, Looking, Social gestures) and duration. From this data it is found that the presence of AIBO had an adverse effect on the number of conversations because focus was divided between the robot and the visitor and not focused on the visitor. In addition, when AIBO was present, participants spent more time looking at AIBO than the visitor.

Another study (Marx et al., 2010) also investigated how different *dog stimuli* affected participants. Findings on 56 participants are based on time in engagement with the stimuli and the Observational Measures of Engagement (OME) tool, providing a five point quantifiable scale for engagement representing negative, neutral, somewhat positive, positive, and very positive. Results indicate that residents were engaged the longest with a puppy video (160s) followed by a real dog (120s), a robotic dog (115s), a plush dog, and a dog-colouring activity.

The engagement is however not very different, with only a 0,5s spread from the engagement of 2,5s and 2,4s on the real and robotic dog, to the dog-colouring activity of 2,0s. As such, the results indicate that the mean duration of engagement of participants was only marginally shorter with the robotic dog compared to the real dog.

With 12 elements with the sole purpose of investigating the effects of Paro, and three comparing Paro to Giraff, Guide and Nao, Paro is by far the most researched Socially Assistive Robot in this domain.

Mirroring the results from the above sections related to AIBO, (Wada, Shibata, Sakamoto, Saito, & Tanie, 2005) found a significant rise in utterances in five persons with Dementia when exposed to Paro two times per week for one year. However, the paper does not reflect on the central issue that with this setup, the conversations and utterances were inherently one-sided conversations with a Socially Assistive Robot that is not able to respond in any meaningful way. This central issue is found in (Wada & Shibata, 2008) where video recordings, covering free use of the robot over a period of five weeks in a common-room, reach the findings that mean time spent in social interaction by the 12 participants varied greatly. Specifically, while overall time spent in interaction is increased from five to six hours when comparing pre and final week of intervention, the amount of time spent in interaction with others without Paro is decreased from approximately 4:30 hours to 2 hours. This would suggest that, as found with AIBO, participants' attention is focused on the Socially Assistive Robots, and this reduces the interaction with interlocutors that are able to respond and engage in actual interaction. Findings are similar in (Kidd, Taggart, & Turkle, 2006) where 7 of the 23 elderly with dementia or no special needs were found to conduct one-sided conversations with Paro. Some participants had positive experiences and the presence of Paro instigated social interaction between participants, even without the presence of e.g. staff. This increase in social interaction is found throughout research papers on Paro, and Socially Assistive Robots in general, underpinning the notion that Socially Assistive Robots function as a *social lubricant* providing a common and immediate frame of reference and conversation and is presented in (Chang, Šabanović, & Huber, 2013; Marti, Bacigalupo, Giusti, Mennecozzi, & Shibata, 2006; Šabanovic, Bennett, Chang, & Huber, 2013) although (Chang et al., 2013) found that groups-sessions of 2-3 persons with assistance of staff provided the best result. (Joranson, Pedersen, Rokstad, & Ihlebaek, 2015) applied the *The Brief Agitation Rating Scale* (BARS), measuring nine frequent behaviours that are measured on a 7-point Likert-scale according to frequency of occurrence during the preceding 2 weeks, they found that Paro had a long-term effect on depression and agitation when applied in activity groups for elderly with dementia at nursing homes. They summarise that *Paro might be a suitable non-pharmacological treatment for neuropsychiatric symptoms and should be considered a useful tool in clinical practice* (Joranson et al., 2015, p. 872).

In three included papers Paro is compared to humanoid robots. In (Moyle, Jones, et al., 2013) Paro was compared to Giraff with the purpose of exploring how to best test the efficacy of Socially Assistive Robots in nursing home environments. While their findings relate to many central issues in regard to Socially Assistive Robots, their findings from the Pilot study of two groups of nine elderly with dementia either in an interactive reading group or in interaction with Paro reveal that interaction with Paro was preferred over Giraff.

Similarly, (Robinson et al., 2013) compared Paro to Guide, with the purpose of generating results from successful use of Paro and enrich the development of Guide. From interviews and a restricted Pilot study it was found that Paro was preferred due to physical appearance and the interface design in Guide was too complicated for non-expert use.

(Valentí Soler et al., 2015) investigate and compare the effects of interaction with Paro, Nao and a live dog in elderly with dementia. The study was set up with approximately 100 elderly with dementia where groups of 9-15 participants were seated in interaction with Paro, Nao or a living dog. Using a large variety of qualitative methods to assess level of dementia, Quality Of Life and Neuropsychiatric symptoms it was statistically found that patients in both robot groups showed the same level of improvement in apathy. Patients in NAO group showed a decline in cognition as measured by the MMSE scores. Patients in Paro group showed increase in Quality Of Life as measured by QUALID scores. This indicates that while Nao and Paro are comparable in some ways, it would appear that interactions with Nao do not improve Quality Of Life in persons with dementia. As for the results regarding interaction with a living dog, the results seems to be comparable to those where robots are in use. Similar findings are presented in (Bemelmans, Gelderblom, Jonker, & de Witte, 2015) where a four month ABAB test was conducted with alternating setups applying either Paro or nothing in interventions of 15 minutes. The main findings suggest that *Paro is clearly effective for interventions aiming at a therapeutic effect, if applied in a well thought-out manner and tailored to the individual situation of the elderly* (Bemelmans et al., 2015, p. 950).

With four elements specifically investigating humanoid robots, all could be said to be outliers in the field. In (Tapus, Tapus, & Mataric, 2009) a human-like torso is investigated for its effect in regard to motivating elderly with dementia to participate in musical therapy. This is done with a one-on-one session running once a week for six months. Findings are based on evaluation of task performance and mean time spent performing the task of pushing a button, corresponding to the correct song being played. Over time, participants were faster and more frequently right. While the results are overall not within the scope of the review, the elements do present findings relevant to the central issue of whether or not a humanoid can motivate persons with dementia to engage in activities akin to cognitive therapy.

Central to this dissertation is the work done in the explorative studies of (R. Yamazaki, Nishio, Ogawa, & Ishiguro, 2012; Ryuji Yamazaki et al., 2014) aimed at investigating the effects of Telenoid presence in interaction with persons with dementia. Based on a one-time 20 minute one-one-one interaction, and remembering the central point that the Operator of Telenoid can respond to participants' utterances and behaviour, (R. Yamazaki, Nishio, Ogawa, et al., 2012) found that Telenoid elicited positive and interactive reactions from the elderly with both mild and severe dementia. Centrally, and in sharp contrast to their typical demeanour, many were verbally active, and although operated by an adult, most interacted with Telenoid as if with a small child. After this first Pilot study, (Ryuji Yamazaki et al., 2014) conducted a case-study on two elderly, one with dementia and one with no special needs. Based on two one-on-one sessions of two hours it was found that participants were verbally active and engaged in conversation and physical interaction throughout sessions.

It should be noted that due to the relevance of the studies in this domain, they are investigated further in the latter section 4.1 from page 104 with focus on the methods applied and the ensuing analysis.

2.3.3.2 Adults and Elderly with No Special Needs

With six elements and five different robots, the domain of adults and elderly with no special needs is one of the most diversified in this review although not thoroughly researched. Two elements investigate the use of Paro, three examine humanoids and a single element investigates the use of the zoomorphic AIBO.

In (Banks, Willoughby, & Banks, 2008) it is investigated if AIBO can serve as a means to decrease loneliness and how this compares to that of a living dog. This was done by dividing the 37 participants into three conditions where they receive one weekly visit of 30 minutes from either a dog, AIBO, or were part of a *no-visit* control group. The data is primarily focused on assessing loneliness and participant attachment to the *pet*. Based on the Lexington Attachment to Pets Scale (LAPS) and University of California Los Angeles (UCLA) Loneliness scale it is found that there is no difference between using a live or robotic dog and that the participants were indeed attached to both AIBO and the live dog.

In line with this, (Sung, Chang, Chin, & Lee, 2015) found that, based on a population of 12 elderly subjected to Paro 30 minutes twice a week for a month, participant participation in social and verbal interaction was increased. Similarly, (Robinson, MacDonald, & Broadbent, 2015) uses an interesting setup where 12 elderly are subjected to Paro for 30 minutes. Based on measurements of blood pressure and heart-rate before, during and after interaction it was found that interaction with Paro can temporarily significantly reduce blood pressure and heart rate.

In (Kidd & Breazeal, 2008), the purpose is to evaluate if and how the humanoid Autom performs in regard to motivating adults to complete weight loss-training, when compared to virtual programs or no programs at all. Here, it is found that among the 45 adults with free use of the tested system at home for six weeks, there was no discernable mean weight loss. This is attributed to the duration of the study and it is presumed that a longer period of study would yield a discernable mean weight loss. It is noted that Autom was in use for significantly longer than in other conditions and far beyond the scope of the study, which would indicate that participants at the very least were accustomed to the presence of Autom. The paper has other findings regarding the design of the AI, but these are omitted here.

In the final two elements, the purpose of the studies was to evaluate if the robots used can improve aspects of communication. In (Chan & Nejat, 2010) the studies serve as a proof of concept and involves six adults as the basis for arguing that cognitive training-programs can function for persons with dementia. In this 20 min. one-time interaction, the purpose of the study was to investigate the participants' object of attention during a memory game. Comparing two setups where a) several distractions and b) several distractions and Brian 2.0 were present it was found that with the assistance of Brian, participants' attention on the game was held for longer periods of time. In (Tanaka et al., 2012) it was evaluated if communication with a Kabochan Nodding Communication Robot could improve cognitive functions in 34 elderly women living at home. Participants had free use of either the robot or a non-responding placebo at home for eight weeks. Before and after the intervention, MMSE, Cognistat, ADL and other measurements were taken with the purpose of evaluating cognitive functions. Of 16 participants using the actual robot, no statistical significant results were gathered.

2.3.3.3 Adults with Pervasive Developmental Disorders

With only (Marti et al., 2005) addressing Adults with Pervasive Developmental Disorders within the restrictions of this review, this section hardly qualifies as a saturated investigation of the domain. Nevertheless, this element is the only one that deals with adults with special needs in interaction with Socially Assistive Robots. In the element, it is investigated if adults with Down's syndrome benefit socially from interacting with Paro by way of an unstructured qualitative exploratory study. The element provides insights into the target participants and concludes that Paro to some degree assist the participants with putting words to feelings that were otherwise left unspoken and thus perhaps cause of anger and anxiety (Marti et al., 2005, p. 105). This could indicate that Paro can serve as a focusing-artefact/agent for users' emotions and in that role serve as a way for persons without the ability to express their emotions or behaviours. This resonates in some ways with the overall effects of Humanoid and Zoomorphic in Health and Welfare and especially so for Paro.

2.3.3.4 Children with No Special Needs

Within the restrictions of the review, the domain of Children with No Special Needs is addressed in three elements. With one element each for Paro, Nao and Telenoid, the main findings of this domain are mostly related to children's impression of pain or children's inclusion in school by way of tele-presence.

In (Okita, 2013) Paro's effect on pain and anxiety in 18 girls age 6-16 is investigated by asking the participants to indicate their experienced level of pain using FACES Pain Rating Scale. The girls are all hospitalised at a paediatric hospital ward and based on this one time interaction it is determined that the presence of Paro can alleviate pain, but the presence of a parent is still preferable.

In (Beran, Ramirez-Serrano, Vanderkooi, & Kuhn, 2015), the use of Nao is seen as a non-pharmacological method of distraction when 57 children are exposed to the robot during an annual flu-vaccine. By video-recording the interaction, basic emotions were found and compared to a control-setup with no robot present. The element concludes that the participants smiled more often when Nao was present, but they did not cry less. In post-intervention interviews parents indicated that children held stronger memories for the robot than for the needle, wanted the robot present in the future, and felt empowered to cope by its presence.

Lastly, (Yamazaki et al., 2013) focus on how the Telenoid can facilitate the inclusion of long-term absent children in daily school activities. This is done with a focus on how best to include these children in group-work during school hours. Data is collected from a two time 90 minute session where 28 students are divided into groups of four to five members. The task of each group was to, in turn, engage in group-tasks with one Telenoid through which a group member was present. Results indicate that the children operating Telenoid felt left out of aspects of the conversation, and that the group was, with practice, able to include the Telenoid in some aspects of the conversation, both verbally and physically.

2.3.3.5 Children with Pervasive Developmental Disorders

Overall, there are five elements in this section, divided with three on Zoomorphic and two on Humanoid robots. The first article in this domain within the review is (Kozima et al., 2005). Here, the effect of Keepon as a toy for children with PDD is evaluated. The setup in the element is unclear and span multiple locations and timeframes. Results are anecdotal and in the form of summarising overall observations. Here it is presented that interaction with Keepon relaxes children with Autism and Pervasive Developmental Disorders (PDD) and often facilitates inclusion of other children in their play with Keepon, unlike with other toys.

In (Robins et al., 2009), the effects of KASPAR is evaluated. Specifically it is investigated how the humanoid can motivate children with autism to communicate and participate in social interaction. To this aim, three children with autism was video recorded during “*several months*” of progressively more complex interaction and in some cases allowing the participating children to operate KASPAR. While the authors are explicit in the limitations of generalising the presented results, they find that the participants shows an increased understanding of others’ social interaction and that the presence of KASPAR facilitated an increase in important interaction competencies that was not previously seen in the participants.

Both (Klein, Gelderblom, de Witte, & Vanstipelen, 2011) and (Bernd et al., 2010) report on the same study, data source, results perspectives and are thus merged in this section. Data is collected from 12-14 sessions of 30 minutes over a period of seven weeks where three children with PDD were exposed to IROMEC in two different play scenarios. Data collected proved no significant change in either element, and interviews with therapists present during interventions support this and reveal optimism regarding the use of IROMEC as a toy, but little hope for a therapeutic effect.

Finally, (Shamsuddin et al., 2012) focuses on the effects of Nao with regard to how its presence affected the communication skills in five children with PDD during a one time 15 minute intervention. When comparing the participants’ Full Scale IQ (FSIQ) to the pronunciation of their autistic traits using various measures, and then comparing results to observations of normal behaviour, it was found that four out of five had reduced autistic traits.

2.3.4. SUMMARISING THE USE OF HUMANOID AND ZOOMORPHIC ROBOTS IN HEALTH AND WELFARE.

For the purpose of clarity the following section will summarise the domains into one coherent presentation on the use of Humanoid and Zoomorphic Robots in Health and Welfare.

As presented above, the best-saturated domain within this review is that of Elderly with Dementia. Between the 38 elements, it is generally found that Socially Assistive Robots are able to provide a means to engage persons with dementia in emotionally engaging situations with positive effects on mood, anxiety and other BPSD-like symptoms. For the humanoids, the work is indicative of also contributing to an increased verbal activity, but for both the Humanoid and Zoomorphic robots, more research is needed. The results found here are also found in the domains of Adults with Pervasive Developmental Disorders and Children with Pervasive Developmental Disorders, although these domains lack the same saturation in terms of number of elements.

The domain of Children with No Special Needs as well as that of Adults and Elderly with No Special Needs are in need of additional studies. While there are positive indications of interaction, the effects of Socially Assistive Robots in this domain are not clear and lack saturation. From results in general it would appear that persons, with above middle-range intelligence, are not likely to benefit or seek interaction with Socially Assistive Robots. This aspect is central to overall development and implementation of Socially Assistive Robots in all domains, as it is a common item of interest that, sadly, has not been evaluated in many elements within this review.

Another common denominator between the presented domains is a high prevalence of small-sample pilot-studies as well as concerns regarding the connection between methods, data and conclusion. These concerns will be addressed in section 2.5 from page 59.

2.3.5. PERSPECTIVES FROM OTHER REVIEWS

With the limitations set in this review, many articles were not included. While numerous versions of the search-string were tested before settling on the final version, none, in my opinion, included all central papers in the field without also including copious amounts of elements that would be excluded for the reasons presented above. For this reason, as described above, the *snowballing-method* of including references from lists of references was employed.

I will also include a summary of conclusions and discussions from selected relevant reviews in the field of Socially Assistive Robots in Health and Welfare. All reviews presented were (re)discovered during the course of the review and relevant references were included, if not already present. For the reviews to be included in this section, they had to fall within the scope of the above search-string or by means of snow-balling.

Overall, the eight included reviews support that of the present review, as it is surmised above. In addition, as some reviews present aspects and discussions that are prudent when investigating the field as a whole, these aspects will be the focus of this section. I have restricted the presentations heavily to the core of relevant information and thus many aspects and nuances from the elements are omitted. There are obviously overlaps in their findings, and as such, elements here will be presented in terms of findings and not as individual elements. As with the elements of my own review, the reviews presented below can all be found in Appendix A on page 238.

2.3.5.1 Stakeholder involvement and acceptance of robotics

In their 2009 review (Broadbent, Stafford, & MacDonald, 2009) survey the elements that support the acceptance of healthcare robots in the older population. With an investigation of acceptance of healthcare robots at point of origin, the authors investigate what factors contribute to the “*three basic requirements: a motivation for using the robot, sufficient ease of use, and comfort with the robot physically, cognitively and emotionally*” (Broadbent et al., 2009, p. 320).

With regard to the user of robotics, the authors find that old age and lacking experience with technology/robots diminish willingness to use robotics, which is related to their feelings of distrust toward and insecurity in using technology in general. This central issue is alleviated if and when the robot is perceived to assist with the needs of whoever is using it. This is indicating that it is necessary for the purpose of deployment to be clear if users are to accept the robot in whatever role. In the uncovering of these needs the authors provide examples of several projects that did in fact not investigate the actual needs of participants or expected users. The issues of addressing a perceived need as well as insecurity in using technology is also found in (Bemelmans, Gelderblom, Jonker, & de Witte, 2012; Flandorfer, 2012).

With regard to the robots themselves, (Broadbent et al., 2009) find that while much study has been devoted to appearance, behaviour remains a vital and under-investigated aspect, especially so because the presence of assistive technology in general can lead to stigma being aggravated by mere design aspects. This relates heavily to the relationship of expectations of the part of robot. Here expectations become greater with a more complex, humanoid or *high-tech* design.

Regarding the humanness of humanoid robots, the authors find that “*different applications may require different degrees of human-likeness*” (Broadbent et al., 2009, p. 324) and especially so for persons with diminished cognitive capacity. In regard to zoomorphic robots, it was found that “*people with a general dislike of pets or animals tended not to engage with the robotic animal. However people who were fearful of risky aspects of real animals, such as being bitten, or being unhygienic, did tend to engage with the robots as they felt the robotic animal was safe*” (Broadbent et al., 2009, p. 324).

(Broadbent et al., 2009) conclude that “*many studies have been artificial and observational rather than experimental and in real settings. However, early findings suggest that the robot must meet the person’s needs, be slow, safe and reliable, small, easy to use and have an appearance that is serious, not too human-like, not patronising or stigmatizing, and have a serious personality*” (Broadbent et al., 2009, p. 325). This resonates with the *Seven Matters of Concern* found in (Frennert & Östlund, 2014). Specifically they are, (1) the role of robots in older

people's lives, (2) factors affecting older people's acceptance of robots, (3) lack of mutual inspiration in the development of robots for older people, (4) robot aesthetics, (5) ethical implications of using robots in caring for older people, (6) robotic research methodology, and (7) technical determinism versus social construction of social robots.

Frennert & Östlund summarise their results to "*indicate that older people are implicated but not present in the development of robots and that their matters of concern are not identified in the design process. Instead, they are ascribed general needs of social robots due to societal changes such as ageing demographics and demands from the healthcare industry*" (Frennert & Östlund, 2014, p. 299).

2.3.5.2 Methods, measures and setup

In (Broadbent et al., 2009, p. 325) the authors find that, while there exists many validated methods of evaluation of elderly persons' needs, very few studies have employed these. In addition, many studies are inadequately described and thus difficult to replicate. Specifically, it is found that only 26 of 40 studies address socio-demographic factors in their research, and in these 26, the factors were largely only collected and thus the implications of the factors were not discussed. On this note (Flandorfer, 2012) elaborates in her review on the use of socio-demographic factors in the elements. Here it is presented that when found, these factors contribute in adding accuracy to the path of identifying target populations for RAT using Socially Assistive Robots. Related to this are both (Broekens, Heerink, & Rosendal, 2009, p. 99) and (Kachouie, Sedighadeli, Khosla, & Chu, 2014, p. 386) where the authors remark on the cultural inheritance in the results, as most of the included elements originate in Japan. In their review of long-term studies (Leite, Martinho, & Paiva, 2013, p. 293) found positive results of interaction in the application domains Health Care and Therapy, Education, Home and finally Work Environments and Public Spaces. With the few result identified and often a very limited number of users, they find that "*further research is needed to consolidate these results*".

2.4. RELEVANT DEMENTIA INITIATIVES TODAY

As mentioned above, the frame for this dissertation is to evaluate the humanoid Socially Assistive Robot Telenoid as a tool for alleviation of symptoms of dementia. As such, the following section will focus on the initiatives currently used. This section is inspired by my own paper on the matter (Strandbech, 2015) and offered here as a frame for alternatives to the use of Socially Assistive Robots.

Initiatives to alleviate the symptoms of dementia can be divided into *pharmacological* and *non-pharmacological*. Centrally, non-pharmacological interventions are those that address aspects of social and psychological behaviours

and symptoms of dementia that do not involve drugs (Brodaty & Arasaratnam, 2012, p. 946). As this dissertation focuses on the effects of interaction and conversation with Socially Assistive Robots, the pharmacological initiatives are not relevant and thus omitted. (Strandbech, 2015, p. 7)

“The purpose for implementing non-pharmacological approaches is often to maintain cognitive functions or helping the brain compensate for impairments. Generally, these initiatives focus on improving Quality Of Life. (Brodaty & Arasaratnam, 2012, p. 951) summarise this in their paper stating that” (Strandbech, 2015, p. 7).

“Successful interventions included approximately nine to twelve sessions tailored to the needs of the person with dementia and the caregiver and were delivered individually in the home using multiple components over 3–6 months interspersed with telephone sessions and subsequent individual or group telephone follow-ups. Behaviors more likely to respond to such interventions appear to be agitation, aggression, disruption, shadowing, depression, and repetitive behaviors rather than psychosis. From the emerging pattern for success, we recommend adopting interventions that are multicomponent, tailored to the needs of the caregiver and the person with dementia, and delivered at home with periodic follow-ups” (Brodaty & Arasaratnam, 2012, p. 951).

“Efforts include both Physical and Cognitive Therapy, focusing on activating the body as well as different areas of the brain. The activation of the brain can be done by presenting tasks relevant to the areas in focus – such as math, logic, memory or a concrete task related to Activities of Daily Life (ADL), enriching autonomy, Quality Of Life (QOL) and possibly sparking memories in general. Another central form of cognitive therapy is conversation, where the subject is engaged in casual off-topic conversation. This task requires the formulation of sentences, the comprehension of language and words as well as logical reasoning and memory processing on the topic in question. As such, casual conversation can in fact be both a monumental task for e.g. persons with dementia and a task that includes many of the central issues and symptoms persons with dementia are faced with” (Strandbech, 2015, p. 8). This is seen in both the NPI-NH and MMSE evaluation tools presented in section 3.3.3 from page 90, as both include the verbal activity of the test-subject as a central part of the examination. Thus, as the use of verbal skills is central to the evaluation of dementia, simple off-topic conversation may provide a possibility for cognitive training, if used properly. *“In addition to Cognitive Therapy, the use of animals in so-called Animal-Assisted-Activities (AAA) and the use of robotic pets in Robot-Assisted-Activities (RAA) have been proven quite effective. In AAA, specially trained animals will visit or live at e.g. eldercare facilities or other institutions, providing the inhabitants with the opportunities for enjoyment either with or without obligations to care for the animal.*

Because persons with special needs, and especially those with dementia, sometimes find social interactions overwhelming or ‘too rich’, it is natural to use these robots in interaction with this user group and RAA has broadly speaking proven very successful in reducing symptoms and providing companionship. The most used initiative in RAA is perhaps the Paro-seal as described above” ... “For an introduction to and results regarding both AAA and RAA I encourage reading (Cevizci, Murat, Gunes, & Karaahmet, 2013; Chandler, 2012; K. Wada, T. Shibata, T. Saito, Kayoko Sakamoto, & K. Tanie, 2005)” (Strandbech, 2015, p. 8).

As a general statement, (Broadbent et al., 2009, p. 327) states that:

“A single perfect design of a healthcare robot [humanoid or otherwise] is unlikely, and carefully assessing individual needs and preferences and matching these to the robot may enable greater acceptance”.

“In addition, the robot should ‘match the human’s expectations’. While the use of Paro in connection with persons with dementia or other special needs has proven to alleviate symptoms, it has some major constraints. First and foremost, while it is common to anthropomorphise IT-devices, the capability to converse with humans remains a human attribute – or at least not an attribute of other living beings. As such, the Zoomorphic design does not support conversation between a robot animal and a person, although, to my knowledge, no concrete research on this has been undertaken yet.

With Zoomorphic robots not being suitable for off-topic cognitive therapy, there exists the possibility of creating an anthropomorphic robot, capable of ‘Common Sense Reasoning’ via ‘Natural Language Processing’ – i.e. understanding and responding correctly to a large body of topics. This has been researched for many years from many perspectives, but so far proven to be a complex task that is still under way. Presently, the hyper-realistic ‘Erica’ by ATR is by some considered the most advanced AI employed in a humanoid, and ‘she’ is currently restricted to simple conversation (Jst.go.jp, 2015), but little information and no research exists on her as of yet.

Nevertheless, as off-topic conversation is a central point in cognitive therapy and due to ethical concerns as wells as the fact that there is still no autonomous system capable of performing well in engaging in this, it is natural to at least investigate the use of Tele-operated Functionally Designed Anthropomorphic Robots in off-topic conversation, or rather if their restrained behaviour and simplistic design remove the ‘rich’ communication causing an overwhelming communications-experience for persons with e.g. autism and dementia” (Strandbech, 2015, p. 9).

2.5. BROADER QUESTIONS IN RESEARCH INTO SOCIALLY ASSISTIVE ROBOTS

When writing the above presentation on the domains of application, it became clear that it is necessary to address two central issues brought forward by several authors in relation to the quality, scope and function of the field of Socially Assistive Robots as a whole. Firstly, that of the scientific rigour within the field of robotics, comprising how studies are documented, analysed and reported; and secondly, the question of why and from what perspective these studies are carried out.

This section is based on the elements of the previous review. As such the issues raised here should not be seen as a summary of the issues I intend to address. While the issues identified have in some ways acted as guiding lights for my research, I cannot claim to be free of all the implications raised.

Both of these issues seem, some 21 years after the first article on Paro, to have become systemic and persistent to the field of Socially Assistive Robotics Research. In my view, this can hardly be summarised better and more compactly than done by (Rabbitt, Kazdin, & Scassellati, 2015, p. 41):

”... SAR research in mental healthcare is truly an emerging literature. This work is characterized by small studies (e.g., case studies, pilot research), with restricted samples and in limited settings (e.g., laboratories, long-term care facilities), and frequently without adequate methodological controls and comparison conditions. [...] Perhaps even more importantly from a clinical perspective, no work to date has indicated lasting clinically relevant changes as the result of interactions with SAR systems”.

2.5.1. ON SCIENTIFIC RIGOUR

At present, most of the findings driving the deployment of Socially Assistive Robots in Health and Welfare can be characterised in summary by the above quote. Centrally, most of the results regarding the deployment of Paro are based on inadequate data or methods to support the modality of their presented findings. Indeed, (Moyle, Jones, et al., 2013, p. 610) describe having *“failed to identify rigorous research using PARO”*.

Specifically, many of the findings that claim that interaction with Paro can improve mood is based on data from the *Profile Of Moods Scale* (POMS) (Lorish & Maisiak, 1986), where subjects select a face depicting their appropriate mood for the day. These faces range from happiest to saddest over 20 or sometimes seven stages, and are in turn converted to a numerical value, such as in (Wada, Shibata, Saito, & Tanie, 2006). In the above sections, other methods have been used with

success, but at the core of both on-going and past research, central claims are based on POMS. However, from (Bucks & Radford, 2004; Burnham & Hogervorst, 2004) it seems to be unclear if persons with severe dementia are able to correctly identify images of emotions and thus by extension the validity of this core tool, which brings the arguments and results that follow into question. At present, I am not arguing that the results should be void; I am only arguing for a detailed analysis of the use of POMS in relations to persons with severe dementia to ensure the validity of the setup as I was unable to establish such.

In her 2012 review, Flandorfer advocates for use of a common core of models and methods in evaluations of Socially Assistive Robots and stresses that a qualitative explorative Pilot study as an “...*inductive approach offers deeper insights into the feelings and perceptions of older adults towards robotic technologies*” (Flandorfer, 2012, p. 9). In (Broekens et al., 2009) this issue is also mentioned as the authors find that while “*there is some qualitative evidence as well as limited quantitative evidence of the positive effects of assistive social robots [...] the research designs [...] are [however] not robust enough to establish this*” and that “*...more work on methods is needed as well as robust, large-scale studies to establish the effects of these devices*” (Broekens et al., 2009, p. 101).

In regard to sample sizes the issue becomes evident when reviewing both the actual populations described in the research, and more to the point, when synthesising the results. It also becomes evident that the nature of Dementia yields difficulties in quantifying both exact and general effects of the conducted studies and interventions.

As such, many elements in the present review formulate conclusions based on small sample sizes and methods such as unstructured qualitative data in the form of remarks from staff that surmise the effect of a long term study as seen in (Wada, Shibata, & Kawaguchi, 2009). While some methods are indeed well tested they are not *rigorous*, in the words of Moyle et al. The obvious conclusion is to move beyond pilot studies in limited settings, using well-defined methods that can be validated and compared to baselines. This, however, is easier said than done.

2.5.2. THE TECHNOLOGICAL DETERMINISTIC APPROACH

The second central issue is the more abstract question of why and from what perspective the research is being conducted. As mentioned in section 2.3.1 from page 36, some elements were removed due to only presenting results relevant for the further development of the software. While this in itself is an important and central task, it must be supported with findings related to the experiences of and effects on subjects. Indeed, as described in (Leite et al., 2013) this very purpose was found in apparent abundance in their review:

“The purpose of the majority of the experiments was to gain familiarity with the environment where the robot would be placed, and to better understand the nature of the situations that may happen after repeated interactions” (Leite et al., 2013, p. 306).

From my own findings and from several descriptions that mirror the above, it would seem that the predominant mass of research being done on Socially Assistive Robots is being performed with a focus on the robot, rather than its *Socially Assistive* properties.

As presented in (Mordoch et al., 2013, p. 18), there is an issue in regard to the overall frame and conditions under which the core findings have been found. Here, this is presented in reference to Paro but the perspectives concern the entire field as presented later in this section.

“There is a volume of writing from Japan, mainly in IEEE conference proceeding reports, on the therapeutic robotic baby harp seal Paro. Some of these studies collected data from physiological measures such as EEG and urinalysis reports, and face scales measuring affect changes pre and post intervention. While these studies are gathering data and building the knowledge base in the area of therapeutic robotics, several significant problems exist within this literature. It is often difficult to clearly understand the study design, to decipher which studies are the original primary studies and which are pieces of the same study. In addition, the authors of these papers often work with the inventor of Paro, the robotic seal” (Mordoch et al., 2013, p. 18).

The key issues by Rabbitt, Kazdin, & Scassellati cited in the beginning of section 2.5 again become evident when reviewing what (Frennert & Östlund, 2014, p. 305) calls *“the technological deterministic approach that characterises mainstream social robotic research”*, which comprises the vast majority of research on Socially Assistive Robots. Here, technology, and by extension Socially Assistive Robots, are, concisely rephrased, seen as the agents of change and the users are mere receivers.

Frennert & Östlund and others remain strong in their advocacy for the adaptation of an approach with a point of origin in Science and Technology Studies (STS), highlighting the contrast and benefits with contrast to the current Techno Deterministic Approach below:

“From an STS point of view, the adoption and use of social robots depend on how well older people and such innovations co-evolve. Consequently, the adoption of technology is seen as a dual process where the social robots as well as the users can change. For this reason, STS emphasises the sociotechnical aspects and the dual process of adaption and use of social robots, which comprises a network of people, organisations, artefacts, culture and meanings. As a result, the meaning of social robots will be created through a complex network of users, scientists, engineers, designers, manufactures, mass media, etc.”.

In addition, as brought forth by (Šabanović, 2010, p. 439), the field can in some ways be described as techno deterministic in nature, with mostly *“experts from academia, industry, and government”* serving as the writers and fulfillers of the prophecies and promises of Socially Assistive Robots. This, according to Šabanović, leads to a field driven by these central self-fulfilling prophecies:

“A technocentric approach to robotics is further supported by dominant perspectives on the relationship between social change and technological development, which depict a linear relationship between robotics and society. In these narratives, technological development in robotics, led by experts from academia, industry, and government, figures as the primary driver of social progress, while society fills a passive role of accepting and adapting to the results of technological innovation. This technologically determinist framing of the dynamics between technology and society acts as a self-fulfilling prophecy, encouraging the public to view technological change as an inevitability and focus “on how to adapt to technology, not on how to shape it”.

As such, it would seem that this technocentric approach has implications for the traditionally non-technical fields of study that investigates Socially Assistive Robots. While studies carried out with a point of origin in sociological or clinical methods are present, they are the exception to the rule, where most studies that focus on the actual interaction, only rarely use other than quantitative methods.

CHAPTER 3. STUDY OVERVIEW

The purpose of this chapter is to provide insights into the purpose of conducting the Pilot and Main studies of this dissertation.

Initially, I outline the reasoning for conducting the present studies focused on Telenoid in interaction with persons with dementia. Here I also present the session script, as well as ethical and legal considerations and the application process in relation to conducting the studies. Lastly I present the team and Telenoid so as to fully frame the coming sections.

Secondly, I present what I call the Pilot study in this dissertation; a short study that tested Telenoid *in the field*, and was aimed at providing initial knowledge and insights into the interaction between Telenoid and persons with severe dementia.

Finally, I present the setup of the Main study of this dissertation with an initial overview of the participants as well as the types of data collected.

3.1. SETUP, CONSIDERATIONS AND SCRIPT

Following the above reasoning on Dementia and the use of Humanoid and Zoomorphic robots within the domain of Health and Welfare it is clear that there is little qualitative data using *Functionally Designed Socially Assistive Robots* in interaction within the domain of Health and Welfare. As presented from page 50, it is clear that persons with severe dementia will talk to themselves or a Zoomorphic robot such as Paro, and that, in some cases, the introduction of Paro has led to a decline in interaction with other humans. Because talking to a human is a human trait, having e.g. Paro engage in conversation with elderly persons with severe dementia is not likely to cause more positive results than having a human-like robot do the same. To date, there is no extensive research on the subject of verbal interaction with Zoomorphic robots, so we are left with the common sense presumption that the best interlocutor for a human is a human, and perhaps especially so for persons with diminished cognitive capacity.

In addition, by following the above reasoning, persons with diminished cognitive abilities such as dementia will perceive a Functionally Designed Socially Assistive Humanoid Robot as a more manageable conversation partner and will thus be able to engage in or maintain conversations for longer periods, with central benefits in regard to cognitive functions and ADL.

As such, the purpose of the studies is to evaluate if Telenoid as a Functionally Designed Socially Assistive Humanoid Robot can serve as a beneficial tool for engaging in cognitive conversational therapy. This is not done with the aim of replacing human-human-interaction, but to evaluate the benefits of this new medium for conversing, specifically addressing needs in persons with dementia and other impairments.

3.1.1. STUDY SETUP AND SCRIPT

As Telenoid was relatively new and research done on interaction between persons with dementia and Functionally Designed Socially Assistive Humanoid Robots is sparse, there was no existing scientific data with which to compare or build a study on apart from the few studies from ATR. As such I formulated a Pilot study, so as to gain knowledge about the technical aspects, as well as some notions on what to expect and what methods to use for study, before setting up the later Main study. This was done in collaboration with colleagues at ATR and Aalborg University to draw on the experiences that, if not published, were at least collected.

Role	Core function
Participant	The participant in the study.
Operator	SOSU Nord staff controlling the Telenoid remotely.
Assistant	SOSU Nord staff facilitating the conversation and interaction between the Participant and Telenoid.
Observer	Observer with no function or assisting with setup and technical issues.
Telenoid	The robot <i>Telenoid</i> .

Table 4: Overview of roles and core functions

This Pilot study was initially designed as a series of one-on-one conversations between the Telenoid and six elderly persons with moderate or severe dementia. Based on experiences from ATR, this was changed to include the presence of an Assistant in the role of facilitator, because few Japanese Participants there were able to relate to the Telenoid as a lone interlocutor.

The setup of the Pilot study was repeated for the Main study, with the exception that the latter included a group of Participants who talked with a human, and thus the setup of Telenoid was not warranted for those sessions. These Participants are not included in this dissertation and the below description does therefore not reflect these settings. Due to the close resemblance between the setups of the Pilot- and Main- Study, the below sections, which present the application, overview and location serve as the primary descriptions of the studies, with the later sections 3.2 and 3.3 from page 83 presenting details specific to the Pilot- and Main study respectively.

3.1.1.1 Ethical Application

As a point of transparency this section includes sections of the ethical approval application to the Regional Committee on Health Research Ethics and appears here with minor changes. The application is found in Appendix

The experiment will include 10-20 participants, divided into a test group and a control group. All participants will be residents at an eldercare facility for elderly people with dementia. The test group will be invited to sessions with the Telenoid 3 times a week for 2-4 months. Each session will take approx. 15-20 minutes.

The control group will be invited to sessions where the operator of the Telenoid will talk to participants face-to-face 3 times a week for 2-4 months. The topic of the conversation is aimed at being pleasant, and will take its point of origin in the participant's life-journal and the care-staffs knowledge of the participant. The nature of the session is not an interview, but a pleasant conversation with an interested stranger who is visiting.

All sessions will take place in either a common room with only the participant and a moderator, or in the privacy or the participants own room. The participants will not be left alone to converse with the robot at any time.

All participants must be at least 50 years of age and be diagnosed with moderate to severe dementia – preferably with the use of imaging technologies (E.g., CT scan). Participants are excluded if they have other neurological symptoms or illnesses such as Parkinson's or schizophrenia. In addition, all participants must be verbally active and able to maintain a simple conversation for 15-20 min.

During the intervention period, the Telenoid will be an addition to any other forms of activity for the participants and therefore, the participants will not be excluded from their usual social and rehabilitative activities during their participation in the experiment.

3.1.1.2 Study overview

While we did not establish a firm adherence to a script in regard to the session progression, I formulated a guideline and general boundaries for the sessions in terms of presentation of Telenoid, conversational topics and abort-criteria, as presented in the consent as well as included in the below sections.

For all participants the team was given access to residents' personal file, which holds all relevant information about their life story, status of health, likes, dislikes etc. We used the information for general participant profiles and specifically the section on *Life story* where family provide information about the individual, their habits, likes, dislikes and other relevant information as an initial frame for conversation.

For conversation with Telenoid the Operator was located in the bathroom adjacent to the living room due to issues with the wireless signal strength. For documentation-purposes two video cameras were set up in the living room using tripods. One USB-webcam was mounted on one camera, allowing the Operator to see the interaction setting. The Operator was also able to hear the conversation using the microphones in Telenoid's ears.

The bathroom was, in most cases, sufficiently soundproof so as to not alert the Participants to the presence of the Operator. In some later sessions of the Main study, Telenoid was fitted with a camera inside the skull of the robot, allowing the Operator to turn the head of Telenoid and see the changed angle of vision.

The nature of the conversations was not an interview per se, but a friendly conversation with a starting point in the Participant's *Life story*, which served as a means of establishing an initial frame from which we could initiate conversation with the participant, if no obvious topic presented itself, and provided socio-demographic as well as health-related information.

In each case, the Assistant would introduce herself and Telenoid as "*someone who is visiting for a chat*", and perhaps follow up with "*we are looking for good stories*", and from there argue that the staff had told them that the Participant had interesting stories to tell. Again, this was not a firm script but a suggestion as to how conversations could be started with participants, who, as I will describe later on, were likely to reject even close relatives.

Often the Assistant saw fit to introduce Telenoid specifically. Prior to the study the team discussed the formulation and found that using words and phrases familiar to the participant, while being as truthful as possible, was the best solution. As such it was determined that Telenoid would be introduced as "*My friend who collects funny stories*", and then, upon the frequent questions of *his* appearance, the Assistant would say that "*it is a 'telephone-doll' allowing a friend of mine to sit somewhere and see you through the camera, and hear what you say, and then she can respond*". By this time, the Operator would offer a greeting, if this had not been done before.

It was decided that the formats of the sessions were not to be an interview, but rather a conversation between the Participant and the Operator, with the assistance of the Assistant. Ideally, the Participant would offer stories and the Telenoid would be a stranger with an actual interest in the stories and the life of the Participant. In actuality, this is not far from the truth, as both the Assistant and the Operator are teachers on issues regarding dementia and saw this as an excellent way of gaining even more first hand knowledge regarding the life and abilities of persons with dementia. In actuality, this protocol was far from the actual progression of sessions, as later chapters will reveal. Keeping in mind that the team consisted of experienced professionals, it was decided that if the Participant were to become distressed by e.g. the presence of the Telenoid or the topic of conversation, the session would be aborted and appropriate measures taken to alleviate the situation. As I will describe later on, only once did we encounter a situation that was a clear negative experience, and at the few occasions when Participants showed signs of sadness, they also smiled and were comfortable with the situation.

3.1.1.3 The location

As a general vignette depicting the setting of the sessions, I've chosen the description of Ethel's apartment, which is part of (Strandbech, 2015, p. 13):

“Ethel's apartment is all in all a sparsely furnished and decorated one-room apartment fitting most Danish stereotypes of a public eldercare-facility apartment. The care-facility is just a few years old, the air is fresh and with the signature hint of industrial cleaning-products and hand sanitizer. The fresh air is likely a result of Ethel opening the windows to throw out food, picture frames, shoes or clothes, rather than the ventilation.

Just inside the door is the kitchenette, which is never in use. Another step inside, Ethel has placed a small table by which she enjoys her solitary meals and looks through the same old mangled and faded magazines about royalty and celebrity parties. On occasion, during family visits or when staff has the time, she moves to the run-down green velvet sofa, which has just enough room for two. Opposite the sofa is a matching armchair and a coffee table. A side table flanks these and a tall dresser is placed back to back with four tall and slim closets that come with the apartment. Windowsills are populated by a variety of hardy plants that require little water and prominently displayed on the dresser are pictures of relatives, some outfitted with nametags, and some with contextual writing on the back. Behind the dresser and closets, with a view to the bathroom, is her bed, over which two landscape-paintings are hung.

The brick walls are newly painted in white, as they are every time a new resident moves in, and decorated with paintings, photos and religious ornaments above the bed. From the bed there is a clear line of sight to the bathroom, which features stale, damp air with a strong urine smell from an un-flushed toilet. Apart from shampoo, a toothbrush and paste, we find no personal items here, and what little storage there is, is being used to store washcloths used by the staff when Ethel is offered a shower”.

3.1.2. LEGAL AND ETHICAL ASPECTS OF THE STUDY SETUP

While I note that the purpose of the studies is to research conversational therapy, this section will present what specifically is meant by therapy. In addition, I will present other aspects of conducting studies or experiments in what might be described as a medical setting. Finally I will present the actual process of ethical approval for the studies, as well as the process of obtaining consent and the protection of the participants' privacy as well as reflections on the process.

3.1.2.1 Therapy & Medical devices

Using Technology in a health setting raises the prudent question if Telenoid can be considered a medical technology. In the then active law on Committees on Health Research Ethics (Sundheds- og Ældreministeriet, 2011), which has since been replaced by (Sundheds- og Ældreministeriet, 2017) §2 subsection 1-3 defines *health science research* (Sundhedsvidenskabelig Forskning) as any of three things, of which the last is pertaining to the present context. Here, health science research is defined as what I translate and paraphrase to "*experiments on humans with the intent to uncover, test or document the safety or effect of medical devices*". To this end (Sundheds- og Ældreministeriet, 2008) §1 subsection 1 defines medical devices to what I translate and paraphrase to "*...instruments, apparatuses, equipment, software, ... which by the manufacturer are designed to have diagnostic or therapeutic purposes and which with correct use...are designed to be used to...a) diagnose, prevent, monitor, treat or alleviate illnesses ...*". As Telenoid does not alleviate illnesses, but rather symptoms of illnesses it is legally not considered a medical technology, and even if Telenoid is used in interaction with persons with severe dementia, it is by its very nature not health science research in a legal sense.

As to the point of therapy, it is important to address any misconceptions as the term covers both chemotherapy, psychological conversational therapy and others forms of interventions, which aims at increasing physical and/or mental wellbeing. In this dissertation, the use of *therapy* stems from the definition of Robot Assisted Therapy, and does not as such have traits common with the above definition, which covers the alleviation of illnesses as well as other forms of therapeutic actions. Instead used reluctantly but accurately to describe the process of facilitating conversation between the Participant and the Telenoid with the purpose of alleviating symptoms of dementia, increase verbal activity and in an attempt to improve quality of life.

In addition, the risk assessment of Telenoid, which is used in the import licences of the robot, describes Telenoid as a “*communications unit used for research purposes*” (Laustsen, 2013, p. 2). The risk assessment concludes that “*in respect to current laws and regulations, there are a number of potential risks which need to be addressed before Telenoid can be marketed in the European market. In respect to the monitored tests, there does not appear to be any significant risks to safety or health which will constitute danger to research participants, as staff is constantly monitoring Telenoid. Staff who monitor tests is trained in the use, handling and functions of Telenoid*” (Laustsen, 2013, p. 2).

Apart from the above, the care centre manager contacted the municipal legal representation who, verbally, argued that the above was correct and the municipality of Rebild saw the use of Telenoid like they do the use of professionally trained dogs who visit. Specifically, she noted that in the event of harm to anyone due to the use of Telenoid, SOSU Nord’s insurance must cover. In addition it was reaffirmed that participation must be approved by the care centre manager as well as by the Participant and the Participant’s family.

3.1.2.2 Process of approval and consent

While Telenoid and the use of Telenoid in the present context and use does not constitute *health science research* or the use of *medical technology* in the eyes of the law, there are aspects of the ethical practices and procedures, which I have adhered to when relevant, or in the case of informed consent, been legally bound.

After having planned and conducted the Pilot study under the assumption of not needing the approval from government bodies, I tested my reading of the legal aspects by addressing the regional committee on Health Science Research (Region Nordjylland, 2017) by following the then process of submitting a short summary application detailing the study setup, data collection and timeline which is found in Appendix B which also holds the template for informed consent.

I twice received notice from the board that the study had been reviewed and found not to be within the legal boundaries of a *health science research* and as such I was free to proceed. With the completion of these processes, the University had no other formal process of ethical approval as long as I adhered to good clinical practices.

I had already investigated the ISO standard on Good Clinical Practices (ISO, 2011) and its implementation into Danish law (Sundheds- og Ældreministeriet, 2013). While it neither applies to the present context, in that they govern experiments mainly with pharmaceuticals and issues of incompetence due to sponsored studies, I found some notions of transparency and protocol relevant and incorporated some of these into the present study.

With respect to informed consent by proxy given by family members I adhered to the Danish law on consent and informed consent within health science research (Sundheds- og Ældreministeriet, 1996) and the Regional Committee on Health Research Ethics standard forms on informed consent and the rights of participants in health science research (Region Nordjylland, 2012, 2014).

While all participants were legally normal adults and thus not declared incapable of managing their own affairs, I and (Alzheimer Europe, 2011b) found that given their inability to comprehend the extent of the information given to them in the information brochure and consent form, consent could not be obtained without a proxy. As such, and in line with the guidelines of the legal council of the municipality, I created a notice of informed consent, which stated the purpose and setup of the study as well as expected results, ethical concerns and action taken in the event of negative reaction on the part of the Participants. This was in addition to the legally required information of identification of the study, privacy and data storage, (non)payment and the ability to withdraw without repercussions, etc. The template of this consent form is found in Appendix B.

This document was presented to the family members of prospective Participants at a meeting at the care facility at which I demonstrated Telenoid, reviewed the research on it and similar robots, as well as answered question of use, setup, data collection and privacy. In the form, it is stated that video records would be anonymised in terms of name, but not voice, face or location. For this reason, participants and their family members appear here and elsewhere with pseudonyms, and with personal information such as vocations, locations or other information either replaced by something similar or made somewhat unspecific.

It was also made clear that the data could be used for educational purposes and dissemination at academic conferences. On this point there was some discussion with the family members, as we did not want to exclude participants due to this. As such we offered to draw up a second informed consent form, which prohibited any showing of video beyond strictly analytical purposes without separate preview of sequences and consent to specific use. This was rejected by all family members as they found the agreed upon consent form adequate, with the understanding that videos of Participants in compromising situations would not be needlessly shared or shown. This is not a part of the consent form, but something the team has both promised and stayed true to.

It was also specified that the consent covered the sharing of the Participant's facility records with the research team and that all personal information was stored in accordance with good clinical practice and legal requirements.

The actual consent forms are signed by husbands, daughters, sons, sisters and brothers of the Participants. All were provided with a signed copy, as well as a page detailing the specifics of the study and range of consent given. In addition to this proxy-consent we asked the Participant at the start of each session if they were interested in a conversation with Telenoid. Due to privacy concerns we asked before starting the recording, which in hindsight may have been wrong. Whenever a Participant refused we respected this, but on several occasions we found that when they would later see us walking around with Telenoid, the same refusing Participants would ask for Telenoid to come visit. On the occasions of Participants asking about the nature and reasoning of recording the sessions, we explained this in great detail. On one occasion, at the first session with a Participant of the Pilot study, this led to the Participant's immediate exclusion from the study as well as the destruction of all materials pertaining to him/her.

3.1.2.3 Ethical reflections on consent and working with persons with severe dementia

The purpose of this short but central section is to outline some of the pressing matters in working with persons with dementia. They are included here to highlight the need for ethical research practices, as well as a topic of general interest and relevance.

A tale of ethical issues

Based on the above characteristics of dementia and the symptoms influencing the interaction with persons with dementia, there are significant ethical considerations to be made before implementing Socially Assistive Robots in interaction with persons with cognitive disabilities such as dementia. This dissertation does not fully investigate the ethical aspects of applying Telenoid or other Functionally Designed Socially Assistive Robots in the domain of Health and Welfare or in interaction with elderly persons with dementia. I will however include some matters relevant to understanding the outlines of what constitutes normal interaction with persons with dementia as well as some ethical considerations of doing research and obtaining consent from this specific special needs group.

Due to the symptoms presented, and especially due to the symptom of hallucinations, dilemmas such as residents asking daily for their long dead spouse, occur regularly. I present this as an example of the ethical dilemmas facing both care staff and researchers using Socially Assistive Robots in the domain. The central question to this dissertation is that of deception and that of applying a white lie in service of the greater good. On the one hand, care staff must choose between being truthful to the Participant and thereby telling him, perhaps daily, that his spouse is dead. On the other, they can choose to apply the deceptive white lie and tell him that "*she is out shopping and will come back later*".

Reports from the care staff indicate that the choices are weighed in each situation and with the resident's personality taken into account, but nevertheless, deception is used regularly to *control the residents' emotions*. The choice is ethically justified from various positions, but in Denmark the Danish philosopher and theologian K.E. Løgstrup's 1956 book is a preferred citation (Løgstrup, 2010). In short, Løgstrup argues that by and through interaction, all humans have a responsibility towards each other as we influence each other's lives. This responsibility becomes ethical if we live our life according to ethics rooted in what he calls *Sovereign Expressions of Life*. These include *Benevolence, Openness of speech, Trust, Love and Compassion*. Interacting according to these will result in ethically justifiable actions. Applied to the present example, the care staff acts with e.g. *compassion* in protecting the welfare of the person with dementia, as he will not benefit from being reminded daily of the loss of his spouse. Conversely, the lie is not truthfully open speech, as we at the very least will use ambiguity in our responses so as to not present the truth outright.

In the present context of applying Socially Assistive Robots in the domain, we are faced with much the same dilemma, as we introduce a tele-operated robot to a person with severe dementia after having done extensive research on her and with several explicit purposes. On the one hand we could be truthful and explain the artificial nature of the setup, our knowledge and purposes, but as will become evident in the explications of interaction later on, this approach causes the deterioration of the relationship that forms. On the other hand, all or some of the information could be kept from the Participant, and thus a degree of artificiality is created, and some truth is kept from the Participant. From a research standpoint there is a good argument against revealing the true nature of the study to some participants, but this is not such a case.

Ethical standards

While Løgstrup is widely used in Danish healthcare, there are ethical standards and guidelines for both healthcare and dementia. The University of Aalborg Department of Communications and Psychology website has no local guidelines, but refers to overall National, International or Interest organisations' guidelines for *inspiration* (AAU, n.d.-a) as well as *upcoming guidelines* (AAU, n.d.-b). After having secured the above ethical approval I researched some the suggested sources from the AAU Department website and found most relevance in the *Danish Code of Conduct for Research Integrity* (Danmark & Uddannelses- og Forskningsministeriet, 2014, p. 6), which presents three overall principles: Honesty, Transparency and Accountability. It is with these in mind that the present dissertation often refers to transparency when presenting matters of e.g. self-citation as well as honesty in matters of structure. The precise text calls for integrity in all aspects of research as well as in the discovery of impropriety in other research. While relevant, these standards do not offer insights into how best to navigate informed consent from persons with dementia.

In addition and closer to the ethical issues at heart to this dissertation, (Alzheimer Europe, 2011a) poses both relevant notions of consent and research in general. In summary, it states that apart from the legal obligation to secure consent from a competent participant or their Proxy, there is an ethical motivation to do so as part of Good Clinical Practise.

Centrally, the report cites several authors in the overall argument that the steering notion for any research should be to allow persons with dementia *Self-determination* or *Autonomy* with regard to their participation. This is required by law in Denmark, as Participants in research must always be notified that their participation is voluntary and they will suffer no consequences from aborting the study (Region Nordjylland, 2012). This however is problematic when working with persons with dementia who by the symptoms of their illness are often hallucinating or incapable of correctly perceiving the world around them.

As such it falls to the study staff to observe these notions of self-determination in the situation and act according to what they believe the Participant would do if they could. As described in the below, this requires a great deal of what we might call emotional intelligence as well as the ability to correctly interpret whatever notions are communicated by the Participants. In addition to the knowledge about persons with dementia, this was a primary motivation for recruiting SOSU Nord staff with extensive experience with working with persons with severe dementia, as described below from page 77.

Ethical standpoint of this dissertation

With the above sections on ethics and law as well as the description of interaction with dementia and the tale of ethical issues, I found it prudent to summarise these and make the ethical standpoint of this dissertation clear.

The idea of securing consent solely from Participants with severe dementia for participation in studies such as the ones described in this dissertation is appalling to me. The notion is however legally justified even if the Participant is still deemed competent, and it is my opinion as well as the opinion of both (Alzheimer Europe, 2011b) and the staff, that the Participants are not capable of understanding the range and consequences of their actions.

Because of this, the relatives of Participants were extensively informed as to the nature and purpose of the study, and Participants were informed to the extent they are able to comprehend at the start of all sessions. In addition, legitimate questions to the setup and nature of the experiment were never answered with a lie. That being said, we adhered to the local procedure of not always telling the Participant the truth, when, for instance, they asked for long dead spouses. This middle ground was chosen to provide as much information as possible to Participants in the study, but not so much that it would encumber them in their already precarious state.

It is fair to argue that any authority claiming to protect the weak in their precarious state is merely enforcing their power, but I, the study staff, the healthcare professionals and the legal council at the municipality all agreed that this was a good plan of action. In addition, we were sometimes vague in our responses when a Participant would pose repeated questions to the nature of Telenoid. In severe cases, as is described in the later section detailing the interaction, we would simply abort the session with the understanding that if this happened again the Participant should be excluded.

The data recorded in connection with this dissertation has and will be stored securely and in accordance with good clinical practice until the review of this dissertation is complete. Pertaining to the informed consent form, video material may however be stored and used by SOSU Nord for educational purposes or in subsequent research under the same consent form as described in the original consent form.

3.1.3. THE TEAM AND THEIR ROLES

In the following, I will outline the competencies of the team, the roles they performed as well as challenges faced with each role.

3.1.3.1 The team

The purpose of this section is not to profile or publicise the team, but to provide a full picture of the competencies needed to conduct the study, as well as support a later argument of even more extensive experiences.

Jens Dinesen Strandbech



I am a Master of Science (MSc) in Information Architecture, and have studied interaction from a communications and humanities perspective during most of my time as a student. With no prior experiences in regard to persons with dementia and no formal or informal health-related education I allied myself with the team members from SOSU Nord presented below who all have first hand experiences with persons with dementia. In the project, I was the principal investigator and Project manager with principal responsibilities for the EU-funding that made the project possible. During the Pilot study I performed the role of Assistant, and during the Main study, I took the role of Observer, and was thus only on rare occasions present in the room when sessions were recorded.

Anna-Mette Nedergaard Boch



Anna-Mette has 13 years of practical experience as a Social and Healthcare Assistant working with geriatric care and elderly with dementia. In addition, she has completed several courses regarding persons with dementia and has worked for another 13 years as a teacher at SOSU Nord, with special emphasis on handling persons with dementia and non-pharmacological interventions. In the project, Anna-Mette was the sole Operator of Telenoid in all sessions in the Main study. Before this, she operated Telenoid in several sessions during the Pilot study. In addition, she served as healthcare professional advisor with respect to setup, measurements and planning throughout the study.

Birgitte Ryesgaard Larsen



Birgitte has more than 20 years of experience as a registered nurse working within the psychiatric field. She has several titles including a Diploma Programme in Psychology and has worked 9 years as a teacher focused on innovation and dementia. She performed the role of the Assistant for half the participants in both study conditions. In addition, she served as healthcare professional advisor with respect to setup, measurements and planning throughout the study.

Rikke Krogsgaard



Rikke is an Occupational Therapist and has 8 years of experience working with acquired brain injury within the psychiatric field focusing on personality disorders and interpersonal relations. For the last three years, she has worked as a teacher with focus on rehabilitation, welfare-technology, and psychiatry with focus on dementia. She performed the role of the Assistant for half the participants in both study conditions. In addition, she served as healthcare professional advisor with respect to setup, measurements and planning throughout the study.

3.1.3.2 The roles

Overall, there was no predetermined profile for the roles played in the study other than that which has been described briefly in the section regarding the study setup. This was to acknowledge that others should not define the relationship between two persons.

The Assistant

The function of the Assistant was to provide comfort and assist in maintaining a fluent conversation, as well as assist on technical issues in the event of malfunction during operation. It was our understanding that the role required first hand knowledge and experience on how to converse with persons with severe dementia and as such the expert competencies provided above were well suited. Frequently we saw Participants address the Assistant directly in brief conversations in between interactions with Telenoid, and in these instances we would try to redirect the attention of the Participant back towards Telenoid. As addressed in the analysis, this happened more or less on the Participants' own initiative more than by our involvement. As such, the interaction remained primarily a conversation between Telenoid and the Participant.

The Operator

The Function of the Operator was to operate Telenoid and solve the technical issues that arose. The Operator was placed in an adjacent room due to technical restraints, and thus her voice is sometimes noticeable. As mentioned above, this role carried some discomfort due to the echo-effect of the information transmission to and from Telenoid, and thus in itself required a good deal of practice.

3.1.4. THE TELENOID

While one may argue that Telenoid performs a role in the interactions that are the focus of this dissertation, Telenoid remains an artefact. As such, I have dedicated a separate section to the robot with the purpose of providing a description of Telenoid's appearance and presence, and to provide insights into the operation of the robot. I have chosen to largely omit the finer technical points regarding the software, as it is frankly beyond me, and irrelevant to our purposes.

The Telenoid robot was first developed in 2010 as a joint venture between the Hiroshi Ishiguro Laboratories at the Advanced Telecommunications Research Institute International (ATR) (Geminoid.jp, 2015) and the Intelligent Robotics Laboratory (Ishiguro Lab) at Osaka University (Osaka-u.ac.jp, 2016).

This collaboration has since seen the development of six iterations of the robot, making the robot lighter, improving functionality and adjusting the appearance toward the indented *minimal human appearance* that is the design purpose of the robot, and viewed as an opposite to the hyper-realistic Geminoid-series by the same joint venture.



Image 16: The Telenoid and a Participant in a previous study

The robot used in this study is version R3b and in the last weeks of the study R4. As mentioned in the previous overview of robots in the review, the Telenoids used are 50 cm tall, completely white, have no legs, bodily or facial features, and thus consist primarily of a white torso with 15 cm long arm-stumps and a head. The only realistic feature of the robot is the eyes that are truly hyper-realistic.



Image 17: Telenoid R3b

Telenoid is equipped with one actuator in its shoulders and mouth and three in the neck. As Telenoid is tele-operated, it cannot do anything on its own and thus requires that an Operator continuously transmits movements of his or her neck as well as voice, which is then processed by the Control PC and enacted by Telenoid. The Voice may be modulated by software on the Control PC, although we did not do this. The movement of the shoulder allows for a simplified but rather effective hug, by moving the arms horizontally forward while the command is given, and

then returning the arms to their natural position afterwards. The simplified face allows for some movement of the mouth, and although the eyes are able to move automatically with two degrees of freedom this was not used.

3.1.4.1 Pulling the strings

As hinted at in the above, Telenoid is controlled by the Operator using the Operator PC. Connected to this PC is a headset with an accelerometer attached. With this mounted on the head of the Operator, the movements of the head and actual voice is recorded and transmitted to Telenoid.

In Telenoid, there are two BeagleBone mini-computers that hold some of the core software of the robot and connect to the Operator PC by connecting to a dedicated Wi-Fi hotspot or Ethernet cable. Using Wi-Fi, the experienced range of Telenoid is some 20 meters, but is reduced by obstacles such as walls. Using Ethernet cables between the hotspot and the Wi-Fi router obviously extends the range greatly and will minimise the delay of information transmission. Telenoid is controllable using a global IP, which would mean that any Telenoid could be remotely controlled by inputting the correct IP address in the control software, or, in some future scenario, a web browser. This would however yield a delay in information transmission due to distance and routing of the information. The software solution is currently possible, but the functionality was not used due to the lack of security measures in the software and a comparatively unstable connection when using the global IP.

It should be noted that in the later Telenoid R4, an HD-video camera has been added in the forehead of the robot after my initial findings were collected and added to the experiences of the staff at ATR. This version was used during the last weeks of the study, but due to technical limitations, it was not possible to record the video-streams. As such, in the data accompanying this dissertation, you may notice the camera lens in the form of a 5 cm black spot in the forehead of the Telenoid. The camera allows the Operator to not only be aware of the situational context, but also the direction of Telenoid's head and supports the ease of interaction between persons and makes it easier for Operators to relate to their distant interlocutors and vice versa. While the placement is obvious, it does not seem to bother persons with dementia beyond the initial interest.

3.1.4.2 Challenges faced with Telenoid

In the studies and from general use of Telenoid, the team and I have identified some central challenges that influenced the use and operation of the robot. These are not meant as improvement points per se, but as a further description of the operation of the robot. Unfortunately, the information sent between Telenoid and the Operator PC is greatly influenced by a time-delay. This delay relates to the setup location and software and is not something that can be directly controlled.

In the below table I have presented the different forms of information that is being transmitted and the approximate delay. This delay is not timed, and varies from time to time.

Direction	Nature	Information Type	Description
From Operator to Telenoid	Distortion	Voice	Metallic sounds with occasional sudden high volume increase
	Delay	Voice	2-4 seconds delay
	Delay	Movement	0-1 second delay
From Telenoid to Operator	Distortion	Location Audio	Near constant fast paced ticking sounds in low to moderate volume
	Delay	Location Audio	0-1 second delay
	Delay	Video (version R4 only)	0-1 second delay

Table 5: Overview of information transmission issues experienced with Telenoid R3b and R4

In essence, the Operator's voice is delayed asynchronous to the delay of Location Audio which results in the Operator hearing a constant echo of his or her own voice, in addition to the near constant fast paced ticking sounds in low to moderate volume and movements being delayed as well. This makes operating Telenoid in small groups of low verbal activity such as the present setting quite hard and something that requires training and practice. In larger groups or in settings with e.g. persons that have a below normal or normal level of verbal activity, or where ambient noise is present, the chances of successfully conducting a session are slim, even with trained and experienced staff.

Despite this, the Operation of Telenoid is quite easy, and once the initial setup is in place, the system can be set up almost anywhere. There were however persistent issues with Wi-Fi connectivity in version R3b as well as sensor malfunctions, which occasionally resulted in consistent delay on Voice or Movement well above 10 seconds. This issue resulted in frequent restarts, which would often resolve the issue. When taking into account that the study called for sessions to be conducted in participant's own apartments, the issues faced with version R3b are too complex and persistent for practical implementation. They are improved in version R4, but remain a heavy influence and hindrance for practical implementation of Telenoid in the domain of Health and Welfare.

3.2. PILOT STUDY

As mentioned above, the Pilot study tested Telenoid *in the field*, with the aim of providing initial knowledge and insights into the interaction between Telenoid and persons with severe dementia.

With the overall study setup as presented in the above on page 66, on-site healthcare professionals with knowledge of both the residents and dementia chose six Participants based on their expressed symptoms of dementia and my explanation of the study as well as written informed consent forms explaining the study. As mentioned above, consent was given verbally from participants for each session, and a written informed consent was given prior to the study by the head of the facility, municipal authorities as well as the guardians for each participant. All Participants were diagnosed with some form of dementia in either moderate or severe form. Two participants were removed from the study after the first session as one fell ill during the study and another showed clear discomfort regarding the camera equipment and her privacy, despite having given verbal consent just prior to setting up. The conversations were spread out over five weeks with an average of 4,75 conversations with each Participant. Each conversation was held in the Participant's apartment living room at the eldercare facility.

3.2.1. METHODS AND FINDINGS

In addition to the video recordings, the staff charted the mood of the Participants every half hour for all weeks in preformatted categories of e.g. *Awake, Calm, Restless/Wandering, Angry/Violent*. This was supplemented by short informal descriptions of the Participant's mood and times of significant interest aimed at providing a format for the staff to share their observations of changed behaviour in a non-formal but usable fashion. None of the data obtained has been analysed in detail, but from recurring discussions during and after the sessions and study as a whole, the following points of interest were found.

3.2.1.1 Alleviation of selected symptoms of dementia

Both the Study and on-site healthcare staff found strong indications of changes in behaviour. Specifically it was reported that all participants showed a decrease in stressful behaviour and were, in general, more relaxed and engaged in conversations after interactions with Telenoid. This effect was perceived by on site staff to span from anywhere from hours to two days. There were however no discernable patterns as to for which Participants interactions had the most effect, as some interaction would some days yield very positive results that lasted for days, and other times the same Participant would regress into his or her normal reclusive state after just a few hours.

3.2.1.2 Initial response

The immediate first-time reaction from many Participants was disgust. We saw several cases of Participants moving away from the robot, and even more cases where Participants would completely ignore the presence of the Telenoid, despite it being placed very near them and in their line of sight, or on their knees and accompanied by friendly gestures and remarks by the Assistant.

We have, however, over the course of the sessions, identified several cases of recognition, where Participants were able to recognise the Telenoid and Assistant, but unable to answer as to from where. In addition, the same Participants with the immediate reaction of disgust would, after several visits, pick Telenoid from the arms of the staff and lift it so the forehead of the robot aligned with their own foreheads; holding the Telenoid like this for several seconds and verbally greeting it in either a very low and pleasant voice or in laughter as seen below.



Image 18: Elderly woman with severe dementia seeing Telenoid several days after her previous session.

In one instance, three weeks after the conclusion of the Pilot study, a participant rose from her chair and walked briskly toward me, as I was entering the common room with Telenoid on my arm. Surprisingly, and without recognising or acknowledging me, she took Telenoid from my arms and sat down in a sofa by herself and began talking to Telenoid who was not turned on at the time.

3.2.1.3 Regaining verbal skills

One female Participant who wore a hearing aid and was wheelchair bound had, prior to our visit, not been verbally active for approximately four years. During our studies, but outside of videotaping, she has on at least two occasions provided staff with relevant answers to simple Yes/no questions. As she was verbally inactive, we did not perform conversations as such, but would, without actively encouraging her, initiate conversation with her and ask simple questions or make casual off-topic conversation regarding the weather, items in her apartment or daily activities.

From the video as well as descriptions of conversations and comments from staff we concluded that several of the Participants showed an increase in willingness to engage in conversation as well as in vocabulary and general verbal activity during and after sessions. As such, Participants grew more talkative and used a variety of words that neither staff nor we had heard before.

3.2.1.4 Responses from non-participants

Over the course of the study, relatives of non-Participants contacted us with hopes of entering their spouse or parent into the study as they had witnessed a changed behaviour in Participants that they would seek in their own relative. This changed behaviour was always described as *“for the better”*, in terms of a now social and verbally active person whose mood was now less melancholic, but formal documentation was not collected.

3.2.2. INDICATIONS FROM THE PILOT STUDY

From this Pilot study, we found that there are some indications that interactions with Telenoid can alleviate symptoms of dementia. Specifically, we found that Participants, while perhaps initially frightened, regained a dormant vocabulary and willingness to engage in conversation and social interaction after interactions with Telenoid.

However, we are unsure if these effects are a result of interacting with the Telenoid, or a result of her simply being surrounded by more words than previously. This is a somewhat crucial point in general, as there is little evidence that it is the engagement of conversation with Telenoid, and not just conversation in general that is the determining factor for the results. As argued, we found that for those persons reluctant to engage in conversations with others, Telenoid could be seen as a conversational stepping-stone. In this role, Telenoid can serve as a short-term training-technology with which these persons can engage and thereby improve dormant conversational abilities. As a conversational stepping-stone Telenoid's function is not permanent and should therefore be removed when the user is able to engage and seeks social interaction by herself.

It was also found that while Participants were presumed to not remember Telenoid, at least in one unique experience, several weeks later, she did. In general, it was found that Participants, during the study, would not remember the Assistant, but Telenoid itself was remembered and associated with positive feelings, as participants smiled and often remarked enthusiastically along the lines of “*now we’re supposed to talk, right?*”.

The duration of the sessions was found to be too long, as participants would grow tired and sometimes lose focus to the point of falling asleep without warning. A consensus of 2-3 sessions of 15-20 minutes was formed, based on experiences from the study and input from ATR researchers.

In addition, it was found that the staff setting up the study and controlling Telenoid should have at least an intermediate level of competence in doing so, and an expert level in engaging with persons with dementia, prior to the study. While the staff in this study had this expert level of competence, they did not have intermediate competencies regarding Telenoid, which contributed to initial frustration. It was also found that changing the Operator from session to sessions is not a positive contribution and should be avoided. It did not directly contribute negatively, but knowledge about reactions to conversational subjects was crucial so as to not touch upon negative emotions or memories unknowingly.

The collection of daily feedback regarding the mood and activity of participants did not provide any meaningful information in regard to the study, and the method was abandoned. It became clear that a variety of methods of investigating the development of the participant’s life would be needed in the Main study.

3.3. MAIN STUDY

Based on the Pilot study and subsequent research that was later formulated, re-focused and re-done as presented in the presentation of the review in section 2.3 from page 36, I formulated the below Main study that will serve as the primary study in this dissertation.

As mentioned above, and with the addition of the Pilot study, there is still no stable scientific core of established methods that could be used as a frame of reference with which to compare results. As such, the study presented here is extremely exploratory, drawing on a multitude of data collection formats and methods.

3.3.1. MAIN STUDY OVERVIEW

“In an effort to investigate the perception of Functionally Designed Socially Assistive Humanoid Robots in conversation with persons with dementia, we conducted a series of studies at a dementia-care facility in North Jutland, Denmark. The care-facility has three units, each housing ten elderly citizens with either strong indications or a diagnosis of moderate-severe or severe dementia. The study focused on identifying positive and negative effects of conversing with Telenoid.

To this end, the ten participants were divided into two groups, and invited to two personal sessions of 15-20 minutes per week with either Telenoid or a human. The Human-group was established to form a baseline comparison to Telenoid-conversations, and measure the effects of conversations in general. It should be noted that the entire team behind the study maintain that comparing participant- or diagnosis-results to other participants or diagnosis is at best problematic and subject to uncertainty. This entails that the effects and progression observed in one participant is hardly applicable to any other persons, even with similar diagnosis, progression, etc.

This [conversations] was done for a period of five weeks and following this, there was a four-week pause with no conversations, and then a two-week period with conversations following the previous pattern. While some Participants declined conversations some days, eight of ten Participants completed two conversations per week. With very few exceptions, all sessions were held in the comfort of the participant’s own apartment” (Strandbech, 2015, pp. 10–11).

Activity	Running week													
	-2 & -1	0	1	2	3	4	5	6	7	8	9 & 10	11 & 12	13 & 14	
Daily Questions														
Pre-test														
Intervention														
Post-test														
Exit-Interview														

Table 6: Timeline displaying running weeks of the Main study with activities

Initially, the setup was planned as an eight week study that was to be concluded with appropriate post-test and exit-interview as seen in week six. Due to extra funding, the study could be extended, so as to possibly measure the effects after four weeks without interaction. During the study, a variety of data was collected, as seen in the below table. These will be described in greater detail in the below section 3.3.3 from page 90. It was planned and approved to outfit participants with Galvanic Skin Response (GSR) readers, but this was abandoned due to availability issues just prior to the start of the study.

Action	Data collected
Daily Questions	Daily NPI-HN overview questions
Pre and Post test	Full NPI-HN screening, Mini Mental State Evaluation, The Barthel Index, Observed Emotional Rating Scale.
Intervention	Two weekly sessions, 15-20 minutes of video recorded for each
Exit-interview	Interview with staff

Table 7: Overview of research-actions and data collection

3.3.2. PARTICIPANTS OVERVIEW

Of the 26 citizens living at the facility at the time of the study, ten were deemed relevant for conversational activities by staff, as some were either too cognitively impaired, too physically ill, or seemed to show no interest in Telenoid. Participants were also selected based on the diversity of symptoms found by staff. As such, this explorative study focused on providing width in participant profiles, rather than a narrow participant profile.

As seen in the table below, the participants have a broad variety of dementia diagnoses, but all were assessed as having moderate-severe or severe stage dementia.

Name	Diagnosis	Group	Age
<i>Alice</i>	Unknown Mix	Mix	81
Benny	Unknown Mix	Telenoid	75
<i>Ethel</i>	Alzheimer's	Telenoid	89
<i>Ingrid</i>	Alzheimer's	Telenoid	83
<i>Isabella</i>	Vascular	Telenoid	93
<i>Beatrice</i>	Vascular	Mix	88
<i>Henry</i>	Vascular	Human	89
<i>Joan</i>	Alzheimer's or Vascular	Human	90
<i>Margret</i>	Alzheimer's	Human	82
<i>Maureen</i>	Unknown Mix	Human	86

Table 8: Anonymised participant overview

Participant age ranged from 75 years to 93, and averaged at 85,6 years. Two participants switched group, marked as Mix in the above table, as one participant in the human-group repeatedly wished to interact with Telenoid, and one showed signs of discomfort when interacting with the robot. With eight females and two males, the population reflects the gender distribution at the test-facility.

3.3.3. OVERVIEW OF COLLECTED DATA

The Main study collected a multitude of different data with respect to the alleviation of symptoms of dementia. The purpose of this section is therefore to provide an overview of the collected data by describing the methods and metrics and by providing examples. Further data contains personal information and is therefore not offered here, but is offered encrypted to the committee.

3.3.3.1 Video-recordings

We used several cameras to record the interaction, so as to preserve a detailed record for further analysis. The recordings from the two or three cameras were synchronised, and video ID, camera identifier and time-code were added for detailed identification as seen in the below example. The video ID is coded using a Participant alias, session number, date and running time code with a 25-frame identifier as the last two digits. Using this formula, we can identify this screenshot as being from Ethel's 1st session on January 6th, at index 4:21, frame 12. Using the camera identifiers we can investigate and direct attention to the unfolding interaction using the camera identifiers A, B and C.

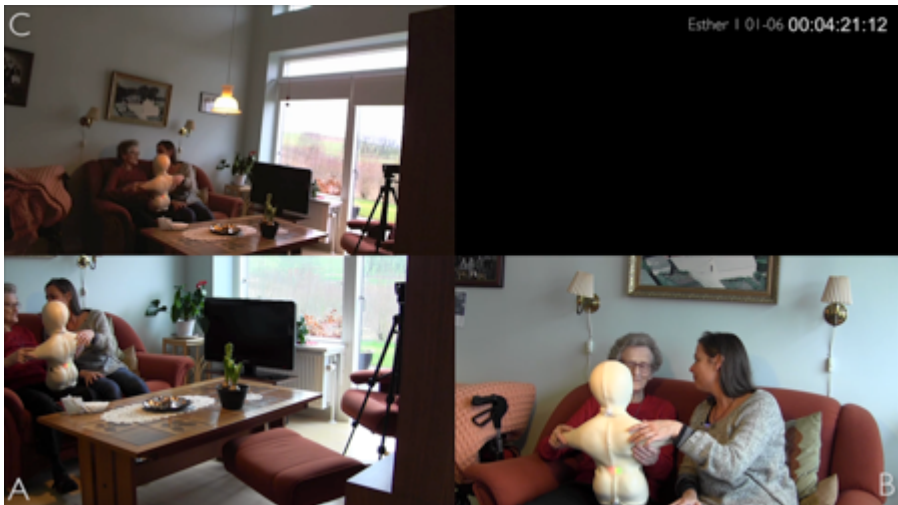


Image 19: Still images from recorded video (Ethel 1, 4:21:12)

3.3.3.2 Session log

At the end of every day the Assistant or Operator would discuss each session and divide the session between them for a preliminary review (Heath, Hindmarsh, & Luff, 2010, p. 61) with the purpose of noting observations, thoughts and general notes. To this end, I created a standardised document with a template that

emphasised free-form notes and a section for each of the primary symptoms of dementia, the so-called *Five A's*: *Apathy, Aphasia, Apraxia, Agnosia* and *Amnesia*, as described in Table 2 on page 33. Each *Study Journal* contained information on the Participant regarding his or her condition and life in general. This was incorporated by merging facility records, comments and stories from carers and relatives, as well as team members. This method allowed the team to structure general observations and notes on the interaction, as well as notes on the specific primary symptoms found in persons with dementia. This tool proved extremely useful, not only for noting down observations and interpretations, but also to provide a long term detailed view of the progression of symptoms due to the frequency of two sessions/logs per week.

3.3.3.3 Video Log

As described above, the study includes a non-intervention period after four weeks. With inspiration from (Jordan & Henderson, 1995, p. 43) we analysed a number of the recorded videos and paired them with the collected data at the time, as well as the Session Logs in Group Sessions. This was to kick-start the examination of the data and to provide multiple views on the data, and resulted in discussions and rough transcriptions of the individual sessions.

3.3.3.4 Neuropsychiatric Inventory Nursing Home Version (NPI-NH)

Two weeks before the first conversation and two weeks after the last, we administered the NPI-HN, providing an assessment of Psychopathology in Patients with Dementia Residing in Nursing Homes. The exact schema is summarily described here and can be found in (Cummings, 2009, p. 20). The NPI-HN was “*developed to help characterize the neuropsychiatric symptoms and psychopathology of patients with Alzheimer’s disease and other dementias*” (Cummings, 2009, p. 1) and does this by interviewing staff with intimate knowledge about the subject, on the 12 different symptoms and behaviours listed below with an extract of their respective initial screening question: After each of the initial screening questions, a series of sub-questions is posed if the symptom is found present. These detail the type and details of the symptom present. The symptom is then rated in terms of frequency on a scale from 1 to 4, Severity on a scale of 1-3 and Occupational Disruptiveness on a score of 0-5, with high scores indicating more frequent, severe and disruptive symptoms. Leaving the symptoms of Sleeping and Eating aside as supporting the other symptoms, the remaining scores are then calculated by multiplying the Frequency and Severity-scores for each symptom gives a result of 0-12 and a combined NPI-NH score of 0-120. The Occupational Disruptiveness score is multiplied, providing a score of 0-50.

As such, the tool provides a quantifiable number for each symptom and a final score that is then comparable. On further examination of the data, if the test is administered multiple times, such as in this case, you are able to pinpoint the exact development within each symptom based on the responses of each sub-question.

In an effort to observe the development of the symptoms in participants over time, a sheet with all screening-questions was given to the staff to answer daily for all participants. Instead of a Yes/No answer, the staff was asked to rate each on a scale from 0 to 5, with 0 being *none* and 5 *Very much*. It was hoped that the results could be collected often enough to provide a clear indication of development over time and serve as an indication of reliability when comparing the two full NPI-HN evaluations. Sadly, staff did however not perform the task sufficiently and results are collected so sparsely that they will not be included in this dissertation.

Aspect	Screening question
Delusion	Does the resident have beliefs that you know are not true? For example saying that people are trying to harm him/her or steal from him/her. Has he/she said that family members or staff are not who they say they are or that his/her spouse is having an affair? Has the resident had any unusual beliefs?
Hallucinations	Does the resident have hallucinations – meaning does he/she see, hear, or experience things that are not present?
Agitation / Aggression	Does the resident have periods when he/she refuses to let people help him/her? Is he/she hard to handle?
Depression / Dysphoria	Does the resident seem sad or depressed? Does the resident cry at times?
Anxiety	Is the resident very nervous, worried or frightened for no reason? Does he/she seem very tense or unable to relax?
Elation / Euphoria	Does the resident seem too cheerful or too happy for no reason, for example, laughing at things that others do not find funny?
Apathy / Indifference	Does the resident sit quietly without paying attention to things going on around him/her? Has he/she lost interest in doing things or lack motivation for participating in activities?
Disinhibition	Does the resident do or say things that are not usually done or said in public? Does he/she act impulsively without thinking?
Irritability / Lability	Does the resident get easily irritated or disturbed? Are his/her moods very changeable?
Aberrant motor behavior	Does the resident have repetitive activities or <i>habits</i> that he/she performs over and over such as pacing, wheeling back and forth, picking at things or winding string?
Sleep & nighttime behavior disorder	Does the resident have difficulty sleeping? Is the resident awake, wander? Does he/she get dressed at night?
Appetite and eating changes	Does the resident have an extremely good or poor appetite, changes in weight or unusual eating habits?

Table 9: NPI-HN Screening questions overview

Example of NPI-HH

As an example I refer to Ethel's evaluation. Her scores seen in the bottom row suggest that she does not have many symptoms, and that these symptoms are not very disruptive to the staff's work.

However, as I will note in the analysis of her development during the study, a central point is her becoming a remarkably more active resident at the care facility. From spending almost all of her time alone in her apartment, she began and continued to seek out and engage in social interactions as well as continue social interactions instead of e.g. leaving abruptly during mealtime. As such, the increase in NPI-NH score could easily be attributed to the staff engaging more with her and thus becoming more aware of symptoms that were present all along, but hidden from view. It should be noted that the NPI score-method is not without problems. Staff might see the presence of all eight sub-questions with regard to Aggression, but deem these *mildly* in severity and to appear *rarely* which would yield a score of 1/12 for Aggression. Conversely, a score with just one sub-question being present *sometimes* would yield a score for the symptom of 2/12. If we compare the scores, they are not very different, but in the life of the resident, a life with a symptom being present in eight different ways, compared to one, is very different. As such, in my view, it is important to not only rely on the quantitative data that NPI provides, but investigate the precise development in responses to sub-questions. In addition, there is the issue of rate bias, as the data is based on an interview with staff and not the actual resident. When collecting the data, we interviewed two or more staff-members where at least one served as the Participant's primary contact-person. This standard protocol at Danish eldercare-facilities ensures that all residents are observed closely by at least two members of staff, and that relatives, researchers and external medical staff have a primary contact-person for each resident.

Symptom	Date: 15/12				Date: 9/2			
	(F)requency	(S)everity	Score (F*S)	Occupational Disruptiveness	(F)requency	(S)everity	Score (F*S)	Occupational Disruptiveness
<i>A. Delusion</i>	0	0	0	0	0	0	0	0
<i>B. Hallucinations</i>	0	0	0	0	0	0	0	0
<i>C. Agitation / Aggression</i>	3	2	6	2	3	2	6	3
<i>D. Depression / Dysphoria</i>	0	0	0	0	0	0	0	0
<i>E. Anxiety</i>	3	2	6	4	0	0	0	0
<i>F. Elation / Euphoria</i>	0	0	0	0	0	0	0	0
<i>G. Apathy / Indifference</i>	0	0	0	0	0	0	0	0
<i>H. Disinhibition</i>	0	0	0	0	1	1	1	0
<i>I. Irritability / Lability</i>	3	2	6	4	3	3	9	1
<i>J. Aberrant motor behavior</i>	0	0	0	0	3	2	6	1
Total Score	<u>18/120</u>			<u>10</u> <u>/50</u>	<u>22/120</u>			<u>5</u> <u>/50</u>

Table 10: NPI-HN Overview for Ethel, without sleep and eating behaviour.

3.3.3.5 Mini Mental State Evaluation

The MMSE tool is widely used internationally in dementia-evaluation and has, at least in a Danish context, achieved the status of standard-tool for evaluating memory abilities (Folstein, Folstein, & McHugh, 1975). The MMSE was administered by team-members two weeks before the first conversation and two weeks after the last. The test is comprised of a series of tasks such as e.g. identifying the present year, month or place, understanding a simple three level instruction or repeat a simple sentence. The result is a view of specific areas affected such as e.g. *Language, Praxis and Construction* or *Orientation* with a score of each, and an overall score of 0-30, where 30 is given if all tasks are completed adequately.

Example of Mini Mental State Evaluation

As an example of the MMSE, I refer to Benny's actual data. Here we see an initial score of 6/30, which improves to 13/30. Specifically, we see a three-point improvement in the Language-subsection from 1 to 4/7 and a one-point improvement in the Orientation section, as well as the Registration-section.

By analysing his data this way, the most notable development is in Language, which is interesting seen as Telenoid-intervention is a conversation-based approach. The one-point improvement in Orientation is due to Benny now correctly repeating Date and Weekday, but failing to identify Year, Season or Month. Interestingly, Benny's single point in the pre-test was due to him identifying the Season. As for Registration, using three tries, Benny was now able to correctly name two of the three objects presented to him only seconds before, as opposed to one in the pre-test. In the Language-section, the increase in points is due to Benny identifying two objects without prior presentation, and following two parts of the three-part instruction "*Take this piece of paper in your right hand, fold it at the middle, and place it on the floor*".

Applying the MMSE is not without its issues. Overall, MMSE should be used as it is intended – A mini-examination that therefore is indicative for further investigations. With that premise, the development from 6/30 to 13/30, and the development within the Language-subsection, is notable and warrants further study.

Task	Date 15/12	Date 11/2	Change/note
Orientation			
- Time	1	2	Not significant
- Geography	1	1	
Registration			
- Repeat three items	1	2	Improvement
- Number of attempts before success	3	3	Three allowed
Attention and math			
- Subtract 7 from 100. Repeat five times	2	2	
Recall			
- Recall the three items from before	0	2	Improvement
Language			
- Name two objects	1	2	Significant improvement from 1/7 to 4/7.
- Repeat sentence	0	0	
- Follow instructions	0	2	
- Read sentence	0	0	
Write a sentence			
- Write a sentence	0	0	
Drawing			
- Repeat drawing	0	0	
Overall improvement from 6/30 to 13/30.			

Table 11: MMSE overview for Benny

3.3.3.6 The Barthel Index

In an effort to measure physical capacities, The Barthel Index was administered before and after the sessions (Mahoney & Barthel, 1965). Here, a series of questions are answered by the staff in regard to how much help the participant needs to complete tasks of e.g. eating, personal grooming, walking. The result is a score of 0-100, with no points given for *Totally dependant* or *Unable*, low scores for *Major help*, medium for *Minor help* and high scores for *No help* or *independent*. In our case, the last question of stairs is void, as there are no stairs present at the care-facility. As such, the maximum score is 90 points.

From Benny's Barthel index, we see an overall low score of 45/90, decreasing to 35/90. This is probably due to Benny falling during the test-period and receiving care at a hospital for several days. Staff reports that Benny's mood changed and physical activity was visibly painful for him, despite medication. As such, it is no surprise that his scores in this aspect is decreasing. Overall, the Barthel Index did not provide much usable data for our present purposes, as in Benny's case, there was outside influence that skewed the possible effect of the intervention. As a tool for evaluating the momentary physical performance of an individual the Barthel is no doubt a good tool, but for our present purposes it proved irrelevant.

Example of The Barthel Index

Task	15/12	11/2	Change/Note
Feeding	5	5	
Bathing	0	0	
Grooming	5	0	Decrease
Dressing	5	5	
Bowels	5	5	
Bladder	0	0	
Toilet use	5	0	Decrease
Transfer	10	5	Decrease
Mobility	15	15	
Stairs	X	X	Voided- No stairs
Decrease from 45/90 to 35/90.			

Table 12: Barthel Index overview for Benny

3.3.3.7 Observed Emotional Rating Scale

In an effort to measure the mood of participants more generally, we administered the Observed Emotional Rating Scale (OERS), to form an idea of the changes in mood over time (Lawton, Van Haitsma, & Klapper, 1999). With this tool, staff reports the overall mood of participants for that last two-week period on a scale from one to five, with regard to Happiness, Anger, Nervousness/Fear, Sorrow and Alertness. For our purposes, the staff was asked to provide a summary of how the participants' mood was over the last 14 days. This is not in line with the OERS-format, as the tool is developed with a 10-minute direct observation in mind. We found that for our purposes, this would not provide useable insight into the mood-state of the participants, and thus the format was changed to include a wider time-frame.

Example of Observed Emotional Rating Scale

In Ethel's case, the OERS showed a decrease in Fear, but an increase in sadness and General Alertness. As mentioned before, this might be due to her becoming more socially active and thus staff becoming more observant on her behaviour and demeanour.

Element	12/12	11/2	Change/Note
Pleasure	5	5	
Anger	3	3	
Anxiety / Fear	1	0	Decrease
Sadness	1	3	Increase
General Alertness	4	5	Increase

1: Never, 2: Very rarely, 3: Rarely, 4: Often, 5: Very often, X: No response

Table 13: OERS overview for Ethel

The OERS, as the Barthel Index and the MMSE, is best used as a starting-point for evaluating the participant's life in the aspect that each tool focuses on. The use of OERS was experimental at best and as expected proved to be mostly irrelevant due to its simplicity and the influence of external factors during the long timeframe.

3.3.4. SUMMARY OF COLLECTED DATA

This section has provided an overview of the body of quadata collected during the study. As mentioned, the video serves at the primary data source, which is supported by the session and video logs, as well as the quantitative methods.

In regard to the use of NPI-NH, MMSE, Barthel Index and OERS, the intention was to provide data that would support the video-data that would serve as the primary data-source. After collecting the data and performing a rough analysis of the data, I've found that this assumption was correct and as such the collected secondary data is not something I would base a conclusion on exclusively. The data does however collectively provide insights into many relevant aspects of the participant's life, and will thus be included in the dissertation when relevant.

CHAPTER 4. ANALYTICAL APPROACH

The purpose of this chapter is to present the established methods for analysing the specific setting of elderly persons with dementia in interaction with Socially Assistive Robots, as well as presenting the methodological path chosen in this dissertation.

Drawing from the review in section 2.3, I will initially present the methods used for analysing interaction between persons with dementia and Socially Assistive Robots within the domain of Health and Welfare.

Secondly, I will present a section titled ‘Methodological explorations And reflections’. Here, I outline my initial considerations regarding different methodologies and theories, before settling on Grounded Theory.

Lastly, I will present my methodological approach to the analysis of this setting, which is inspired by the Constructivist Grounded Theory Method. Here, I outline core definitions as well as my own application of the method and some criteria for evaluation.

4.1. METHODS USED IN HUMAN-ROBOT-INTERACTION-RESEARCH IN THE DOMAIN OF ELDERLY PERSONS WITH DEMENTIA

To borrow an expression from Ernst Schaube, the purpose of this dissertation and its studies is to *torture the Telenoid until it confesses its secrets* (Schraube, 2005, p. 1). To this end, we must choose the proper tools for the task and in the absence of universally recognised methods; we must investigate what tools have been applied previously, and with what effect.

As seen from section 2.3 from page 36 where I review the use of humanoid and zoomorphic robots in the domain of Health and Welfare, there is no universally, widely or indeed sporadically agreed upon method.

Referring to the elements presented in the review from page 36, there are 23 elements in this domain. From these I offer the following examples of theories applied, ordered according to methodological tradition in the table below.

Overview of the relationship between Qualitative and Quantitative methods and analyses

		Analysis performed		
		Qualitative	Quantitative	Mixed
Method employed	Qualitative	(Marti et al., 2006; Moyle, Jones, et al., 2013; R. Yamazaki, Nishio, Ogawa, et al., 2012)	(Kramer et al., 2009; Libin & Cohen-Mansfield, 2004; Sabanovic et al., 2013)	(Chang et al., 2013)
	Quantitative		(Bemelmans et al., 2015; Joranson et al., 2015; Kimura, Miura, Murata, Yokoyama, & Naganuma, 2010; Moyle, Cooke, et al., 2013; Sakairi, 2004; Takanori Shibata, Wada, Ikeda, & Sabanovic, 2009; Tapus et al., 2009; Valentí Soler et al., 2015; Wada et al., 2009, 2005)	
	Mixed	(Kidd et al., 2006)		(Gustafsson et al., 2015; Marx et al., 2010; Robinson et al., 2013; Wada & Shibata, 2008; Yamazaki et al., 2014)

Table 14: Overview of the relationship between Qualitative and Quantitative methods and analyses.

4.1.1. QUALITATIVE METHODS LEADING TO QUANTITATIVE ANALYSES

While there are examples of qualitative approaches using especially video, these elements often utilise video-data as a means of creating quantitative data by e.g. counting instances of specific movements such as *touching*. The process varies from element to element depending on the purpose, but is exemplified in (Sabanovic et al., 2013) or the following quote from (Kramer et al., 2009, p. 46) “... [video recordings] were later analyzed to identify types of behaviors that occurred during visits. The [participant] engaging in the behavior and the social object (person, dog or AIBO) at which the behavior was directed were counted in accordance with a standardized rubric developed by [the authors] for the task. Behaviors were described, not interpreted...”. From the following statistical analysis it is clear that while the authors are collecting qualitative data they cannot be said to be performing a qualitative analysis of the interaction. In addition, it should be noted that we here see one of several examples of authors developing methods for analysing their data, contributing to the lack of standardised methods in general.

4.1.2. QUALITATIVE METHODS LEADING TO QUALITATIVE ANALYSES

In (R. Yamazaki, Nishio, Ogawa, et al., 2012) video-recordings were obtained and investigated in terms of positive or negative *narratives* and overall impression but these unstructured and short-term observations are not rigorously analysed further. (Marti et al., 2006) reports on the *development* of a study protocol aimed at increasing social interaction, using rich descriptions of interaction, based on direct as well as video observation. The study uses quantitative MMSE scores to ascertain the level of dementia in participants, but does not use these to support analysis. On a more general level, (Moyle, Jones, et al., 2013) use unstructured observations to primarily inform future cooperation between robotics developers and end-users.

4.1.3. QUANTITATIVE METHODS LEADING TO QUANTITATIVE ANALYSES

As mentioned, the use of quantitative methods leading to quantitative data is the most predominant correlation in this domain. Examples include (Kimura et al., 2010), which uses EEG to analyse neurological activity, and (Bemelmans et al., 2015) using specialised scales to evaluate *mood* and *goal attainment* as well as (Joranson et al., 2015; Moyle, Cooke, et al., 2013; Valentí Soler et al., 2015), which all employ several but different quantitative methods to evaluate a multitude of aspects and their interrelation. (Shibata et al., 2009) takes on a somewhat different approach and investigates cross-cultural attitudes through large-scale questionnaires.

4.1.4. QUALITATIVE METHODS LEADING TO MIXED ANALYSES

Only in (Chang et al., 2013) is this approach used. Here the authors employ video recordings to ascertain group dynamics as well as time spent in different interaction types and as such falls in both analysis categories.

4.1.5. MIXED METHODS LEADING TO MIXED ANALYSES

In (Gustafsson et al., 2015) video and Quality of Life-scales were used to evaluate QOL and overall behaviour such as interaction, communication, etc. In (Marx et al., 2010) both methods are employed and the analysis is built as a symbiosis between the two, leading to interesting results regarding the use and interactional effect of dogs and robotic dogs. (Robinson et al., 2013) uses video to ascertain the amount of time spent performing certain tasks, but video is then abandoned in favour of qualitative interviews used to evaluate relatives' views. Similarly, (Wada & Shibata, 2008) uses video as a basis for establishing arguments of improved and heightened interaction in a facility, based on quantitatively measuring interaction time and behaviour. In addition the authors are among the few who employ urine tests to evaluate stress levels. In (Yamazaki et al., 2014) the authors used video data to establish rich descriptions of developments regarding interaction as well as social and behavioural markers, and perform quantitative analyses of utterances and other supporting markers regarding interaction and socialisation.

4.1.6. MIXED METHODS LEADING TO QUALITATIVE ANALYSES

While (Kidd et al., 2006) employ mostly qualitative methods, the study includes quantitative methods, which result in a narrow and shallow quantitative analysis. The focus of the element is clearly qualitative with a focus on social interaction.

4.1.7. BROAD METHODOLOGICAL CONSIDERATIONS

Of the 23 elements in the domain of elderly with dementia, the vast majority used quantitative scales either developed for the specific aim of the study or to some degree scales, which effect in the domain had already been established. These scales focus on varying metrics such as *Quality of Life, mood, pleasure, interest, relevant clinical symptoms* or *amount of time spent in conversation* to name but a few. Indeed, as mentioned in section 2.5 from page 59 both I and several review articles find, in short, a severe lack of qualitative analysis, rigorous methods and exhaustive descriptions in the reviewed elements, and as mentioned it is these that I in part strive to address through the present research. I find it relevant to give special attention to the following elements, as they bear resemblance to my work or distinguish themselves in other ways.

As mentioned (Chang et al., 2013) employ a qualitative method at arriving at a mixed method analysis, but the study is also noted as a true long-term study with a protocol of one 40 min group session per week for eight weeks. This setup was unknown to me at the time of designing the Main study in this dissertation, but resembles my own work. Other long-term studies include the 10 week intervention described in (Gustafsson et al., 2015), which involves a mixed methods approach relying heavily on video and observational data to develop rich descriptions of the interaction and sessions and the 12 week intervention in (Joranson et al., 2015), which uses purely quantitative measures at arriving at a similar conclusion. In terms of rich descriptions, which are lacking in many qualitatively based elements, (Ryuji Yamazaki et al., 2014) provide good base for finding inspiration to this.

Because of the novel nature of the studies being conducted, the methodological outliers (Kimura et al., 2010; Wada & Shibata, 2008) should be noted for employing EEG and urine tests in an attempt to collect revealing data suited for their respective purposes.

4.2. METHODOLOGICAL EXPLORATIONS AND REFLECTIONS

As hinted, the purpose of this section is to provide a view of my early methodological testing of different approaches, before my settling on the use of Constructivist Grounded Theory as described later in this chapter. I will here present reflections on different methodologies and theories that were tested lightly and reflected upon in discussion with my supervisors, as well as other researchers and care facility staff.

My initial process started by reading literature, talking to fellow researchers and healthcare professionals and then formulating the Pilot study of 2014 as described in Chapter 3. Here Ekman's work on facial expressions (Ekman, 2007) was a guidance for my process and design of the study. Ekman's work was at the time thought to be a way of establishing a method of revealing the relationship between the Participant and Telenoid by way of quantitatively analysing instances where the Participant elicited e.g. smiles or sadness. After discussing this with other researchers and investigating what had been done already, I decided that this approach would not be appropriate when used in interaction with persons with dementia. When, in addition, this approach relies on the facial movements of the Participants, I would need assurance that these were in fact reliable to some extent. From talks with staff at the care-facility I was discouraged from employing this theory, as they found that the Participants only rarely had a correlation between emotion and appropriate facial expression. However, this is not something I investigated further from a research standpoint. Looking back, I am quite satisfied that Ekman's work was not applied to this study, but outside Health and Welfare, Ekman's work is used for HRI-research, as seen in e.g. (Vlachos, 2015).

In line with this reasoning I also investigated the works of (A. Kendon, 1990; Adam Kendon, 1990, 2010; Marshall, Rogers, & Pantidi, 2011) in an effort to understand the importance of *Spatial Orientation in Social Interaction*. This again was to make visible how Participants viewed interaction with Telenoid if they remained mute or seemingly indifferent to the presence of the robot. Concisely formulated, Kendon's work focuses on how persons position their body in social interaction and thus reveal their focus in that setting. For artefacts such as Telenoid, there was the possibility that they would regard it as an object and thus not offer it the same attention as they would a person. Kendon's work was at the time thought to be a way of enriching this dimension of the social interaction analysis. From conversations with staff, I was made aware that most Participants were quite static in their bodily movements during the day and thus, without a baseline or existing research, I deemed it uncertain to base central arguments on this theory. Looking back, I am quite satisfied that I did not base my primary analysis on Kendon's work, as most conversations ended up taking place in a sitting position with Telenoid in the lap of the Participant. Kendon's theory of interaction is not wholly applicable to this setting without considerable margins of error.

As described in Chapter 3, I collected insights, re-formulated and re-focused my efforts after having conducted the Pilot study. With a focus on qualitative methods I turned my attention to established frameworks, which would serve to structure the process but not provide answers. I was initially reluctant in settling on any Grounded Theory Method, as this seemed too unstructured, despite its positive traits as described below.

Here, I investigated *The Social Construction of Technological Systems* (SCOT) by (Bijker, Hughes, & Pinch, 2012; Pinch & Bijker, 2012) in an effort to combine the Constructivist notions that I believe serve as a good foundation for understanding and analysing social interaction, and an established methodology of structuring data. While the notions and tools of SCOT remain interesting, they do not lend themselves to the interaction analysis that is the aim of this dissertation. I must admit that the notions of the Technological Frame remain interesting to the overall discussion of how and where we place and develop technology in social settings. Hence, SCOT was abandoned as a methodology and I began investigating methods suited for analysing Human-Computer-Interaction from a video-data perspective. To this end I investigated (Brender, 2005) and other handbooks to point me to frameworks, which would serve my purposes but to no avail.

I then investigated Multimodal Interaction Analysis by (Norris, 2004), which takes a Social Constructivist approach to explaining and dissecting different modes of communication in social interaction, before assigning values and densities to them. This methodology would serve as a way of fragmenting my data, without providing input for analysis or means to restructure the data afterwards.

After both reading and writing about the methodology I became convinced that while it serves a purpose, I saw no reason to include a frame that would provide me with the ability to fragment my data, without the means to put it back together again in new interesting ways. In an effort to find such a tool, I investigated the use of Discourse Analysis and focused my attention on (Roberts & Sarangi, 2005) as their Discourse Analytical Mapping of themes, interaction and structures could provide my investigation of the conversations with this ability. After consideration I found that while this perspective remains interesting, the overt overlap with Constructivist Grounded Theory Methods made the use of Grounded Theory a better candidate than a reduced form of it, as explained in the section below.

4.3. GROUNDED THEORY

I settled on the use of Constructivist Grounded Theory in an effort to apply a method and analytical frame, which would allow me to engage with my data unencumbered by established theories, which in my mind was not the best fit when taking my aim, competencies and data into account. As I will explain in the below, the abductive nature of this particular method allows me to include my theoretical preconceptions and ideas of why my data is structured as it is, while exploring this idea in a structured fashion.

“Our analytic categories and the relationships we draw between them provide a conceptual handle on the studies experience. Thus, we build levels of abstraction directly from the data and, subsequently, gather additional data to check and refine our emerging analytic categories” (Charmaz, 2006, pp. 3–4).

From the above quote, the central tenant of Grounded Theory should be clear: That the analysis of data should not rest on the application of pre-defined theories, but serve as the basis for formulating theories that explain the phenomenon. The purpose, according to Charmaz is to avoid investigating postulates based on pre-defined theories, but instead formulate and investigate hypothesis based on the data, before creating a coherent theory of the phenomenon. As such The Grounded Theory Method, or Grounded Theory in short, is inherently an abductive method because it “...includes reasoning about experiences and [makes] theoretical conjectures [before] checking [these] through further experiences” (Charmaz, 2006, p. 103).

While a Grounded Theory is based on data, there are still different outcomes from using the Grounded Theory Method. According to (Charmaz, 2006, p. 133) when going over articles that claim to have used Grounded Theory in some form, the outputs can be described as “1) an empirical generalization, 2) a category, 3) a predisposition, 4) an explication of a process, 5) a relationship between variables, 6) an explanation, 7) an abstract understanding, [or] 8) a description”.

By her definition, a Grounded Theory does not have to *aim for a general level abstracted from empirical realities*” but can instead be placed in its *“social historical, local and interactional contexts”* (Charmaz, 2006, p. 180) and thus be made extremely specific to particular circumstances and thereby limited in use. This allows readers to make more nuanced comparisons between theories, and determine if a theory devised from a particular dataset is applicable to another set with different circumstances. However, this is not required, and thus a theory can indeed lack particular *“social historical, local and interactional contexts”*. These simply serve to clarify the conditions under which the theory was devised and to some extent applicable.

4.3.1. DIFFERENT APPROACHES

Anselm Strauss and Barney Glasner first formulated Grounded Theory while exploring different methods to analyse dying patients in US hospitals in the 1960ies (Glaser & Strauss, 1966, 1967). Grounded Theory is a method that focuses on creating new theories based on interrelated concepts as opposed to applying existing theories on new data. As a counterpoint to the more quantitative research paradigms at the time, Grounded Theory was adopted by many scholars and have since been criticised for lack of rigour and has fractured into different schools with the two prevailing described below.

I base my own application on the so-called *Constructivist Grounded Theory*, which is part of the interpretive tradition as opposed to the *Objectivist Grounded Theory*, which is part of the positivist tradition (Charmaz, 2006, p. 125).

While the positivist tradition sees a theory as an explanation of social and natural phenomenon and relationships, it does so with no regard for the applicant of the theory; that is to say the analyst, reader or in the case of Grounded Theory, the Theorist as (Charmaz, 2006, p. 126) puts it. Opposite this view, we find the interpretive tradition where the understanding of social and natural phenomenon rests on the theorist’s view of the world. Here, it is accepted that at least social phenomena, are socially constructed as a product of social interaction between persons with unique, or at least varying, influences and viewpoints. As such, theories that are produced by a Theorist are not static, but reflect the Theorist’s viewpoints even if he or she attempted to be unbiased. As such, the best course of action for a theorist adhering to the interpretive tradition is to be aware and explicit regarding ones own bias, and create theories that include explanations to account for the impact of these.

The Constructivist Grounded Theory Method *“...places priority on the phenomenon of study and sees both the data and the analysis as created from shared experiences and relationships with participants...”* (Charmaz, 2006, p. 130).

Here, the Theorist creates not only interpretations of the data, but the data itself through interaction, and thus situates the analysis in a specific time, place and social construct, which carries certain biases. The foci of analysis is on *how and why* events unfold as they do and the Theorist acknowledges that the resulting theory is a subjective interpretation, made as unbiased and generalisable as possible within the confines of the biases and the collected data. As (Charmaz, 2006, p. 132) puts it “*those who take a constructivist approach aim to show the complexities of particular worlds, views and actions*”.

The Objectivist Grounded Theory Method relies on the positivist tradition and thus argues for methods to be completely free from the social context in which they were created. In line with the positivist tradition, the Theorist is not creating the data by interacting with the persons in the data, but rather collecting it in the world. As (Charmaz, 2006, p. 131) so eloquently puts it “*this view assumes an external reality awaiting discovery and an unbiased observer who records facts about it*”.

4.3.2. GROUNDED THEORY IN THIS DISSERTATION

In this field of methodological infighting, I apply Grounded Theory as presented by (Charmaz, 2006) in acceptance of the preconceptions I carry from both my Pilot study and my talks with healthcare professionals and others, alongside my academic endeavours. I choose the Constructivist Grounded Theory as inspired by Charmaz as my base methodology because it allows me to work within a version of Grounded Theory while still applying existing theoretical concepts as they “*provide starting points for looking at [my] data but ... do not offer automatic codes for analysing these data*” (Charmaz, 2006, p. 68).

This dissertation does not follow a *strict* Grounded Theory approach, as the Main study, which is the focus of my attention, is preceded by both a Pilot study and reading volumes of literature and academic articles on robotics, dementia and other relevant topics. As such, my approach, while founded inside the frame of Constructivist Grounded Theory, incorporates preconceptions about e.g. the purpose and implications of conducting the studies or which theoretical frames to look to and investigate further. The topic of preconceptions in Grounded Theory Methods is however a vast one, and I will note that (Charmaz, 2006, p. 48) and others agree with the approach of having some idea and preconceptions of how and what to look for, before starting the investigation. However, I will not include them here as they are described in due detail regarding both the review on page 36 and the methodological reflections above starting page 104.

4.3.2.1 Analytical Process

The analytical process of Grounded Theory is divided into several phases. As presented above, the purpose of Grounded Theory is to seek explanations of social phenomenon through rigorous analysis of data, rather than through application of predefined theories. As such, the adductive analytical process begins with the formulation of a hypothesis that explains the investigated phenomenon, and then, through constant comparison between data, this hypothesis is abandoned or changed to fit the data. While this can sound somewhat unscientific, remember that the hypothesis rests squarely on qualitative data and therefore is not a creation based in the preconceptions of the Theorist.

Data can, or rather should, be introduced at all stages of the analytical process from collection to writing the final theory. This is due to the abductive point of frequently taking steps back and re-examining the codes, concepts, categories or theories already formulated, and thereby ensuring adequate detail and richness in observations.

Before explaining the steps that make up the Grounded Theory Method I will touch upon the themes of Saturation and validity, as these notions are central to the formulation of a useful and valid Ground Theory. As an overview, I offer the below table containing definitions of Grounded Theory. The terms are further described in the following passages.

Central Definitions in Grounded Theory

1. **Saturation** is the point at which no new insight is gained from adding new data.
2. **Incident** is a time period within a session, spanning a particular topic or event. Incidents are named and may be overlapping if pertaining to e.g. separate topics.
3. **Codes** are repetitive central meaningful elements in the collected data.
4. **Focused Codes** are codes that are added or refined to become directed, selective or conceptual in nature.
5. **Concepts** or **Themes** are a collection of related Codes or Focused Codes.
6. **Categories** are broad groups of Concepts that are conceptual in nature.
7. **Memos** are broader narrative descriptions of categories.
8. **Theories** are a collection of memos explaining a social phenomenon with basis in the collected code and subsequent abductive reasoning.

Table 15: Central Definitions in Grounded Theory. Adapted from (Charmaz, 2006)

Saturation and Validity

Saturation can, according to (Bowen, 2008, p. 140) be defined as “...*the point at which no new insights are obtained, no new themes are identified, and no issues arise regarding a category of data*”. Because Grounded Theory is data driven, this is a *Theoretical Point of Saturation*, which occurs when the data at hand seems to have been exhaustively analysed. Opposite to this Theoretical Point of Saturation is the point of *Data Saturation*, which occurs when the addition of new raw data does not reveal additional codes or concepts. This is perhaps best understood from a statistical perspective, where at some point adding new Participants in e.g. a questionnaire will not reveal new information but only strengthen the reliability of what is already determined.

I’ve chosen to adhere to the theoretical point of saturation in that the data included here is analysed extensively and exhaustively to the point that no new concept were revealed. Conversely, Data saturation is only accomplished by using a Grounded Theory Method while actively collecting data and thereby reaching saturation of the data by e.g. adding new Participants to the study. Following the Constructivist Grounded Theory, this is an individual point, in the sense that different minds with different backgrounds and foci, will see and create different codes, concepts, categories and theories. As I will describe below, I have chosen to obtain this theoretical point with only one central Participant who forms the themes for all subsequent Explications of Participant Interaction.

Initial and Focused coding

The analytical process of Grounded Theory is defined as Coding. There are, according to (Charmaz, 2006, p. 46), “...*at least two main phases: 1) an initial phase involving naming each word, line, or segment of data followed by 2) a focused, selective phase that uses the most significant or frequent initial codes to sort, synthesize, integrate, and organize large amounts of data*”.

The Initial Phase of coding is done with respect to observations, and not reflections on action. This is to ensure that the focus remains on the actions that unfold, and not the implications they might entail. For the same reason, theoretical reflections and couplings should not be made at this time. The process is perhaps best described as having an open mind when viewing and annotating the data for meaningful elements of note, but refraining from analysing or applying meaning. The purpose of the individual code is not to function as a label that can be counted and made to serve as an argument for a prevailing theme in a dataset, but rather as a description of the theorist’s observations that serve as a starting point for creating hypotheses, themes or categories that explain larger collections of codes later on. As a side note, it should be noted that this exact point breaks with most of the presented elements in the above methodological review, as especially the creation and counting of labels or instances is a prevailing method of research.

Initial Coding is often achieved by transcribing data and then applying keywords or descriptions either Line-by-line or Incident-by-incident. In *Line-by-Line* coding, each line is attributed with one or more keywords which, as (Charmaz, 2006, p. 50) states this “...*may seem like an arbitrary exercise...*”, but it is useful as a way of forcing the creation of codes in the initial phase. These initial codes “*work particularly well with detailed data about fundamental empirical problems or processes whether these data consist of interviews, observations, or ethnographies...*” and “... *help you to separate data into categories and to see processes*” (Charmaz, 2006, p. 51), which in turn gets raised to themes, if a coherent pattern emerges.

In *Incident-to-Incident* coding, larger segments or incidents within the data are attributed with keywords. Incidents are therefore defined as a time period within a data set, spanning a particular topic or event. Incidents are named and may be overlapping if pertaining to e.g. separate topics. Comparing the codes of different incidents with each other allows for a more abstract level of analysis, which allows the Theorist to identify properties in the emerging concepts (Charmaz, 2006, p. 53). For our purposes, *Incident-to-Incident* coding was chosen as there is often a lack of verbal activity on the part of the Participant, and given their aphasic state and dementia diagnosis, a line-by-line coding would likely lead to a level of fragmentation of the data which would not be beneficial. As the original hypotheses that drives the study is to evaluate the effects of conversations over time, it is natural to include a method which focuses on comparing incidents and not rely too heavily on too miniscule metrics in the data.

The second phase of coding, the Focused Phase, is done with the purpose of identifying interesting relationships between the selected codes or concepts in a more selective, reflective and conceptual fashion. This is done by taking the codes from the initial phase and finding commonalities and directions from what is seen in the data and adding more directed, selective or conceptual codes (Charmaz, 2006, p. 57). These Focused Codes serve to provide further analytic direction and foundation, which was formed in the initial phase. These Focused Codes are then synthesised and reformed in the sense that they take on a more full form of explanation of individual phenomena and their interrelations.

As such, it is likely that new codes are added because of new ideas or the realisations that old codes were either wrong or should be refined. The same holds for data that has already been analysed, which comes into new light after the analysis of later data. This is the product of the abductive reasoning that Constructivist Grounded Theory holds as a central principle. As an example in the case of my video-data, some early analysis of sessions formed the initial hypothesis of relationships and scripts of interaction, which had to be re-defined in terms of theme, concept, and individual codes, due to insights gained from later sessions.

Writing memos and creating theories

After the Initial Coding Phase, the Theorist is left with data which has codes applied to either specific Lines or Incidents, a synthesis explaining some, or all, of the interaction that is analysed, and ideas of where to look next. After the Focused Coding Phase, the Theorist has introduced new Focused Codes to the analysis, and checked the synthesis against new data and thereby confirming or reworking the explanation of the phenomenon.

It is now time to expand these Focused Codes to what Grounded Theory defines as Conceptual Concepts or Themes. This is done through the process of creating a precise conceptual description with analytical direction of the Focused Code. This in effect allows the Code to be split into subordinate codes, because of its conceptual nature. This intermediate but rich description serves to crystallise the idea that the code sought to enlighten. This is done by treating central Focused Codes as categories that require further analysis and thus more attention (Charmaz, 2006, p. 91). The Focused Code now moves beyond a word or short description and becomes a *memo*. *“By writing memos on your focused codes, you build and clarify your category by examining all the data it covers and by identifying variations within it and between other categories. You also become aware of gaps in your analysis”* (Charmaz, 2006, p. 93).

A memo thus encompasses a richer description, which allows the analyst to elaborate and compare Categories and crystallise the idea or emerging theme in narrative form. These narrative statements cover both definitions, properties of the category, conditions under which they are found as well as consequences and relationships with other categories (Charmaz, 2006, p. 92).

With the development of several such memos, the Theorist can now account for several aspects of a social phenomenon, as well as the internal relationship between memos. To fully establish a coherent theory of the phenomenon, it is essential to perform what Grounded Theory defines as *sorting* or *Theoretical sorting*. Here, the level of abstraction is heightened yet again to create narratives, which both encompass relevant memos and provide the reader with the logic of the theory, so as to produce a coherent Grounded Theory-theory.

4.3.3. CRITERIA FOR GROUNDED THEORY STUDIES

As mentioned on page 110 there is a range of plausible outputs from using the Grounded Theory Method. In an effort to formulate what constitutes a Grounded Theory, which is in fact grounded in the data at hand, (Charmaz, 2006, pp. 182–183) lists several criteria, which I will paraphrase below. While these are not checklists, they do provide an initial ambition for any proper Grounded Theory.

On the notions of *Credibility*, Charmaz argues that the author asks if the theory has 1) achieved *intimate familiarity with the subject matter*, 2) included *sufficient data to fit claims* and 3) undergone a *truly abductive process by systematic comparisons between established concepts and new data*. In addition, the theory *must cover the social phenomenon adequately and provide the necessary logical links* so as to be understood by readers.

On the issue of *Originality*, Charmaz argues that the author investigates what social and theoretical significance in theory has brought, and if the theory is able to *challenge, extend or refine* established findings. The underlying notion here is that if a theory does not do either, it merely repeats findings, and while repeated findings can be true and significant, they are not *original*.

A theory must also *Resonate* with the phenomenon by giving full descriptions of the experience. In addition, it must reveal meaning in a broader context and *draw links between larger collectives or institutions* when the data supports this. Finally, the theory must make sense to the involved parties and Participants who contributed.

A Grounded Theory must also be *Useful*. Here, Charmaz calls for interpretations that can be used and possibly studied, as well as spark new research in the domain. Finally, the analyst should ask how the theory contributes to knowledge and to making a better world.

CHAPTER 5. EXPLICATING THE USE OF TELENOID IN DEMENTIA-CARE

The purpose of this chapter is to explicate the process of using Telenoid in dementia care by providing detailed descriptions of several themes found within the data. I do this by analysing the collected video data using a Constructivist Grounded Theory Method Approach as described in the previous chapter, and pairing it with relevant secondary data when applicable in the form of session logs, dementia tests, etc.

I will initially present the analytical process and structure of this chapter, focusing on the process of arriving at the presented form. This section is deliberately short and meant purely as an overview highlighting my Constructivist Grounded Theory Method Approach.

Secondly, in the main part of this chapter, I offer six Explications of Participant Interaction providing analysis and conclusions on the interactions.

I then present a short section on the themes found when treating all Explications of Participant Interaction as a whole focusing on differences and contrasts.

5.1. ANALYTICAL PROCESS AND STRUCTURE

Looking at the six participants included in this dissertation it is clear that the sessions between Ethel and Telenoid are the most rich in conversation and interaction, and it is therefore no surprise that the analysis of her data makes up the single largest Explication of Participant Interaction in this dissertation. While others are interesting in their own merit, Ethel's sessions represent the most full data set and thus provide a good starting point for the analysis of interaction. Due to e.g. lack of speech and interaction, later explications are, not as comprehensive as Ethel's while still having undergone the same detailed analytical process.

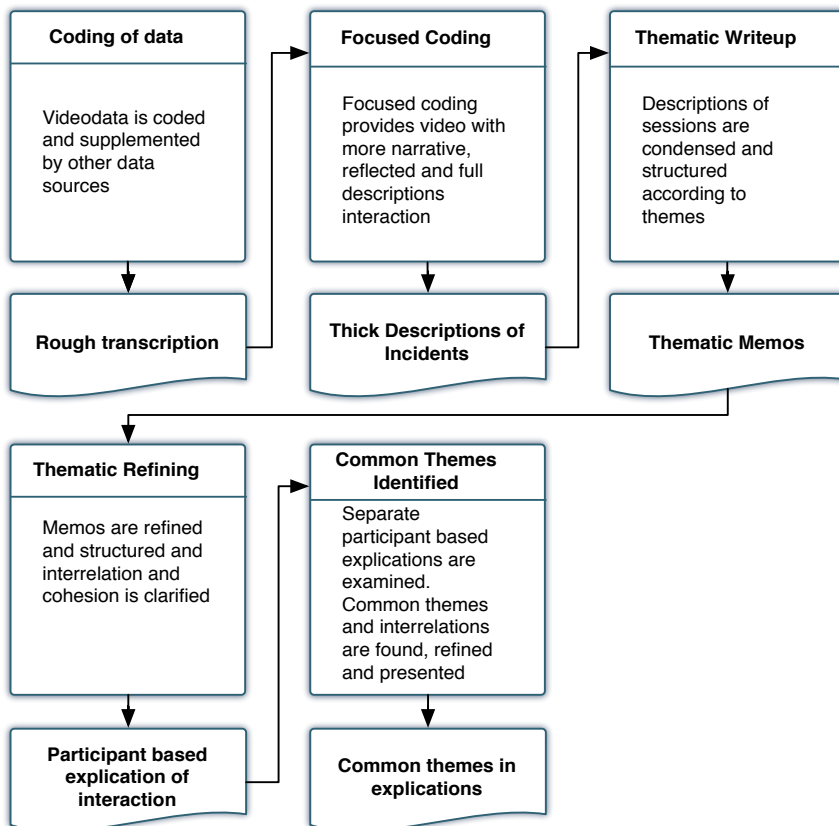


Figure 2: Overview of the analytical process of arriving at the thematic memos in Ethel's data that serve as hypotheses in later datasets. The figure shows the processes with descriptions leading to an output, which is then refined over several steps.

5.1.1. GROUNDING THE GROUNDED THEORY METHOD

Before having finally chosen to apply a Constructivist Grounded Theory Method, I tested the method on sample data by brainstorming keywords based on my preconceptions and tested if these could be applied to several of Ethel's sessions. This was done using an initial *Coding of Data* using the program Transana (Transana.com, 2017), which produced a line-by-line transcription of the interactions, without analytical remarks.

P:	((Sætter sig))d
A:	((sætter sig)) Må jeg sidde ved siden af dig?
P	Ja ((kikker på Telenoid,griner))
S	Ethel jeg tror lige at du skal ryke lidt
den her vej	du sidder midt på den nølde der i
midten der	
S	Sådan, så sidder du godt
P	Jaa[aah
S	Så kan i rigtig sidde [og hygge]
P	[Hvad hedder han?]
(0.9)	
A	Det, den hedder Telenoid den her.
P	Hva?
A	Det, det er en telefondukke
P	Er d[et ? (griner)
A	Ja, så en telefondukke. Han hedder Telenoid.
P	Er det f... [Nåå↑
A	Jah]
A	Syntes du den er sød?
P	Nah ha ha•↓ ((Griner, smiler))
A	JA!
O	((Utydligt, kan ikke høres as P))
P	((Utydelig tale))((Læner sig frem, smiler))
O	Goddag Ethel! ((Meget lavt))
P	Jamen jomen, ska du øhm du kikke sådan (holder begge hænder på Ts hovede) [på sådan en gammel kælding!
Hæ hæ hæ	hæ hæ
A	

Image 20: Screenshot from Transana showing a section of Line-by-Line transcription of (Ethel 1, 01:14 – 02:11)

Drawing on (Jordan & Henderson, 1995) I attempted to provide a transcription which would indicate point of overlapping speech or action by inclosing these in [brackets] and placing these above or below their starting point. Non-verbal actions or notes of interest are marked in ((double parenthesis)). This proved to be a comprehensive task, which yielded results in terms of overlapping speech, but since there was a great deal of aphasia, much of the transcription included ((incomprehensible mumble)) and more interesting nonverbal actions than speech.

After having started this process and confirmed that some of the codes were applicable, I structured the data and began the Initial coding phase, changing the line-by-line approach to an incident-by-incident-approach. The process of applying keywords meant that I continuously could re-evaluate their use and organised them in themes with e.g. all codes pertaining to specific activities grouped together. Inspired by the *Foci Of Analysis* put forth in (Jordan & Henderson, 1995) I began defining incidents by finding points of interest such as e.g. a change of topic or significant events.

Clip: Ethel 10 Shaking during Singing 10-3
 Collection: Ethel > 10 > 1 - Of Interest

Redacted

Time: 0:05:55.7 - 0:08:34.8 (Length: 0:02:39.1)
 Library:
 Episode:
 Episode Transcript: Redacted
 Clip Transcript:

Singing 10-3
 Interesting how P does not show initiative when T says it likes singing with her and P clearly enjoys this.

T says she likes singing with P. T asks if they should sing some more. P agrees and asks what to do now. T asks if she would like to sing and she agrees again. T suggests "Ole sat on a hill and sang" and starts singing. P joins in for several words at a time, but does not start a line or verse. Mostly chorus. Maintains eyecontact. Does not seem to enjoy it during the singing.]

Shaking during Singing 10-3
 2 min into Singing 10-3 T shakes telenoid, then smiles and looks to A. This may be due to her not being able to follow the tempo as she does not partake in any singing other than chorus "tra la la la la" sounds"
 T and P then moves onto repeating "tra la la la la" with no agreed form. P rocks T side-to-side in her lap

Clip Keywords:
 A- Organisation of Activities : 3a Telenoid Interaction
 B- Specific Activities : 3 Singing
 C- Relationships : 1 Positive
 C- Relationships : 4 Undetermined
 E- Facial demeanor : 3 Stern
 F- Gaze : 1a Respondent: Directed
 F- Gaze : 2a Telenoid: Directed
 G- Telenoid position : 2 Telenoid mostly with Participant

Image 21: Incident-by-Incident transcription of (Ethel 10, 05:55- 08:34) showing one incident and another nested incident within it, as well as applied keywords to the two below.

After having reviewed several sessions in this manner I was confident in the use of the approach. It became clear that while my preconceptions were founded in the Pilot study, some keywords, which were considered relevant, were indeed not, and others needed to be refocused or omitted. The process also revealed that while the use of Transana could provide me with statistical data on e.g. the use of keywords such as a stern look or the direction of gazes or frequency of singing, this process was too cumbersome, as it had not revealed anything significant. As such Transana

was abandoned in favour of using MS Word which is lighter and faster to use, but does not offer the possibility to draw statistical data.

I therefore restarted the process of analysing Ethel's data using the above process. This meant an initial forming of a *Rough Transcription* of the data using natural language focusing on providing a detailed description of the incidents without analytical remarks. As mentioned above, coding is done by incident, due, in part, to aphasia and other limitations inherent in dementia. An example is shown below. Note that this is the same sequence as the first examples featured on page 121.

Literally three seconds after sitting down to start the first session (Ethel 1, 01:23) and meeting Telenoid for the first time, Ethel looks at Telenoid and exclaims, "What is his **name**", without prior conversation, introduction or notions to Telenoid. Ethel then (Ethel 1, 01:30), adopts an inquisitive posture toward Telenoid as she greets Telenoid with interest and a directed gaze, almost entirely bypassing the Assistant and certainly bypassing the staff member who is helping her sit down.

While Ethel is told that Telenoid is a Telephone-doll, she does not ask what this concepts entails, and merely reacts to the presence of Telenoid. There is no further investigation of who or what Telenoid is, but Ethel moves to address Telenoid directly, moving close to it and laughingly making remarks about it coming to visit "such as old hag", referring to herself. In the Assistant's session logs, it is notes that "[Ethel's] tone is comparable to that of a mother talking to her child with sounds and nonverbal communications in the form of caring touches with her hands and nose. Her identity as a mother is kindled".



Image 22: The first time Ethel places Telenoids forehead on hers. This specific action is repeated several times in each session, and always with care (Ethel 1, 02:42).

Figure 3: Presentation of a section of Rough Transcription from (Ethel 1).

As such I have emphasised transcription of the interaction and not the actual spoken words, unless in regard to those incidents in which this level of detail was in focus and of importance to the presentation. I have thus opted to ‘paraphrase what is said’, but still “*quote directly most times*”, with the firm belief that what is presented is interesting by its own merit.

(See also (Ingrid 5, 07:05) At (Ingrid 5, 11:00) Ingrid addresses the Assistant in a low voice to which the Assistant answers “I dont know” and offers to hold Telenoid for a bit. Ingrid responds with a “oh I can do that”. This may be the first sign that Ingrid is enjoying the company of Telenoid. As Telenoid is placed with her, she looks at it saying “I cant understand [15 seconds mumble] then it looks at me [3 seconds mumble] [fast paced kissing sounds]”. Telenoid then calls Ingrid sweet, to which she responds with a “I don’t know”. This exchange happens twice, with Ingrid looking directly at Telenoid, and off in the distance behind it. From the interaction it is clear that Ingrid’s use of “I don’t know” and “it looks at me”, is directed at Telenoid and it’s gaze. In the incident, Telenoid gaze is in fact not directed at Ingrid, but somewhere over her left shoulder. This could be supported by Ingrid movement of her head during the incident, where she moves somewhat to the left for an instant, but this may well be incidental. Regardless of this, her criticism of Telenoid is interesting in that it shows us that, in this incident, she defines Telenoid as “it” and finds is irritating that it looking over her shoulder and not at her.



Image 23: Ingrid placing her forehead on Telenoid’s and starting to tap as Telenoid sings (Ingrid 5, 07:05) (left) and the view offered the Operator as Ingrid has lost interest in the singing at (Ingrid 5, 08:24) (right)

Figure 4: Showing an early and partial Thick Description of (Ingrid 5,07:05) with analytical remarks and references to other sequences.

The *Rough Transcription* was revised using *Focused Coding* in which I reviewed all sessions, added analytical remarks and found common codes and traits in incidents. The resulting *Thick Description* is comprised of a chronological description of incidents with relevant incidents related to one another in a separate document and complimented by analytical remarks and developments.

This process allowed for a fully encompassing process in which all related sequences were related to one another, with codes being constantly tested toward one another. This meant using the same sequence several times, as each sequence often had several codes, which at one point or another seemed interesting, as well as the occasional nested sequence within a longer sequence, which then in itself could be of interest.

Based on this process came the *Thematic Write-up* focussed on condensing and structuring the descriptions of theme-based incidents into *Thematic Memos*. These are comprised of categories of incidents with analytical and narrative descriptions added to previous analytical remarks. These served as a form of definition of the themes with a list of incidents below, which by themselves had both analytical remarks and narrative descriptions to them.

Ethel's *Thematic Memos* then underwent *Thematic Refining*, which helped to identify interrelationships between themes that provided a between-theme boundary. This process is shown on Figure 5 on page 126. During this process I formulated, related, merged, separated and deleted several *Thematic Memos* at various stages, aiming for a proper balance between presenting sufficient incidents to warrant my claims, without including several pages of repetitive incidents. This process revealed the seven themes shown in the model on page 126.

Centrally, the process allowed for a merging of themes, as well as the refinement of some themes that did not warrant the level of interest originally anticipated. This process may not seem comprehensive in the figure but is never the less the result of continuing fragmentation and reconstruction of data, which is the essential point in the Constructivist Grounded Theory Method. As such, this step may be seen as the most important step in that this is the step at which the previously coded sequences are now weighed against each other and the themes, which may have been developing are now investigated for their value. As such, Themes that emerge from this process are not the result of notions or Pilot studies, but observations grounded in the data.

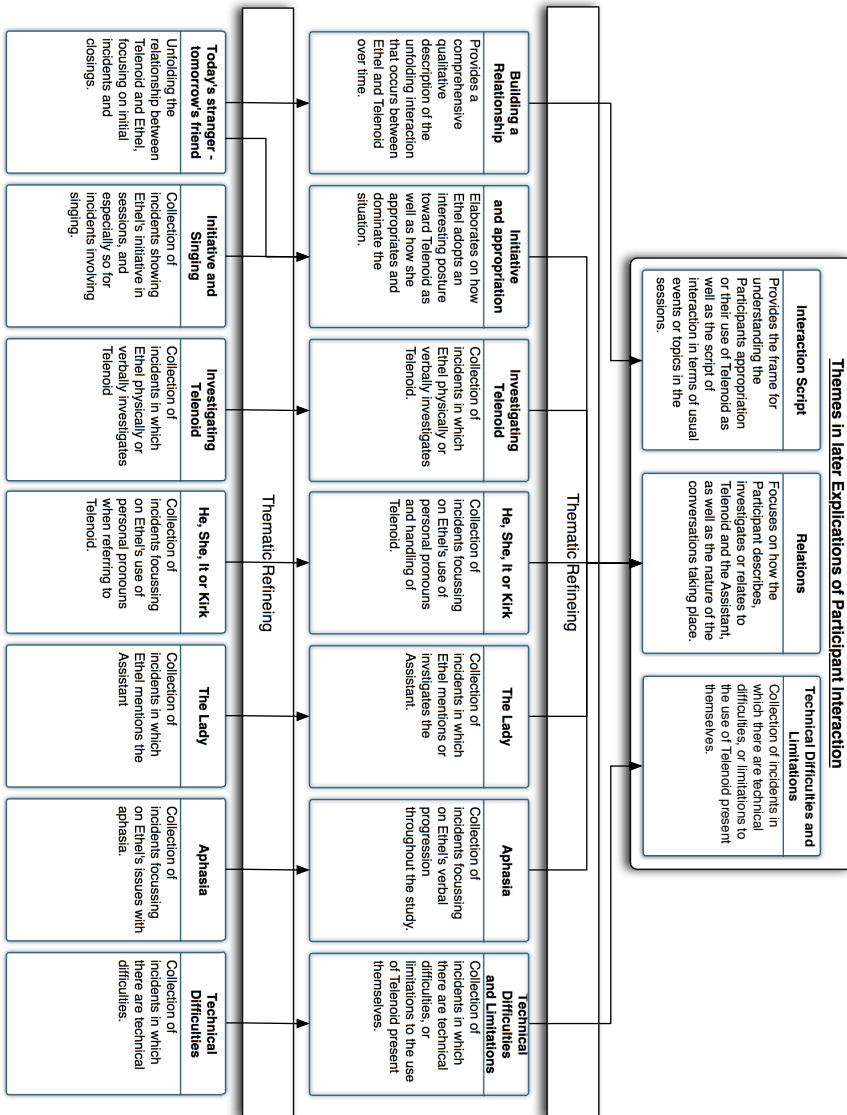


Figure 5: Overview of the Grounded Theory process of refining themes. Initial Memos (bottom) were refined and included in the Explication of Ethel's interaction (middle), and refined again to achieve the themes used in all later Explications of Participant Interaction. (top).

After having fully analysed and concluded on Ethel's interaction with Telenoid using these seven themes, I found several themes too overlapping to provide conclusions that would not be repetitious. As a result, I chose a second Thematic Refinement in which I defined three primary themes on which to conclude, and used these in the conclusions regarding all Participants. As such, these themes are found in the conclusion of all participants and in the structure of analysis of some of them. As their scope is sufficiently wide so as to encompass the different themes found within the dataset for each participant, their use does not steer the analytical process. In those cases where they are applied as headlines in the analysis, this is done with supplemental reasoning presented. The methods applied are thus still the results of the fragmentation and reconstruction of data.

These primary themes are *Interaction script*, *Relations* as well as *Technical Difficulties and Limitations*. The purpose of Interaction Script is to provide the framework for understanding the Participants' appropriation or their use of Telenoid as well as the script of interaction in terms of usual events or topics in the sessions. Next, the theme of Relations focuses on how the Participant describes, investigates or relates to Telenoid and the Assistant as well as the nature of the conversations taking place. Finally, the section on Technical Difficulties and Limitations collects incidents in which Technical Difficulties or limitations to the use of Telenoid present themselves. The last part of the process is shown in the diagram below.

The analysis and conclusions of the themes found in the data of each participant comprise the *Explication Of Participant Interaction* below with one for each participant. The later between-participant analysis reviews the findings of each theme across participants with conclusions found in Chapter 6 from page 215.

5.2. EXPLICATION OF PARTICIPANT INTERACTION

The purpose of this section is to provide a counterweight to the technological deterministic approach described in section 2.5.2 from page 61 above. Namely, it is the purpose to provide a rich qualitative description and analysis of the interaction that unfolds when each participant interacts with Telenoid. As presented in Chapter 3, the study encompasses 10 participants with five in either condition, and one from each having switched to the other during the study, and I have included all six participants that have been in contact with Telenoid and omitted the remaining four due to constraints in time and scope. The included participants are presented in turn with the initial focus on Ethel's full and comprehensive interaction and analysis before moving on to Beatrice's polite rejection of Telenoid and then Alice's violent rejection. Then follows Ingrid's largely passive interaction before ending with Benny's mumbled interaction and Isabella's passive presence.

This section contains six explications, each pertaining to one of the included participants. Before each of these explications I will present an introduction to the Participant based on the care facility records as well as the post-study exit interview and a session overview. The purpose is to provide an overall frame of reference for understanding the significance of the following explications.

As mentioned earlier, severe dementia manifests itself differently in almost every case, and thus there are significant differences in how each of the included participants behave and to what degree they usually participate or indeed speak. As an example, Ethel is usually verbally active but socially isolated if not joined in her own room. This is in sharp contrast to Ingrid who is mostly silent. Sadly, the nature of how the participants engage with Telenoid has resulted in especially two explications being based on limited available data. We see this with Isabella and Benny. Perhaps due to Isabella's diagnosis of manic-depression, her sessions unfold in two distinct ways, with three *active* sessions and five *passive*. In her *passive* sessions she appears entirely passive and sits idly and produces no sounds or mimicry and very limited bodily movement. As a result most of her sessions offer very little data to analyse. Benny's first three sessions are recorded in the common room, and unfortunately a combination of his tendency to mumble and speak at a low volume, technical difficulties with the equipment as well as ambient noise has caused the audio in (Benny 1-3) to become almost entirely undesirable. While the following three sessions were recorded in his apartment, the spoken words are literally heard as a mumble on the video. Coupled with his largely stationary body language and mimicry, the available data from the sessions are severely limited. As a result the analysis here is limited and purposely not titled *explications*.

5.2.1. ETHEL

As mentioned above, Ethel is the one who, in my mind, shows the most explicit signs of change following interaction with Telenoid, and was thus the first participant who's sessions were analysed. Parts of this section was first published in my own work found in (Strandbech, 2015) and is presented here with only minor alterations. The present analysis however greatly expands the reference's short analysis of Ethel's first four sessions.

“From facility records, we know that Ethel moved there one year before the study began. Diagnosed with Alzheimer's disease, she moved because she and her husband were unable to take care of her, even with the help of government home care. She has excellent hearing, uses glasses at times, but is impaired by impressive and expressive aphasia. This impaired ability to correctly understand or produce meaningful speech is at times severely impairing to Ethel's social life, but will some days be less pronounced. Ethel has a sweet tooth, but is otherwise a light eater and underweight. This is compounded by her typically dining by herself or finishing meals in a hurry, if enjoyed in the company of residents or staff in the common areas. If staff does not sit with her she will get up, decline eating any more, and leave. Generally Ethel keeps to herself and is known to reject invitations to social gatherings, even just for watching a movie in the common area, five meters from her apartment door. Ethel enjoys showing pictures of family to staff and visitors, and the staff makes a point of doing this once a day as it 'calms her down'. Other activities include singing and walking around inside the facility on her own. She will likely decline taking outside walks in the garden. A key point for staff is to provide Ethel with 'a predictable and structured daily life, so as to calm her' (Strandbech, 2015, pp. 12–13).

In the exit interview with the staff members (Staff interview Ethel, 01:42) they are adamant that they have seen a definite change in Ethel over the course of the study, as she was previously unwilling to engage in social interactions for a long period, but in the last months they have seen a definite increase in her willingness to engage in both short and long term social interaction. In addition, Ethel has become more “*present*” in conversations up to 15 minutes at a time (Staff interview Ethel, 17:00), and will now e.g. finish her meal and stay seated, as opposed to previously where she would leave at the first chance (Staff interview Ethel, 18:00). Ethel is more relaxed in her body language (Staff interview Ethel, 10:30) and showing signs of having become “*more free*” (Staff interview Ethel, 36:20) in her behaviour as well as “*smiling, open, happy and relaxed when in social interaction*” (Staff interview Ethel, 23:40). Previously she was prone to backing into her room when faced with a group of residents sitting at dinnertime, but now she engages and sits with them, as well as enjoys the evenings watching TV with others.

The staff points out that due to the effects of the study they have officially requested additional funding for PARO and additional *Psykisk pleje og støtte* or *Psychological care and support*, which is the municipal title for funds spent on time devoted to social interaction and off topic conversation with residents (Staff interview Ethel, 34:00). This is due to staff now noticing Ethel's improvement across many parameters due to "*one on one interaction in which you do not necessarily have to say much*" such as watching TV or reading a magazine together. Interestingly, the staff notes that when the sessions stopped, there was a short increase in disruptive behaviour, which they speculate was due to her becoming under-stimulated as she was now accustomed to interacting with Telenoid and the Assistant, and then suddenly was lacking this (Staff interview Ethel, 37:00).

Her language and vocabulary may have increased and she is still troubled by aphasia but seems to understand more of what is being said (Staff interview Ethel, 12:50). Ethel does not seem to be creating longer sentences, and it is difficult to say if she has an increased vocabulary (Staff interview Ethel, 07:40). It is however certain that her repetition of staff member's sentences has increased, and that she is no longer as prone to aphasia as before. The staff also reports that Ethel is now more pleasant to be around and causes less frequent and lower level vocational disruptions. Lastly, the staff notes that they believe that Ethel's self-perception has changed for the better (Staff interview Ethel, 19:50) and that she is more happy (Staff interview Ethel, 28:00, but note that her functional memory has not changed (Staff interview Ethel, 24:00).

5.2.1.1 Session overview

Ethel 1

Overall this first session offers an introduction to interaction with Telenoid, but due to technical difficulties, interaction is not possible. Ethel does however show several signs of wanting to engage and interact with Telenoid, but also shows signs of wanting to limit interaction with Telenoid as is common in the first sessions. Throughout the session, Ethel applies a broad range of personal pronouns toward Telenoid.

Ethel 2

While Ethel's second session is overall positive, she is strikingly critical of Telenoid. The overall feel of the session therefore remains one of scepticism and Ethel trying to identify both Telenoid and the setting in which she is. The session covers many conversational topics, which is indicative of Ethel's eagerness to engage in conversation, but all conversations have a persistently slow pace due to Ethel's latency in responses, and the dissonance that she sometimes causes.

Ethel 3

Ethel's third session begins with immediate recognition of Telenoid as well as positive interaction between Ethel and Telenoid. Ethel is eager to engage in conversation and quickly engages in the same form of interaction as seen before. Telenoid is experiencing technical difficulties and verbal distortion, and Ethel is experiencing aphasia at times, which both have some impact on the interaction at times. Late in the session Ethel becomes either overly eager or annoyed at Telenoid for not engaging enough. Towards the end of the session, Ethel seems to experience remembering something, and turns silent and smiling.

Ethel 4

This session is characterised first and foremost by the elevation in Ethel's engagement in the conversation. In earlier sessions we do not see her offer opinions, topics or thoughts, but in this session this initiative is a recurring action on her part. This session is also characterised by laughter, smiling and singing with Ethel asking several times for more singing. Despite her investigations of Telenoid, Ethel remains overall positive throughout the session.

Ethel 5

This session is centred on four incidents of singing, as well as several incidents where Telenoid, Ethel and the Assistant are engaging in conversation. Interestingly, Ethel is weary of Telenoid in the beginning, and again at the very end of the session, but does not seem to want the interaction to end because of it. At times Ethel takes the initiative in e.g. suggesting singing or specific songs, but does not engage in these when initiated by Telenoid or the Assistant. The session is overall positive and supports the notion that Ethel remembers the situation and the interaction that is taking place, and is building a relationship on previous experiences with Telenoid.

Ethel 6

In this sixth session, the by far predominant theme is Ethel's investigation of Telenoid, whom she believes to be her son *Kirk*. For 13 consecutive minutes, Ethel is engaged in understanding and creating a connection to Kirk. Due to technical difficulties this is however often not successful, as Telenoid often mishears what is being said and thus does not follow Ethel's initiative.

Ethel 7

In this session, we see numerous incidents in which Telenoid is singing, and incidents with positive interaction between Telenoid and Ethel. However, Telenoid is experiencing the perhaps most severe latency issues seen in the study, which presents as heavy verbal delay and a resulting persistent echo of the Operator. This is especially present during singing activities.

Ethel 8

In this eighth session, we see several examples of positive interaction between Telenoid and Ethel. We also find an apparent change in the behaviour of Telenoid and the Assistant. Comparing to earlier sessions, both now seem to be more confident in their handling of the situation despite severe verbal delay in Telenoid. There are several incidents in which the Assistant and Telenoid appear to correctly identify what Ethel is saying during an aphasic episode.

Ethel 9

Compared to (Ethel 8), this ninth session is interesting in the sense that while Telenoid is persistently looking away in this session Ethel does not attempt to reorient its face as in earlier sessions. Over the course of three incidents, spanning some 10 minutes, we see how Ethel is both able and unable to remember information just seconds old.

Ethel 10

In the tenth session Ethel identifies the actions of earlier sessions and shows clear signs of moving toward becoming more socially engaged. She both repeatedly seeks confirmation in negotiating future activities, as well as initiative in closing the interaction at the end. In addition we see how Ethel moves from coherent to incoherent over the course of a few minutes, and finally expresses a desire to end the session in her own way. This is the last session before the five-week break.

Ethel 11

This eleventh session is the first session after a five week break, and the first in which Telenoid has a head-mounted camera and improved software that reduces latency, as well as verbal distortion and delay. Overall, the recognition and repetition of activities in this session is unremarkable, was it not for the five-week break between this and the preceding session. This would seem to indicate that Ethel remembers both the interaction script as well as her relation to Telenoid from weeks past. During this session Ethel makes several short remarks about the Assistant at her side, but never engages in actual conversation about her.

Ethel 12

In this twelfth session the Operator is changed for the first time. Overall Ethel does not show the same signs of aphasia as in earlier sessions and thus her vocabulary and tonality is dramatically improved. This makes interaction with her more fluid and relevant. We also see how it appears that Ethel prefers interacting with Telenoid over the Assistant. The closing of the session is remarkable in that Ethel is repeating a wish to have Telenoid left with her, as opposed to the Assistant leaving and returning with it.

Ethel 13

In this thirteenth and final session, Telenoid does not work. Initially Ethel responds to Telenoid presence with joy and happiness, and despite it not working she tries for several minutes to engage it in conversation and interaction, tapping it on the head and talking directly to it. Even after repeated attempts by the Assistant to explain that Telenoid will not work, Ethel is adamant in trying to elicit a response from Telenoid. Looking through this video it becomes clear that this session should have been aborted when it was clear that Telenoid would not work, as Ethel does not understand this and does not benefit from the interaction but instead becomes aggravated.

5.2.1.2 Explication of Ethel's Interactions

As mentioned above, Ethel's interactions and data represent the richest dataset in the study, and thus serves as an excellent starting point for developing a grounded theory based study of interaction. For that reason, this explication is significantly longer than the others.

Building a Relationship

This section is the result of numerous different approaches to providing a comprehensive qualitative description of the unfolding interaction that occurs between Ethel and Telenoid over time. It is in part a direct attempt to address this lacking perspective in Socially Assistive Robot research as described in section 2.5 from page 59 above.

The structure of this section has a natural emphasis on the openings and closings of the sessions, as Ethel is particularly explicit about her view of Telenoid in these incidents. I have included other incidents as well, but relatively the openings and closings of sessions are well represented below.

Having hoped for a positive initial response from Ethel, we were delighted that literally three seconds after sitting down to start the first session with Telenoid at (Ethel 1, 01:15), Ethel looks at Telenoid and exclaims, "*What is his name*", without prior conversation introduction to or questions about Telenoid. Sadly, Telenoid cannot respond at the time due to technical difficulties. Our delight was both for the immediate interaction, but also when taking into account that during the Pilot study we saw a few examples of initial rejections becoming persistent over time.

In this first session, Ethel seems initially to identify Telenoid to be a male, and someone that cannot respond. Otherwise, the natural question would be to ask "*what is your name?*" rather than "*what is his name?*". Interestingly, there is no further investigation of who or what Telenoid is, but Ethel does move on to address Telenoid directly, moving closer to it and laughingly making remarks about it coming to visit "*such as old hag*", referring to herself.

After having greeted Telenoid and tried to interact with it for some time, Ethel's positive and caring posture toward Telenoid now fluctuates as she starts to investigate Telenoid's eyes, lifting it, turning it and finally placing it with the Assistant (Ethel 1, 03:51). Her physical investigation of the eyes as well as her handling of the body as a whole, strongly suggests that she here views Telenoid not as an agent, but more as an artefact.

While Telenoid is with the Assistant, Ethel's posture is anxious to the point of being scared of Telenoid (Ethel 1, 05:35) and she starts asking the Assistant where "it" is from and adopts an overall sceptical posture. At this time, Telenoid is yet to have uttered a single sound, so other than the physical humanoid form, it does not convey any affordance, which would suggest that it is an agent so her handling would seem justified at this time.



Image 24: The first time Ethel places Telenoid's forehead on hers (Left) at (Ethel 1, 02:42) and the first time she withdraws from it (right) at (Ethel 1, 05:47)

While this initial interaction proved interesting and promising for the coming sessions, it also functions as a clear example of what happens when Telenoid does not meet expectations. In this case, Ethel either has or develops the clear expectation that Telenoid can talk in that she addresses it directly, but when there is no answer and Telenoid does not move, the inanimate bodily appearance presumably triggers negative emotions in Ethel leading to rejection. Indicative of the later sessions, the first session ends on a positive note. Here, at (Ethel 1, 09:29) the Assistant remarks that the team has to leave, prompting Ethel to suggest several times that "they", then "he" and then "it" return, as well as noting that "he smiles".

In Ethel's second session Ethel's initial response, just seconds after seeing Telenoid (Ethel 2, 00:25), is that of careful but joyful reunification, despite this being the first time the two actually interact verbally. As Ethel sees Telenoid she starts rubbing her hands together in an apparent effort to warm them, and then takes hold of Telenoid's head as shown below. She then caresses Telenoid's face and touches both arms gently.



Image 25: Still from (Ethel 2, 00:33) showing the second greeting of Telenoid by Ethel

As Ethel is doing this, the Assistant is asking “do you remember it?”, to which she adamantly responds “ohh yes”. Telenoid then says “Hello” which prompts her to look at the Assistant with a smile and then look back to Telenoid saying “Hello, what is your name”. For the next minute the conversation is a rapid exchange of short sentences back and forth between Telenoid and Ethel, focusing on Telenoid’s name and appearance. Ethel concludes that “it is a funny one”, while looking at the Assistant, before asking her “Do you think she knows?” at (Ethel 2, 01:17). From her directed gaze and posture toward Telenoid as well as her use of “she” throughout the incident, I believe Ethel in this first interaction sees Telenoid as a female agent, and although her identification fluctuates in the coming sessions between *artefact* and *agent*, Ethel most commonly relates to Telenoid as an agent with which she can speak and interact.

Following this, Ethel takes on the caring posture as seen in (Ethel 1) when she is handed Telenoid at (Ethel 2, 01:50). Here she engages in conversation with it about her “looking after” it, with Ethel several times ensuring Telenoid that “you will not be home alone”.



Image 26 Ethel with Telenoid on her lap (left) at (Ethel 2, 04:13-B) and Ethel restoring Telenoid upright (right) at (Ethel 2, 04:19-A)

The nature of the conversation shifts some one minute later at (Ethel 2, 03:00) Ethel starts investigating Telenoid physically, questioning its appearance, and reacting to verbal distortion in Telenoid. Here, Ethel looks to the Assistant saying “*it’s weird*” and starts physically investigating Telenoid’s bottom and laughing when Telenoid moves its head. While Ethel does not seem afraid, anxious or reluctant to hold Telenoid, she does rest Telenoid in a lying position on her legs as shown in the image above.

This lying position is not a natural position to hold e.g. a child, and thus suggests, to some extent, that Ethel is aware that Telenoid is in fact not an agent or a normal conversational partner. While the position is only brief, it is repeated a few times later on. She then moves on to looking at the Assistant and spontaneously utters “*I don’t know*” which may be indicative of her not being able to identify Telenoid as i.e. either agent or artefact, and then due to her aphasia she cannot formulate this in a coherent sentence. Interestingly Ethel starts singing spontaneously after saying this, while still investigating Telenoid visually. Her spontaneous but brief singing is interesting in this context because it is an activity, which she has practiced for many years and still enjoys immensely. As such it may be an unconscious way for her to engage in a calming activity in a somewhat stressful situation. On the other hand, she may simply be singing to Telenoid in response to its appearance, which is childlike in size.

Over the course of (Ethel 2), Ethel uses both positive and negative adjectives in talking about Telenoid. At (Ethel 2, 13:13) Ethel spontaneously starts laughing and then tells Telenoid “*Du er fin, rigtig fin*” in Danish, which translates roughly into “*you look beautiful*”. The statement is one you could use to describe the clothes of a small child wearing formal clothes not normally worn. Because use of “*fin*” is usually used to compliment the appearance of something or someone, Ethel is here presumably observing that Telenoid’s design is pleasing. It is interesting that Ethel never once remarks on Telenoid being naked. Conversely, toward the end of the session, at (Ethel 2, 15:13) the relationship takes a turn for the worse. Here, Telenoid makes a three second rather abrupt motion with the neck, causing Ethel to look directly at Telenoid and say “*It, it looks ugly*”. The Operator presumably mishears what is being said, and says, “*There’s no one laughing here*”. Ethel waits for a second before turning to the Assistant and saying “*It’s unfathomable*” in the slightest whisper but with a smile, and then directs her gaze at Telenoid in silence. The abrupt motions made by Telenoid contributes to the erosion of the relationship between Ethel and Telenoid, with Ethel now directly calling Telenoid *ugly* and perhaps noticing its artificiality calling Telenoid “*it*” rather than “*she*” as seen before. Her point about Telenoid being “*unfathomable*” may be an indicator of her finding Telenoid artificial, but interestingly it is also one said while smiling. As a result, it is unclear if Ethel is joking when stating that Telenoid “*look ugly*” (sic), or if she simply forgets this seconds after the statement. Both cases are plausible and found exemplified elsewhere in the data.

(Ethel 3) starts with Ethel sitting reclined in her sofa, looking at the Assistant carrying Telenoid and setting up the cameras, as pictured in the left image below. Here she remarks casually at (Ethel 3, 00:47) *“Is that fellow with you?”*. The wording of this sentence is casual to the point of being jovial, and her demeanour is certainly laid back and relaxed, as she is attentive and smiling, while following the Assistant round the room with her eyes, and her hands interlaced behind her head.

Ethel then twice asks if *“it”* is something the Assistant has brought, as well as answers twice positively to the question of whether she recognises it. As the Assistant sits down at (Ethel 3,01:20), Ethel adjusts her position, looks at Telenoid and then practically grabs it from the Assistant’s arms with a subtle *“Come on then”*, in the same manner someone would welcome a small dog or child to jump into one’s lap. She then starts laughing when Telenoid says *“hi there!”*.



Image 27: Ethel sitting laid back, looking at the Assistant and Telenoid (left) (Ethel 3, 00:57- A) and Ethel with Telenoid (right) (Ethel 3, 01:21- B)

While Telenoid exhibits a technical malfunction and utters a loud metallic sound, Ethel is unimpressed by this and is all but jumping around the sofa, while looking at the Assistant, asking what to do next. In this case, Ethel does not react to the sounds that Telenoid makes. She instead takes the initiative to start singing before engaging in this activity. Contrary to the closing of (Ethel 2) Ethel is now unimpressed with the technical difficulties and verbal distortion of Telenoid, and proceeds with being delighted at the prospect of engaging with Telenoid and the Assistant. In addition, these first seconds of interaction show how Ethel has already established a script of sorts for how she would like the interaction to play out, as she appropriates Telenoid, calls on it to engage and then starts singing, as done elsewhere in (Ethel 2). More to the point, Ethel’s positive reaction and calls for singing is not directed at the Assistant but solely at Telenoid both in this case and almost every other example in later sessions.

At (Ethel 4, 00:42) we see Ethel's initial response to seeing Telenoid again. Having been reclined in the sofa for some minutes as the staff is setting up the equipment, she immediately leans forward and greets first the Assistant and then Telenoid with words of caution to not get cold. This would seem to indicate that she views Telenoid as something or rather someone who is indeed able to *be* cold.



Image 28: Ethel, Telenoid and the Assistant. Left at (Ethel 4, 00:52), Right at (Ethel 4, 01:50)

Moving forward, Ethel taps Telenoid's chest, face and forehead lightly and playfully while trying, with great vigour, to say something that unfortunately remains incomprehensible due to aphasia. In addition, she spontaneously utters "*Oh, yes yes yes yes!*" when Telenoid is handed to her, at her own request, at (Ethel 4, 01:25) and proceeds to give Telenoid a spontaneous hug, when Telenoid says it is nice to visit her. She ends the hug with the words "*Everything is good*" at (Ethel 4, 01:55). Ethel then moves to tell Telenoid that "*we need to talk*" in a jovial and cheerful manner. Ethel remains visibly engaged in the conversation in this initial incident as well as well beyond it for several minutes. She seeks the affirmation of the Assistant at times, where the audio drops intermittently but otherwise her attention is, as usual, focused on Telenoid without fail or fluctuation.

It appears that this fourth session serves to somewhat solidify the emerging relationship of a *welcome conversational partner*. This is best exemplified in the incident (Ethel 4, 09:25) when Telenoid and the Assistant start singing a song about the shoemaker's boy being a "*swine*". While passive in the short activity, Ethel does react with a grin at the use of "*swine*", leading to full on laughter. Ethel also tells of the weather being cold and asks Telenoid "*Are you cold?*". The engagement with Telenoid, the sharing of laughter and Ethel's explanation of coughing, as well as her concern for Telenoid's wellbeing is interesting as it collectively illuminates that there is a dynamic between them that is unfolding. Here the two are engaging in building a relationship that includes singing and laughter at odd remarks and happenings, which is far from what we thought to be engaging in when setting up the study.

Despite the Assistant twice having introduced Telenoid as a *robot-telephone-doll who collects funny stories*, Ethel has yet to offer a story or ask for one. This could perhaps indicate that she has appropriated Telenoid's function into her pretences, creating her preferred social interaction from what is offered to her.

Further on in the session we find the same pattern in the relationship between Ethel and Telenoid developing. Overall, Telenoid is introduced by the Assistant to Ethel who is often seated in her soft sofa with arms stretched in anticipation of holding Telenoid. After some initial greeting and perhaps a short off-topic conversation Ethel or Telenoid will suggest singing, which will then take up most of the session. This is seen at e.g. (Ethel 5, 00:49; Ethel 6, 00:05; Ethel 7, 00:28) and is found to be the overall *script* for openings. However, as we proceed to later sessions, Ethel's reaction to Telenoid becomes stronger, as exemplified at (Ethel 8, 00:12). Here Ethel starts to laugh as Telenoid approaches and she immediately engages in conversation with Telenoid as seen before.



Image 29: Ethel seeing Telenoid (left) at (Ethel 8, 00:12-B) and Ethel greeting Telenoid in laughter (right) at (Ethel 8, 00:23-A)

We also see examples of Ethel becoming increasingly aware of what constitutes normal interaction with Telenoid. At (Ethel 10, 00:13), when Telenoid mentions Ethel's name in an initial greeting, she claps hard and seems invigorated for a short while. She then turns aphasic, stutters and repeats fractions of two sentences, which roughly form "*And now we are going to sing together*". From this initial greeting it is interesting to see how Ethel remembers what we could characterise as normal interaction for the two, as singing constitutes a great portion of their time spent together. By remembering the activity as well as initiating it herself, as opposed to following directions from the Assistant or Telenoid, she shows a clear initiative. These two points are significant as they illustrate Ethel's progression from passive to active in social settings.

Indeed, we also find this relationship between Telenoid and Ethel after the four week break at (Ethel 11, 02:30). Here, the introduction of Telenoid to the setting makes Ethel laugh greatly and joyfully, immediately when it is brought through the door. To the question by the Assistant of “*Do you remember it?*” Ethel immediately states “*Ohh yes I do!*”. As Telenoid says “*Hello Ethel!*”, she sits up from her reclined position in the sofa, taps Telenoid on each side of the head and says “*Ohh hello hello, are you visiting me today*” in a joyful and high pitched tone while keeping in close proximity to Telenoid’s face.

From the initial closings we find the script of the typical closing of sessions to include often numerous promises to return by the Assistant with some injected topics of conversation by Ethel, in an effort to prolong the interaction as though wanting to prolong the session without telling Telenoid or the Assistant that the sessions ought not to end. This script is not changed over time, but as we see Ethel’s reaction to Telenoid become stronger over time following (Ethel 8), we also see the same change in the closing, beginning at (Ethel 7). Here we see the first decisive example of Ethel all but commanding Telenoid to return. In previous closings, Ethel has answered positively, and often repeatedly, to the *question* of whether she wanted Telenoid and the Assistant to return as exemplified in the initial sessions above. This time however, Ethel exclaims adamantly “*You **have** to come back!*” (Ethel 7, 22:42), and thus becomes an active force in the interaction in contrast to her previous passive role.

Sadly, the cameras are shut off just after the Assistant promises to do so, so we end this incident with Ethel starting to smile at the positive response. Indeed, at (Ethel 9, 21:15), where Telenoid and Ethel talks about her going to lunch with the others at the care facility, she continues to drive the conversation forward despite efforts to close it. Specifically, despite talking about the impending closing of the session and Telenoid leaving, Ethel makes no effort to hand over Telenoid or indeed close the conversation. This results in the Assistant physically removing Telenoid from Ethel’s hands. This would seem to indicate that while both Telenoid and the Assistant can identify signs that Ethel is in fact tired and a closing of the session is in her best interest, she is either not aware or more interested in prolonging the interaction.

Initiative and Appropriation of Telenoid

We knew that Ethel likes to sing and therefore encouraged this in an effort to both form an initial relationship and as a way of engaging in verbal activity. Therefore, it comes as no surprise that, with approximately 44 incidents, singing is by far the most frequent activity, compared to specific topics of conversation or other activities. While the initial goal was to form a bond with Ethel, it quickly became clear that while Ethel enjoyed the singing, she was far from always engaged in the actual activity. This section elaborates on how Ethel adopts an interesting posture toward Telenoid as well as how she appropriates and dominates the situation.

In an effort to gauge her participation in singing over time I performed a structured investigation of the 44 incidents in which Ethel sings during her sessions by determining the peak and mean level of participation, as determined by her verbal engagement in the actual singing or humming. This manner of investigation did not reveal any progression or development, but the investigation revealed that while Ethel did not seem to increase her verbal activity during the activity of singing, she showed initiative and was engaged and present to a degree that is not seen in incidents which does not involve singing. Initiative is of central importance because it is the opposite of the symptom of dementia described as Apathy and thus may reveal if conversations with Telenoid can alleviate this symptom. As such, this section focuses overall on initiative and Ethel's appropriation of Telenoid, with an emphasis on the activity of singing.

The first time we see Ethel showing initiative is at (Ethel 1, 06:40) presented above. Here, the Assistant asks Ethel if she has any children, and if she sang to them. Following an aphasic response from Ethel, she starts rocking Telenoid from side to side and starts humming a Danish children's song, which includes the chorus *"First we'll go one way, and then well go the other"*.

This is said in synchronisation with the rocking of Telenoid while looking and smiling at it. Ethel's initiative to start singing is not entirely spontaneous as the Assistant does ask regarding this activity, but her choosing to start singing a children's song does support the previous descriptions above regarding her view of Telenoid as a child, and her initiative is remarkable when compared to her actions and behaviour when not in interaction with Telenoid, as described in the introduction above.



Image 30: Ethel singing to Telenoid for the first time at (Ethel 1, 06:22)

At (Ethel 3, 00:47) Ethel casually remarks “*Is that fellow with you?*”. The wording of the sentence is casual to the point of being jovial, and her demeanour is certainly laid back and relaxed as shown in the images below, and she is attentive and smiling, while following the Assistant round the room with her eyes. Here Ethel is directly asking the Assistant for information, which in itself is a most rare occasion that only happens but a few times during the sessions, and is never directed to the Assistant, but always at Telenoid.



Image 31: Ethel sitting laid back, looking at the Assistant and Telenoid (left) (Ethel 3, 00:57- A) and Ethel with Telenoid (right) (Ethel 3, 01:21- B)

Ethel then twice asks if “*it*” is something the Assistant has brought, and twice answers positively to the question of whether she recognises it. As the Assistant sits down at (Ethel 3,01:20), Ethel adjusts her position, looks at Telenoid and all but grabs it from the Assistant’s arms with a subtle “*Come on then*”, in rising intonation and in the same manner one would welcome a small dog to jump into one’s lap. Ethel then starts laughing when Telenoid says “*hi there!*”. While Telenoid exhibits a technical malfunction and utters a loud metallic sound, Ethel is all but jumping around the sofa in anticipation and excitement.

While doing this, she is looking at the Assistant, asking what to do next and so Ethel does not react to the sounds that Telenoid makes. She instead takes the initiative to start singing. As she does this at (Ethel 3, 01:58) she makes a few fast-paced remarks about “*the lady*” to her side. Neither the Assistant nor the Operator acts on this, and the Assistant moves on to suggest a song and starts singing. Ethel starts laughing and then joins in. These actions are remarkable in almost every way. Ethel, who would decline invitations to social interaction, keep to herself and remain a passive presence in the rare gatherings she did partake in, is now jumping in the sofa at the chance – not to talk to a human being, but at a chance to talk to Telenoid.

These first examples of Ethel's initiative in social interaction and specifically in singing are also the most complex in terms of the verbal interaction back and forth between Telenoid, the Assistant and Ethel. In the following examples, we will see how Ethel is tight-lipped, offering mostly spontaneous utterances of "*and now what*" or "*come on then*" at times of momentary pauses, either between or immediately after singing, and to a lesser degree at the end of sentences by the Assistant, Telenoid or even herself. Overall, her participation in conversation is rising as described elsewhere in this explication, but during the activity of singing, it would appear that she refrains from talking or even engaging to the same degree as elsewhere.

The change is first noticed when the singing starts following the incident above. Here, at (Ethel 3, 02:16), Telenoid and the Assistant are humming with Ethel remaining silent and rocking Telenoid from side to side in her lap. When the two finish the first verse, Ethel asks "*and now what?*" without any pause. This immediate reaction could indicate that while Ethel is enjoying the activity and welcomes both it and the social aspect, she cannot, or will not, partake for whatever reason. When the trio resumes, Ethel remains mostly silent while at times humming in the correct intonation. This incident is comprised of approximately two and a half minute of singing, with Ethel being active just over a minute and the remaining minute and a half being filled with coordinating small talk and a stray conversation about "*the lady*". The structure seen here will become prototypical for later incidents of singing, with a duration of singing that is often separated by coordinating talk about what song to sing, between the Assistant and Telenoid and questions to Ethel about what song she would like based on suggestions. Mostly, Ethel does not respond coherently and the Assistant and Telenoid will start singing a song without her expressed wish, but to her delight.

Another interesting example is found at (Ethel 13, 12:09) where the Assistant suggests singing without Telenoid. Ethel agrees and participates to a degree of near inactivity while maintaining eye contact with Telenoid. As the song comes to a natural pause between verses, Ethel tells Telenoid "*And now you have to say Ethel!*", and places her forehead on Telenoid's before asking it repeatedly to say Ethel and "*say something*". The Assistant tries yet again to tell Ethel that Telenoid will not be talking due to massive technical difficulties in this session, but Ethel does not react to this and keeps shaking Telenoid lightly and tapping its head, and turning it toward the Assistant. At (Ethel 13, 14:25) Ethel asks the Assistant outright "*can you make him talk*", to which she says no. Ethel says "*ohh ok*" and then turns to Telenoid asking it to speak, tapping its head. Sadly, this is the last interaction between Telenoid and Ethel.

Versions of this is seen earlier at (Ethel 4, 14:00) where Ethel's initial humming turns into full singing for a short while, but she then relapses into humming, which is matched by Telenoid and the Assistant, who then hum the melody for 30 seconds. Singing in general brings much joy to Ethel and at the end she is quick in demanding, "*Can you do one more?*". The Assistant and Telenoid try another song, but without success. Here Ethel is sitting with her gaze directed at Telenoid without pulling a muscle.

This relationship of helping Telenoid sing becomes clear in a later session at (Ethel 8, 03:41), where we see early examples of how Ethel seemingly continues singing as long as Telenoid is singing with skewed timing, as though wanting to support it in the activity. This relationship and appropriation of Telenoid develops later in the session in which Ethel's overall behavior suggests her engaging with the purpose of driving Telenoid to be active in singing, as well as helping at times of technical difficulties. This incident, starting at (Ethel 8, 08:09) is interesting due to Ethel's reactions to Telenoid's singing in each verse, and thus requires a longer presentation than usually.

Initially, Ethel is adamant that Telenoid start singing and starts singing independently of Telenoid with great initial enthusiasm, while matching Telenoid's speed. In the second and third verse, there is some confusion as to the words in the lines, presumably due to her memory deficit and the speed and rhythm of the song. While Ethel remains mostly silent in the fourth verse, she is actively looking at Telenoid while mouthing what appears to be the correct words at the right times, as though not wanting to interrupt Telenoid's singing. The fifth verse is also sung by Telenoid alone, after Ethel asks "*and then what*" at the start and end, as seen before. Ethel starts coughing at (Ethel 8, 10:05) but continues to drive Telenoid to sing and utter some lines, but overall adopts the passive role seen before while seeming to enjoy the setting. Ethel starts some lines independently and correctly, but overall has a passive role in the second half of the activity, but only as long as Telenoid is actively singing.

During the final verse, Ethel repeats the last line of the verse several times, which includes "*having fun*", with great enthusiasm and bodily movement. As the song ends, Ethel seems to repeat a stray line from an earlier verse, as though she remembers that this line is part of the song, but fails to remember that the song has just ended. Telenoid indulges and sings the appropriate verse from the song, and at the end the Assistant asks Ethel if she is having difficulties in hearing "*it*" referring to Telenoid's singing. She does not respond but looks at Telenoid and mutters and speaks some undecipherable words in a rhythmic prosody as though wanting to initiate singing again. It is clear that she indeed wishes to restart the singing, but as she rocks the Telenoid from side to side, the Assistant asks if the Telenoid is heavy, and while she says yes, she is reluctant to hand it over. Doing this does however not break the focused eye contact between Ethel and Telenoid.

From the singing and interaction it is clear that not only does Ethel enjoy the activity, but her constant directed gaze at Telenoid and her facial expression, which is focused but not stern or anxious indicates that she has taken on the role of helping Telenoid sing and learning to sing, as she drives Telenoid on when pausing and singing lines at times of silence. While this is the opposite of what was intended with the interaction, it is interesting and positive in the sense that a previously non-engaging person is now prolonging interaction by her own initiative, and takes on the initiative to help others. After almost four minutes, the incident ends at (Ethel 8, 11:51)

We see this apparent attempt to help Telenoid learning to sing on its own again at (Ethel 9, 18:20) when Ethel asks “*and now what*” and Telenoid suggests a final song of the session and starts singing a song about “*Santa’s little helper*”. Again Ethel is mouthing the correct words during Telenoid’s singing and is only heard when Telenoid is either deliberately waiting for her to join in, or at the end of verses.

Despite Ethel’s overall strong use of statements like “*and now what*” during activities of singing, as well as statements posed as questions, there are but a few examples of incidents in which she initiates singing on her own accord. This is perhaps best seen at (Ethel 11, 21:50) where, following an intermission and period of silence, Ethel changes the subject to being cold and looks outside. Telenoid agrees and uses a sudden strong North Jutlandic accent, which prompts a smile and hidden laugh in Ethel as though recognising it.

Then, at (Ethel 11, 22:40) some 7:30 min after they last sung the song *Tingelingelater* at (Ethel 11, 13:36) Ethel resumes singing the first half of the first verse for no apparent reason while tapping Telenoid playfully on the head as she does many times during the sessions. Telenoid joins in as Ethel stalls in the middle of the verse and asks Telenoid “*and what now*”.

As Telenoid starts again, Ethel joins in with great vigour and enthusiasm and sings faster than Telenoid for some lines. As the two find a rhythm, they sing synchronously and without pause, with Ethel showing no signs of dementia or memory deficit. In this incident, it is interesting not only that Ethel shows initiative and starts signing by herself and thereby initiates an activity by herself, by she also participates far more than usual. In addition, we see how, in this incident, her use of “*and now what*” is not an invitation to Telenoid taking over or resuming singing as seen before, but rather an actual call for help regarding what comes next.

Investigating Telenoid

As presented in the above, the relationship between Ethel and Telenoid is one of care, singing and conversation. However, this overall positive relationship is not without flaws. This section is the result of numerous incidents in which Ethel investigates Telenoid either by questioning the nature of Telenoid or the setting itself, or by physically inspecting Telenoid's features. This often occurs at incidents in which Telenoid suffers from technical difficulties, as though these cause Ethel to investigate or re-evaluate the nature of what Telenoid is. Other times, the investigations occur without *provocation* e.g. with Ethel picking up Telenoid and turning it over without either Telenoid or Ethel having said or done something to initiate this behaviour.

The first *Investigation* occurs at the start of the very first session, when Telenoid does not function in any way. Here, at (Ethel 1, 02:50) Ethel is engaged in conversation with the Assistant regarding Telenoid. Ethel tickles Telenoid and places her forehead on Telenoid's, while adopting an overall positive posture for several minutes as shown on Image 32 below. This specific move is repeated several times over the course of the investigations Ethel make of Telenoid as well as at other times of apparent joy or happiness. Overall Ethel appears to resort to this move when wanting to illicit a response from Telenoid after a period of silence. When doing so she often changes mood from anxious or sceptical of Telenoid to her usual caring nature after the move, such as seen at (Ethel 13, 17:37).



Image 32: Ethel placing her forehead on Telenoid's at (Ethel 13,17:37-B)

Following a series of attempts to interact with Telenoid, who remains non-responsive, Ethel's previously positive and caring posture changes, and she now touches the eyes of Telenoid, lifting it up and remarking "*what ever is this*" in a mumble (Ethel 1, 04:30). Ethel turns Telenoid toward the Assistant, and accepts her offer to hold Telenoid while still calling it "*cute*". While Telenoid is with the Assistant, Ethel remains positive and engages with Telenoid, looking at both it and the Assistant. She then directs Telenoid to look at the Assistant with great laughter.



Image 33: Ethel turning Telenoid in laughter (Ethel 1, 05:07) (left), (Ethel 1, 05:12) (right)

Ethel then tells Telenoid to look at the microphone located at the Assistants chest, prompting the Assistant to ask if she want's Telenoid to look at her. As she smilingly says “oh sure, sure” Ethel moves on to investigating Telenoid eyes again, presumably finding them glasslike and artificial (Ethel 1, 05:23), she immediately leans back and withdraws from it as shown in the pictures below.



Image 34: Ethel investigating Telenoid's eyes (left) at (Ethel 1, 05:36) and the first time she withdraws from it (right) at (Ethel 1, 05:47)

Another type of physical investigation of Telenoid is seen at (Ethel 2, 03:00). Here Ethel has been engaging in her very first conversation with Telenoid for approximately 90 seconds. This positive interaction now fluctuates as Ethel starts questioning Telenoid's appearance and reacting to verbal distortion. Here, Ethel looks to the Assistant saying “it's weird” and starts physically investigating Telenoid's bottom and laughing when Telenoid moves its head. While Ethel does not seem afraid, anxious or reluctant to hold Telenoid, she does rest Telenoid in a lying position on her legs as shown in the image below.



Image 35: Ethel investigating Telenoid at (Ethel 2, 04:13)

This lying position is not a natural position to hold e.g. a child, and thus shows, to some extent that Ethel is aware that Telenoid is in fact not a normal conversational partner. While the position is only brief, she moves on to looking at the Assistant saying, “I don’t know”, and then starts singing on her own, while investigating Telenoid visually. Interestingly, she does not ask the Assistant for information, and in an attempt to motivate her to show initiative, she does not offer any at this time.



Image 36: Ethel investigating Telenoid’s features, and the Assistant redirecting attention at (Ethel 2, 17:00) (left) and (Ethel 4, 19:33) (right)

Ethel’s investigations of Telenoid can at times be redirected into activities. While a natural curiosity was considered good and, well, natural, it can impede the flow of conversation and in effect stop an otherwise good conversation. An example of this is seen at (Ethel 4, 15:28) when the Assistant uses Ethel’s interest in Telenoid’s features to start a rhyme on facial-features, which successful engages Ethel.

The last form of investigation occurs at (Ethel 6, 02:44) when the voice of the Operator is heard in the video, as well as by the Assistant in addition to verbal distortion and delay, causing the conversations to become fragmented. Telenoid tries several times to communicate but fails repeatedly.

As the Assistant takes charge and conveys this to the Operator by effectively describing to Ethel that Telenoid is having a bad day and may be “*sick*”, her facial expression changes for a second or two, until Telenoid speaks again with verbal distortion. It is clear that the actions of the Assistant to convey the status of Telenoid to the Operator has a positive effect on Ethel’s perception of the situation, but as this is followed by Telenoid behaving strangely, this is short-lived. In this case, Ethel does not outright investigate Telenoid, but it is clear from her actions and questions to the Assistant that she identifies Telenoid as having difficulties.

He, She, it or Kirk

Similar to the above section, this section is devoted to the explication of the nature of the relationship between Ethel and Telenoid. While the above section focused on more direct and explicit investigations of Telenoid, this section focuses on Ethel’s repeated and frequently changing use of personal pronouns when referring to Telenoid, with particular emphasis on Ethel calling Telenoid by the name *Kirk*. This section includes several incidents that have been presented in other sections, but are included and presented here with a different thematic focus.

He, she, it

In the initial session (Ethel 1, 01:23), Ethel’s first response when seeing Telenoid is an exclamation of “*What is his name?*”. As mentioned above in the section ‘Building a Relationship’, this would seem to indicate that she finds Telenoid to be male, and as she moves on to addressing Telenoid directly, we can assume that she at least finds it plausible that Telenoid can respond. Interestingly this initial categorisation as male is not static, as we see examples of her using “*they*”, and “*he*” and “*it*” when referring to Telenoid while in conversation with the Assistant (Ethel 1, 09:29), as well as in the opening of the second session at (Ethel 2, 01:17), when Ethel’s spontaneous remark is also off-topic when she asks the Assistant “*Do you think she knows?*”.

Again, as mentioned before, I believe that Ethel at this point sees Telenoid as an agent, and although the gender shifts and Telenoid at times is denoted as an artefact, her handling and verbal denomination of Telenoid is generally aligned with her viewing it as “*an agent capable of understanding and responding*”.

In addition to this view of Telenoid, Ethel seems to at times view Telenoid to be child-like, as she often addresses the Assistant with a clear sentiment of caring or looking after Telenoid such as seen at (Ethel 2, 01:50). Here Ethel several times ensures Telenoid that it will not be home alone and she will look after it. This incident is also the first time Ethel interacts with Telenoid, so her immediate positive and caring posture toward Telenoid is interesting in so far that it tells us something about her immediate impressions of Telenoid.

This caring posture is changed as Ethel changes her focus due to technical difficulties and verbal distortion in Telenoid at (Ethel 2, 03:00), resulting in Ethel looking to the Assistant saying “*its weird*” and starting to investigate Telenoid physically. This change in her perception of Telenoid over the course of little over a minute is interesting because it demonstrates the consequences of technical difficulties and unmet expectations yet again, as well as portraying the fluid identification Ethel has of Telenoid.

We also see a single use of *Paul* at (Ethel 2, 11:15), when Ethel, with no apparent cause, starts tapping Telenoid on the face, and asking “*Is your name Paul?*”. Telenoid asks who Paul might be, and the Assistant explains briefly that Telenoid is in fact Telenoid, to which Ethel has no reaction other than asking whether or not the three should go play outside. This seems to be in line with Ethel’s passing identification of Telenoid as a child, but offers no explanation as to the name *Paul*. The name does not appear in records or in later sessions, and on later questions on what Ethel might think Telenoid’s name is, she simply does not answer.

Kirk

We also find several incidents in which Ethel refers to Telenoid by using the name of one of her sons. To guard privacy, he is here known as Kirk. These incidents are predominantly found in (Ethel 6), but also occur in several later sessions before the five week break between (Ethel 10) and (Ethel 11).

From (Ethel 6, 06:07) and to the very end of the session some 13 minutes later, the overall conversational topic is her son Kirk. This phase in the session consists of several incidents, which I will condense below while keeping in mind that the incidents shown here are separated by other incidents, which are not included or relevant to this theme. Ethel is thus not engaged in one 13-minute conversation on one topic, but rather repeatedly returns to the subject of identifying Telenoid.

Ethel’s initial mention of Kirk is sparked by Telenoid trying to say something, which remains unheard due to technical difficulties. To this Ethel responds “*dammit I think its ‘Kirk!’*”, looking straight at Telenoid, and then starting to laugh when Telenoid asks “*do you think it’s Kirk?*”. Telenoid does not correct this, and plays along with this assumed identity, heavily impaired by technical difficulties and verbal distortion. After Ethel has identified Telenoid as Kirk, the nature of the conversation does not change from what is seen previously, as Ethel remains smiling, laughing and participating in activities, which are mostly offered by the Assistant or Telenoid.

Following this, at (Ethel 6, 09:10) Ethel starts smiling at Telenoid and then looks at the Assistant before asking Telenoid “*is this Kirk*” in a high pitch and clearly happy voice. Over the course of the following 20 seconds, there is a mixture of conversation taking place, as Ethel repeatedly asks Telenoid if this is Kirk, while

the Assistant is singing phrases from a song. Initially Telenoid answers Ethel “*Is this Kirk?*”, but starts singing before a response is offered. Ethel however takes a while to follow the Assistant in singing, and instead looks inquisitively at Telenoid. At the end of the song at (Ethel 6, 10:28) Ethel says “*Hello Kirk*”, indicating that she wants to talk, rather than sing. As Telenoid says “*Why Hello, Kirk*” Ethel starts laughing and, unfortunately, is interrupted by Telenoid who starts saying “*hello hello*”. It is quite clear from multiple viewings of the exchange that Ethel believes that Telenoid is *operated* by Kirk, as opposed to Telenoid *being* Kirk, and wants to talk to him, rather than sing. This sadly remains unnoticed at the time, and Telenoid and the Assistant moves on to singing another song without including Ethel in the process. After Telenoid and the Assistant have sung (Ethel 6, 11:03) Ethel remains adamant in talking to Kirk, and again asks “*is this Kirk?*”.

Telenoid now says, “*We can pretend that this is Kirk*”, which Ethel interprets as an affirmative answer, repeating “*Yes it is Kirk*”, and remains in this belief even as the Assistant and Telenoid repeats “*OK lets play that my name is Kirk and your name is Ethel*”. When given the time to engage with Kirk, Ethel still does not act in any changed fashion, and instead proceeds to lift Telenoid from her lap and investigates it briefly. In the following minutes the conversation is a mixture of several questions from Ethel asking, “*Is this Kirk?*” to Telenoid, and Telenoid trying to initiate a song or some other activity, but due to technical difficulties and verbal distortion, this remains an attempt. The session ends at (Ethel 6, 19:20) with the Assistant saying she and Telenoid will be back, to which Ethel seems joyful. As Telenoid says goodbye, Ethel points at Telenoid saying in a muffled aphasic voice “*That’s Kirk*”.

We find the same negotiation of identity in the later session (Ethel 9, 01:34) when Ethel asks the Assistant “*What’s its name*” and then to Telenoid “*what is your name*” when the Assistant does not answer promptly. Telenoid does not answer, but chooses to repeat the question back to Ethel, who responds with “*Ethel*”. Ethel then asks again, and Telenoid answers with a “*Well what is my name?*” in an effort to engage Ethel in identifying Telenoid. Ethel does not seem irritated at the non-answer, but turns to the Assistant, saying “*say something!*” with a smile.

At (Ethel 9, 02:10) Telenoid mentions that “*there was a day you called me Kirk*”, referring to (Ethel 6). Interestingly, Ethel takes this as an answer to her question and becomes aphasic when saying “*was Kirk out and...*” before beginning to mumble incomprehensibly due to aphasia. Her aphasic episode might here be instigated by sheer joy, as her bodily movements seem to suggest sudden happiness as she tries to speak. Telenoid then asks if Kirk is Ethel’s son and she agrees, placing her hands on Telenoid as she say “*Yes, that is my boy. My boy*”.

The Lady

This section is a result of Ethel's repeated mention of "*the lady*" sitting to her side. Below, I will outline some of the central incidents in which this happens, as they serve to illustrate one method Ethel employs to investigate the Assistant. Ethel mentions "*the Lady*" several times in all sessions apart from (Ethel 1), (Ethel 13) and (Ethel 5).

The first incident in which Ethel mentions "*the lady*" is at (Ethel 2, 07:00), where she, while heavily aphasic, gestures to the Assistant and talks to Telenoid about "*A lady*" sitting besides them. When Ethel introduces "*the lady*", the Assistant is quick to notice Ethel's use of the specific phrase and affirms this, with Telenoid saying "*and her name is Birgitte*". Telenoid then moves on to saying "*and you name is Ethel*", focusing the conversation on Ethel. This clearly amuses Ethel, and the following small talk and stray conversations put Ethel in a good mood. Over the course of the next minutes, Ethel tells the Assistant that "*this is amasing*", before turning to Telenoid, asking "*should we take a walk*" and then telling Telenoid that "*there's a lady sitting by me, and we're having a chat*". Ethel repeats this pattern with short stray conversations before returning to "*the lady*" as though having unanswered questions but never formulates these or puts them to the Assistant herself.



Image 37: Ethel smiling at (Ethel 2, 08:05 - B)

In the first minutes of interaction at (Ethel 3, 01:00), Ethel is visibly thrilled at seeing Telenoid again, calling out "*come on then*", reaching out to take Telenoid from the Assistant who is sitting down in the sofa. She then takes the initiative to start singing on her own, and as she does this, she makes a few fast-paced remarks about "*the lady*" to her side "*who wants to sing*". Here, the Assistant has not yet mentioned wanting to sing, so Ethel's mention of the lady wanting to sing may serve as a form of projection of her own desire to sing.

Some minutes later at (Ethel 3, 04:13) we see Ethel making remarks about the lady several times, but due to aphasia and technical difficulties with Telenoid, the Assistant does not notice this and proceeds with the activity of singing. Later still, at (Ethel 3, 10:12) Telenoid is experiencing severe but intermittent verbal distortion. As Telenoid is asking if Ethel has any good stories, she answers “*Yes, there’s a lady sitting here beside me and we, we are having a little chat*” with heavy mispronunciation of the words, as symptomatic of severe dementia. Telenoid explains that the Assistant’s name is Birgitte, and she is the one bringing Telenoid, before ending in vocal distortion. Ethel laughs this off saying “*it’s the damndest thing!*”, while looking at Telenoid. This is the first time we see the Assistant or Telenoid addressing Ethel’s mentioning of “*the lady*”, and they do this by simply explaining who they are and that the Assistant is bringing Telenoid. Ethel reacts to this by making repeated short aphasic remarks, which seem to calm her. While she expresses a joyful demeanour, she is unable to articulate initiative and specific things she would like to do.

In a later incident at (Ethel 9, 12:15) Ethel is asking the direct question of “*Who is that lady?*”. Telenoid explains that the Assistant is “*Birgitte*” and the Assistant confirms. Ethel then asks Telenoid if this is true, and the two exchange this a couple of times back and forth, but Ethel does not seem to have much of a reaction to this. Telenoid says Ethel’s name is Ethel, but Ethel mishears this as Telenoid saying its name is Ethel, and then seems to settle on the answer that Telenoid’s name is Ethel without wondering further about the chances of the two having the same name. Ethel then mentions the lady again, and the Assistant says her name is Birgitte. Isolated, this incident illustrates how, at times, information such as names or previous conversations can seem to not be remembered at all.

Some minutes later (Ethel 9, 16:19) Ethel, for the second and last time asks directly about the lady when she says, “*who is lady*”. This time in a manner and pace as though posing a question, which is a test rather than an opportunity to learn new information. This is done in much the same manner as during incidents involving singing. Here, Ethel is not engaging in singing, but articulates words from the song as though to reengage Telenoid in the activity.

Aphasia

This section is the result of numerous incidents in which Ethel is impaired by either expressive or impulsive aphasia. For the purpose of this section, as well as the dissertation in general I adhere to the definition by (Aphasia.org, 2016) stating that “*Aphasia is an impairment of language, affecting the production or comprehension of speech and the ability to read or write*”. In effect this is understood, as e.g. Ethel comprehending a word differently from what was said, or producing a different word from what was intended, which results in conversations becoming somewhat dissonant in nature. As such, Aphasia is a sub-theme related to the overall interaction, and due to its prevalence it is found in almost every incident.

When investigating Aphasia separately, we find a collection of incidents showing Ethel's gradual improvement in handling this impairing condition. There is no explicit scale used at the facility to gauge aphasia, and from their records we find only mentions that she does indeed have impressive and expressive aphasia, with expressive aphasia being the predominant. From the staff interview (Ethel Interview, 12:40 & 07:40) we know that she repeats sentences uttered around and to her, and that over the course of the study, she has become more prone to this, but less effected by aphasia overall.

In the first session, at (Ethel 1, 02:10), Ethel is severely aphasic, but continues to converse, and by using a very limited vocabulary she will often supplement words with gestures, such as pointing out the window toward a kindergarten when talking about children. The Assistant notes in her logs that while Ethel is impaired, she seems to understand what is said and done around her. The repetition is seen again in the following sessions with Ethel either repeating whole sentences or fragments such as one or two words.

Ethel's aphasia is seen in several ways, such as her inability to comprehend longer sentences. This is seen at (Ethel 10, 05:45) when Telenoid says "*I like singing with you*", which has no effects on Ethel other than asking, "*Can you?, And now what?*". Which is interesting in itself, as Ethel's use of "*and now what*" is seen several times in situations regarding singing or when she believes that the expectation to talk rests on her. In this case, I do not believe that the use of "*can you*" reflects an actual question to that effect, but rather that it serves much the same purpose as the following "*and now what?*". As such it is clear that Ethel either did not hear Telenoid or did not understand the implicit suggestion to sing.

Telenoid then asks "*Would you like to sing some more?*" to which, due to Ethel's aphasia, she tries to repeat but is unsuccessful beyond sounds resembling "*sing*". Telenoid now rephrases this to "*Yes, singing. Would you like to sing, Ethel?*". During this, Ethel's gaze has been on Telenoid, and her facial expression has been focused, but not emotional. When Telenoid finally asks, "*Would you like to sing the song about Mr. Sandman?*" Ethel smiles joyfully, and her pitch rises sharply as she says "*yes*". In line with aphasia, Ethel here shows an inability to comprehend spoken language in volume, which forces people around her to adjust both their length of sentences as well as their vocabulary. In effect, we see how Ethel responds more positively to direct questions regarding singing a specific song rather than if she wishes to sing.

Ethel's development in terms of managing her aphasia becomes clear in the later sessions as seen e.g. at (Ethel 6, 01:45). Here Ethel becomes severely aphasic, and starts talking about the "*massive snowfall*" and not being "*able to come out*". In previous sessions, Ethel would either abandon the sentence or, with the help of Telenoid, attempt to find the words, which were causing the trouble.

In this incident however, as well as overall in this session, Ethel stops for less than a second while severely aphasic, and takes a breath and resumes her utterance with success and no help from others.

Moving to later sessions we see incidents in which Ethel seems to have improved in her ability to *work through* her aphasic episodes both with and without help and in doing so continues to attempt to find the correct words despite severe aphasia. This is seen e.g. at (Ethel 8, 00:12) during the initial greetings of the session where Ethel is severely aphasic while trying to say several things seemingly at once. Over the course of the incident she manages to produce "*and now we [are going to]*" but cannot finish the sentence. After several attempts to finish the sentence with help from the Assistant, she stutters "*sinj*", which Telenoid interpreters as "*sing*" and from there it is determined that the three are going to sing. This aphasic episode is different from earlier ones as both the Operator and the Assistant are better at understanding Ethel when she is aphasic, and when Ethel is aphasic she continues for longer than in earlier sessions. This improvement, while sporadic, is found in short durations of a few sentences at a time and more frequently in later sessions.

Technical Difficulties and Limitations

The purpose of this section is to present examples of the different types of technical issues occurring during operation of Telenoid in Ethel sessions, as well as the limitations they cause to the interaction. These aspects have been touched upon in other themes above, but are combined here for clarity.

Telenoid's movements are generally not delayed, but the signal is sometimes in error, causing Telenoid to move abruptly. This is seen in (Ethel 2, 15:13) when Telenoid makes a three second rather abrupt spastic movement with the neck, causing Ethel to look directly at Telenoid and say "*It, it looks ugly*". The Operator presumably mishears what is being said, and says, "*There's no one laughing here*".

This incident exemplifies two major concerns with Telenoid. First, the present result of the abrupt movement is a clearly negative reaction on the part of Ethel. In the moments leading up to this incident, there are no signs of Ethel having a negative posture toward Telenoid, and it would seem that the sole cause of her rather direct and negative remark about Telenoid is the abrupt movement. While the software makes sure that the movements are not violent in their acceleration, this error also causes a potential hazard due to Telenoid's normal placement close to the user. Simply put, the abrupt movements can likely cause Telenoid to head-butt the user with significant force.

The second concern revealed in this incident is that of the Operator mishearing what Ethel is saying. In this case, the Operator interrupts a short conversation between Ethel and the Assistant with a response to a remark, which was regarding Telenoid, but directed at the Assistant.

In addition, the response offered has no relevance to the remark, and as neither Ethel nor the Assistant reacts to the response made by Telenoid, Telenoid repeats and adopts a posture in the conversations, mirroring the belief that it was just tickled, when in fact Ethel has adopted an arguably opposite posture. The root of this issue is the limited field of vision offered to the Operator before the camera in the forehead of Telenoid was installed.

In the early sessions the only view offered was the overview angle from one of the cameras placed several meters from the actual interaction, and with a severely reduced image quality. The audio is transmitted from microphones in the ears of Telenoid, but as explained above, it is accompanied by a near constant fast paced ticking sound at low to moderate volume, which makes both identifying one voice among several or identifying the actual words in a mumbled sentence quite hard. With the addition of the camera in the forehead of Telenoid, the field of vision was improved adequately, but the transmission is still subject to intermitted drops in quality, synchronisation and availability meaning it will degrade in picture quality, image and audio and appear out of synchronisation and sometimes disappear or *freeze up*.

As mentioned, the most frequent technical difficulty is verbal distortion. We see this several times in every session, from minor glitches, which are overcome momentarily, to minute-long distortions, which cause Telenoid to withdraw from conversation and several times require the Operator to restart Telenoid. Whether the Operator chooses to do so or not, the inactive Telenoid is a frustration to Ethel on several occasions. This is seen e.g. at (Ethel 3, 08:30) when a verbal distortion effectively ends the activity of singing causing Ethel to start shaking Telenoid in frustration somewhat violently asking “*What should we dooooo?*”. It is unclear if this reaction is due to Telenoid singing at low volume or due to the vocal distortion, but the anxiety and frustration in Ethel is clear and unwanted. Telenoid manages the situation by asking Ethel “*Are you shaking me?*”, to which Ethel responds “*Am I not allowed to do that?*”. Telenoid answers that “*well, yes you are when it’s sweet old you Ethel*”. Ethel’s response is muffled by heavy aphasia at (Ethel 3, 09:46) but with the help of Telenoid, she repeats that her response was “*I’m asking if you want to talk to us*”.

In the space of little over a minute, this incident includes both vocal distortions, dissonance in conversation and aphasia, as well as somewhat violent reactions by Ethel. It is interesting to see how Ethel changes her reactions to Telenoid in the face of frustration, which is in sharp contrast to what is seen earlier. Presumably, this reaction is not one you would find if we presented her with a toddler or dog, creating havoc and behaving as toddlers or dogs do. As such it either tells us something about her view of Telenoid as either robust enough to withstand a shaking, or that she has a moment of disinhibition due to frustration, as severe dementia can cause.

As for incidents in which the Operator chooses to restart Telenoid, or close the session in the event that this does not resolve the issue, the Assistant and the Operator has a protocol established. This is exemplified in (Ethel 3, 11:30) when Telenoid suffers technical difficulties and verbal distortion, which results in Ethel's face turning stern and tense in a situation of singing and laughing. Telenoid lets the Assistant know that this seems to be a persistent problem with the code by saying "*I think my voice is growing tired*", causing her to start closing the session by making remarks about them having to leave and promising to return.

A few times Ethel physically animates Telenoid's body when it lacks motor function. This is seen e.g. at (Ethel 8, 13:29) while the three are humming a melody and Ethel is touching Telenoid's face gently and tries to force it's head upward. During the humming, the head is tilted somewhat downward toward Ethel's stomach. After verse one Ethel does not wait to ask "*and then what*" as she has done before and she moves on to play with Telenoid's face and nose, talking directly to it and maintaining close eye contact and proximity, while the Assistant is holding Telenoid. Ethel's movement of Telenoid's head during this incident indicates that she is eager to reorient Telenoid's gaze to a traditional focus on the eyes instead of Telenoid's present gaze directed at Ethel's body and lover abdomen. It appears that this is not due to Ethel feeling uncomfortable. If this were the case, she would likely have opted to rearrange Telenoid's entire body as seen before, but as she chooses to attempt to move only the head this could indicate that she is, at some level, caring toward Telenoid. Additionally, this issue is likely to be a result of the Operator not being able to see precisely in which direction Telenoid is looking.

Concluding on Ethel's interaction with Telenoid

The purpose of this section is to provide a summary and discussion of the above analysis explicating the interaction between Telenoid and Ethel, referring to the themes of Interaction Script, Relations and Technical Difficulties and Limitations.

Concluding on Interaction Script

As presented above, the interaction between Ethel and Telenoid, has a positive point of origin, with Ethel embracing Telenoid and starting to form a relationship, which follows a particular script from their very first meeting. This relationship develops positively over time, and while there are short periods of some minutes at a time in which Ethel is sceptical of Telenoid, the overall relationship is that of *welcome acquaintances* with a jovial undertone.

In the sessions we see two common activities: Singing and off-topic conversation. In the conversations Ethel is often passive in steering the topic, but will at times offer a statement about what she sees. Ethel will often not react to questions or statements meant to initiate a conversation or answers at random, but as times goes by her engagement and attempts at answering grows more frequent.

While the repetition of stories or topics of conversations is often seen in persons with dementia, Ethel never offers these, and asks no personal questions other than those few to Telenoid regarding identity, which are found mostly in (Ethel 6) when she views Telenoid as her son 'Kirk'.

First proposed by the Assistant and Telenoid, the activity of singing is a recurring activity meant to engage Ethel and build a connection to her. The activity is repeated some 44 times, and while there is no discernable increase in her activity in these incidents, she does show remarkable increase in appropriation of the activity. In doing this she takes on the role akin to teacher and controls the activity by creating a setting in which it is not Telenoid and Ethel singing together, but rather Telenoid singing to Ethel, with her monitoring. This is despite her not correcting Telenoid at any time. This would seem to indicate that while she enjoys the activity as a whole, she is more comfortable with being in a situation of singing, rather than in an activity of singing. The point here may very well be that, due to her history with singing, she enjoys this, but due to dementia she cannot remember the lyrics, and thus finds indirect ways of engaging in pleasant situations without having to commit to singing. This is seen in the several incidents in which Telenoid either takes over singing or Ethel simply does not offer more than the casual remark in an apparent effort to prolong Telenoid's singing.

Outside of singing we see the same form of appropriation, initiative and involvement in the interaction. Centrally we see striking differences between sessions (Ethel 2; Ethel 3) and (Ethel 5; Ethel 6), as her initiative in offering opinions, thoughts and suggestions for activities improves from almost non-existent to a steering factor in the development of the interaction. This overall mirrors her initiative in the singing activities.

Centrally, it is clear that while we found it possible for Telenoid to function in the role of a welcome conversational partner, we had only small hopes for the witnessed level of intimacy and emotional connection between Ethel and Telenoid. As mentioned in Chapter 3, we had contingency plans for situations where the participant had formed too strong an attachment to Telenoid. Acknowledging the memory deficit associated with dementia we had only hoped for Ethel or other participants to form a simple relationship with Telenoid. With Ethel remembering not only Telenoid itself, but also what constitutes normal activities and interaction – singing and Telenoid placed in Ethel's lap, touching and caressing of Telenoid's face – is remarkable. This is seen in addition to her increased social interaction and verbal activity and vocabulary, as well as her appropriation and use of Telenoid.

As presented above, Ethel's initial reaction to Telenoid is commonly one of delight and, over time, increasing familiarity and intimacy. After a period of seven sessions over the course of 20 days, the two have built a relationship in which she is so familiar with Telenoid that she has formed a clear understanding of what is normal

interaction in this setting that she adopts readily at the inception of each following session. While engaging in this normal interaction of conversation and singing, she has progressed from accepting suggestions to interact, to actively calling on Telenoid to do this. For a person with severe dementia, which, as presented, is characterised in part as a “*complete inability to retain new information*”, the fact that while Ethel may not remember what occurred in the last session, but still has a clear relationship with Telenoid on which to build, is remarkable. However, this alone does not entail that Socially Assistive Robots perform better than humans in creating social relationships with persons with severe dementia, but the fact that they *can* remains a primary finding in this dissertation. In addition, we see how Ethel moves from avoiding social interaction before the start of the sessions, to actively calling for Telenoid and the Assistant to return at the end of later sessions. This in itself underlines the inherent need for social interaction in humans and raises the questions of whether Telenoid can provide this need for social interaction and if it can function as a social stepping-stone on the path to at least also seeking out social interaction on her own.

Concluding on Relations

It takes six sessions for the relationship to reach maturity and stabilise. This is seen in the changed dynamic between Ethel and Telenoid, with Ethel progressing from not mentioning the possibility of return at the closing of sessions, to demanding that Telenoid and the Assistant return. In addition we also see Ethel progressing from accepting calls to interact or engage in specific activities, to actively suggesting or initiating them herself.

Regarding Ethel’s relations to Telenoid we must acknowledge the presence of the technical difficulties, which are found in all sessions and often cause severe impairment to the potential of Telenoid and the relationship between Telenoid and Ethel. Despite these issues, the relationship progresses positively with the help of the Assistant, and it is highly doubtful that the level of positive relations between Ethel and Telenoid would be archived if the Assistant had not been present to function as an interpreter and social support for Ethel. When these technical difficulties occur, Ethel is more prone to lose focus and start investigating Telenoid physically or verbally by asking the Assistant about it.

Her investigation of Telenoid suggests that she does not have a set or stable identification of Telenoid, as she treats Telenoid both as an artefact and an agent in her physical handling as well as her use of personal pronouns. This is not surprising in itself, but it is interesting that it appears that she is more prone to overall relate to Telenoid as an artefact in times of technical difficulties, which suggest that the stability of Telenoid’s software should be improved so as to provide a stable interlocutor and thereby help maintain the relationship between Telenoid and whoever uses it.

We see sporadic examples of Ethel relating to Telenoid by using defined names other than “*he, she or it*”; namely “*Kirk*”, the name of her son. While I cannot find a characterisation of the relationship, which accounts for why this occurs, it is interesting that Ethel, during the course of the sessions in which she finds Telenoid to be, or to be controlled by, Kirk, seems to actively attribute Kirk onto Telenoid, despite the Assistant explaining that this is not the case. It would seem that Ethel here tries to apply a known personality onto the simplistic design of Telenoid, perhaps provoked or initiated by a recent visit from Kirk. Over the course of the sessions, Ethel appropriates Telenoid and moulds the interaction by increasingly taking charge of the setting and activities. Her handling of “*Kirk*” in (Ethel 6) session suggests that she is, at least at that time, aware that Telenoid is teleoperated, and that this bodily appearance is not in fact her son. This is a different viewpoint than the caring nature seen especially in the earliest sessions (Ethel 1 & 2), which may be attributed to her initial categorisation of Telenoid based on noting its appearance and the Assistant’s holding of Telenoid as one would a small child.

During the sessions there is no apparent development in Ethel’s use of personal pronouns over time, which could have indicated e.g. her initial viewing Telenoid as an artefact and then progressively viewing it as an agent. However, her use of personal pronouns and physical handling of Telenoid are related to her view of Telenoid and thus to the role Telenoid takes in the interaction. While Ethel is prone to referring to Telenoid by using “*he*” or “*she*”, this is not always the case. In the cases when she refers to Telenoid by “*it*”, her reaction to Telenoid does not seem changed or altered and when reviewing sessions as a whole, her use of personal pronouns does not reflect her visible or mentioned posture toward Telenoid’s identity at the time. As such, her use of personal pronouns is inconsistent and does not reveal significant information about her attitude toward Telenoid. There are some incidents in which the pronoun used by the Assistant is mirrored by Ethel, but these are few and the mirroring occurs sporadically in these cases, which would suggest that these incidents are a mere case of chance.

Regarding the Assistant, we see little development in the relationship between the Assistant and Ethel, which starts out friendly and polite with a natural tendency to hold hands. While this behaviour is not uncommon in a Danish setting, the fact that the relationship does not progress during the course of the sessions is notable, when compared to the development seen in the relationship between Telenoid and Ethel.

Ethel consistently refers to the Assistant as “*The Lady*”, and does so by addressing Telenoid regarding the Assistant, rather than addressing the Assistant regarding who she is. This may be due to Telenoid eliciting fewer non-verbal signals and is thus perceived as a more manageable social presence. This is of course speculation as to Ethel’s motives, and while there may be other explanations, this does provide an answer that takes the information at hand into account.

It is interesting that Ethel only once addresses Telenoid with a question of who the Assistant is, as well as once directly posing this to the Assistant herself. In all other cases she resorts to stating to Telenoid that the lady is present, often without apparent motivation. When offered information about the Assistant, she often does not seem to react, but instead enters a circular and fragmented pattern of conversation compounded by aphasia. We see the same sort of behaviour in recognising that Ethel is prone to uttering statements rather than questions when she is investigating Telenoid, but here her verbal investigations manifest as questions of identity and origin, posed predominantly to the Assistant, while there are only a few examples of Ethel asking Telenoid itself. Thus, Ethel's mentioning of "*the lady*" may be a tactic to investigate the Assistant. It remains unclear why the question is not posed to the Assistant herself, as Ethel regularly asks the Assistant e.g. to make Telenoid talk (Ethel 13, 14:25), what Telenoid is saying, what Ethel is to say now (Ethel 10, 09:10) or where Telenoid comes from (Ethel 1, 05:40).

Due to the amount of verbal interaction in Ethel's sessions we are able to investigate the positive improvement in her ability to engage in conversation despite an aphasic episode. It is however difficult to separate those incidents, which are significant from those that are accidental. This is due to the nature of Ethel's aphasia, which, in terms of severity and frequency, is constantly changing. Despite this, I claim to see a positive tendency in Ethel's functional vocabulary during these episodes, and in her ability to *work through them*. Specifically we see, in the earliest sessions (e.g. Ethel 2; Ethel 3), that there are frequent incidents where she stalls and then stops uttering a given sentence after trying for a few seconds. While these incidents remain in the later sessions, they are fewer and they are supplemented by incidents in which she tries for longer, and occasionally succeeds in forming comprehensible meaning. In addition, and perhaps most of note, whether she stalls or not, she does so with a smile on her face. On this the Assistant has noted that she believes this to be the result of Ethel acknowledging her impairment, but not feeling embarrassed. From the video this is not evident, and the notion here is anecdotal, it is included in (Staff interview Ethel, Ethel 5 & Ethel 6) with remarks of her "*using all of her restricted vocabulary*". While only loosely grounded in the data, it appears that Telenoid in interaction with Ethel causes her ability to work through aphasic episodes to increase, and that she appears to have a larger vocabulary than otherwise or previously. This in turn may very well influence her willingness to engage in social interaction and conversation outside the sessions, as reported in (Staff interview Ethel).

Concluding on Technical Difficulties and limitations

Ethel's unfortunate experience with Telenoid's technical difficulties tells us what can happen when the expectations of Telenoid are not fulfilled. In the case of the first interaction, Ethel either has or develops the clear expectation that Telenoid can talk, which we see when she addresses it directly. When there is no answer and

Telenoid does not move, the inanimate bodily appearance presumably triggers negative emotions in Ethel leading to rejection. This is seen again in subsequent incidents of technical difficulties where Ethel's attention is no longer centred on the conversation, but on the inanimate bodily appearance of Telenoid. In the few cases of Ethel investigating Telenoid without technical difficulties present, the topic of conversation is often Telenoid itself. Overall, the frequency and severity of technical difficulties severely impair the performance of Telenoid and the relationship unfolding between Ethel and Telenoid. As presented elsewhere, Ethel and Telenoid do have an overall positive relationship despite these technical difficulties, and I believe that this is due to the excellent performance by the Operator and the Assistant.

5.2.2. BEATRICE

Beatrice joined the care-facility in late 2012, some 29 months before the study. During her life, she has worked several different jobs and has three children as well as several grand children. After retiring in 87, she enjoyed the company of her family as well as physical activity. She has however become frail and is no longer as physically active as before. Beatrice enjoys engaging in social activities with both staff and residents, but also requires time to herself so as not to become over stimulated. When this happens, she can and will tell staff and residents, but requires help to tell e.g. family to leave. Her use of language is not affected by dementia. Due to low appetite she is weighed once a week. Compared to other participants, and residents, Beatrice is unusually articulate and still retains most of her social and verbal skills as seen in her fondness for social activities and upholding proper social conduct. She relocated to the centre due to a diagnosis of dementia and was accompanied by her husband who lived almost next door for some time before passing away some time ago. She was included in the Telenoid-group in an effort to broaden the range of verbal skills in the participants. As a result, Beatrice is able to remember and actively do far more than most other participants or residents.

The quantitative data recorded for Beatrice shows two minor inconclusive changes in her MMSE-test (19-20/30) and NPI-NH 4-9/120, which show an increase in apathy. The OERS show Beatrice as increased with respect to *Happy*, but less *Actively present* in social interaction and less *Nervous*. Unfortunately, the exit interview pertaining to Beatrice has been lost.

5.2.2.1 Session overview

While it was first intended that she should participate in the Telenoid-group, this was discontinued after two sessions due to ethical concerns. As a result, I focus mainly on the two first sessions, and then provide a general overview of Beatrice's interaction with the Assistant in the following sessions.

Beatrice 1

This is the first of the two sessions in Beatrice's *Telenoid-interaction*. In this session, Beatrice has no indications of a diminished vocabulary or signs of dementia. She tells the correct tale of her childhood in great detail, makes and understands jokes as well as giving her opinion on Telenoid's appearance, which she finds "nice" and not to look like anyone in particular. She does state that she finds its head movement to be irritating. Throughout the some 12 minutes of interaction, Beatrice remains in almost constant eye contact with Telenoid, only looking at the Assistant at the start of the session.

Beatrice 2

This is the second of two sessions in Beatrice's *Telenoid-interaction*. As in (Beatrice 1), Beatrice is verbally active and keeps eye contact with Telenoid throughout the session, makes and understands jokes and tells stories in great detail. There are several incidents in which she is sceptical about the presence of Telenoid and "it not responding", despite long and uninterrupted conversations between the two. After this session Beatrice made it clear to care-staff that she did not wish to talk to Telenoid again but would like to see "the nice lady with the curls", referring to the Assistant. As a result, she was removed from the Telenoid-group.

Beatrice 3

This is the first *Post-Telenoid* session with Beatrice, five days after (Beatrice 2). Beatrice engages in conversation with the Assistant without any problems, and can easily present arguments to her opinions and statements, describing her young life in great detail in stories spanning several minutes, but acknowledges her own lacking memory at times. Beatrice asks very few questions, offers many details in her answers and appears to enjoy the interaction.

Beatrice 4

This is the second *Post-Telenoid*' session, recorded seven days after Beatrice's last encounter with Telenoid. While the Assistant mentions Telenoid, it is unclear if Beatrice remembers it. There is no mention of Telenoid in the conversation beyond the initial greeting. The Assistant finds Beatrice to be more inquisitive than before. As before, Beatrice offers details about stories and seems to enjoy the interaction. Complains of dry mouth due to more than usual talking, which the Assistant finds to be true.

Beatrice 5

In this fifth session with Beatrice, she engages in conversation, but seems somewhat tired, offering shorter sentences and less information than before. Says she is not bored living at the facility. She clearly remembers the Assistant, and asks her several times when she was there last. Does not mention Telenoid.

Beatrice 6

This sixth session is unchanged from previous sessions in the sense that there is a close and personal conversation between the Assistant and Beatrice, who offers a great number of stories and opinions on many topics. Beatrice is relevant and alert throughout, and in the middle of the session, almost five minutes of conversation is spent on her late husband and their life together. The conversation is not inappropriately personal to the relationship, but certainly touches on personal issues to which Beatrice elaborates greatly, even after the Assistant changes the subject.

Beatrice 7

This seventh session is much like previous sessions with a varied breath of topics and good chemistry between the Assistant and Beatrice who is engaged and alert throughout. In addition, Beatrice offers a great number of thoughts on the topics and does not seem significantly affected by dementia. The Assistant has the distinct impression that Beatrice remembers her, but not precisely what they have talked about.

Beatrice 8

In this session Beatrice is served breakfast in her apartment and after a period of initial silence while having breakfast she continues to engage in conversation. The position is nowhere near ideal. It is possible that Beatrice's attention to proper social form keeps her entertaining. Beatrice is, when not eating, active, alert and present in the conversation.

Beatrice 9

In this ninth session, Beatrice appears almost asleep during the session and refuses to end the session despite several attempts. The Assistant is far more active in this session, asking more questions and receiving shorter answers, apart from a few longer stories, which overall contain less detail than usually; this may well be due to fatigue. The Assistant notes that Beatrice appears to remember her and somewhat sadly tells her off camera that she has "*loved talking*" to her these past weeks, as a reaction to the Assistant saying this is the last planned session.

Beatrice 10

This 10th session is the only session with Beatrice in the final extension of the study, conducted some five weeks after (Beatrice 9). Since the last session, Beatrice has had a significant fall and has been in severe pain, causing her mood to decline greatly. In the days prior to the session, the Assistant has made attempts at initiating sessions, but Beatrice has been too frail for this. In this session, Beatrice greets the Assistant with a heartfelt welcome and tells her she remembers her visits but not topics with a great smile. The conversation is conducted face to face at a low and intimate pace. The Assistant notes that holding this position clearly helps Beatrice read her face, and then introduces topics, which she has known Beatrice to enjoy from past sessions.

5.2.2.2 Explication of Beatrice's Interaction

As mentioned in the above, Beatrice's interaction with Telenoid is divided into *Telenoid-interaction* found in (Beatrice 1 & 2) and the *Post-Telenoid interaction* found in sessions (Beatrice 3 - 10). As with Alice, I have chosen to apply the themes from the conclusions as headings to her explication in an effort to guide the presentation, using additional subheadings when appropriate. Due to Beatrice engaging with Telenoid in just two sessions, this explication is naturally shorter than otherwise seen.

Interaction Script

In Beatrice's interaction with Telenoid, we overall see an initial positive reaction, as well as both a continuing positive conversation and engagement in the interaction. In both of Beatrice's sessions with Telenoid, she maintains a static posture with Telenoid in hand.



Image 38: Beatrice's posture throughout both sessions (Beatrice 1, 04:23)

This posture, as noted on the image above, is one of physical proximity as well as maintained eye contact throughout the some 10 minutes of actual interaction found in either session. The conversation between the two is continuous, with Telenoid asking questions and Beatrice responding with relevant answers, providing relevant stories with great detail and occasionally making a joke. Beatrice initially remarks about the appearance of Telenoid and its head movements being annoying (Beatrice 1, 09:20), and its appearance being both “nice” (Beatrice 1, 01:25), “laughable” (Beatrice 1, 05:00) but “looks like no one in particular” (Beatrice 1, 03:35). At times Beatrice will note that she cannot hear what Telenoid is saying, and in both sessions she becomes annoyed about this, as exemplified here in the second incident found at (Beatrice 2, 10:20). Here, after a longer conversation prior to this point in which Telenoid and Beatrice have been in eye contact, Beatrice utters “he doesn't respond. I'm fed up with it”, and then looks to the Assistant who asks her

what she means, explaining that a voice is coming out of Telenoid. Beatrice agrees and says “*I do not know*” as though accepting the Assistant’s statement but still displeased with something she cannot or will not elaborate on. Telenoid then explains that “*I work just like a phone*” to which Beatrice responds “*Is it possible that he’s soon done talking with me?*”, directed at the Assistant (Beatrice 2, 11:01). As a result Telenoid suggests taking a break or ending the session, to which Beatrice says “*Ohh thank you*”. Beatrice agrees to a visit at a later time, being almost superfluously gracious in her use of “*please*” and “*ohh yes*” in her acceptance. Relevant to understanding this incident is at least three pieces of information. First, we know from facility records that Beatrice has trouble rejecting family when they visit. Secondly, we know that she likes to engage in conversation and has no apparent issues with doing so, as evident from facility records as well as session recordings. Lastly, Beatrice is known as someone who cares about proper social conduct and discretion.

In Beatrice’s interaction with the Assistant (Beatrice 3-10) there is no significant change in behaviour compared to what is seen in (Beatrice 1-2). Beatrice appears engaged in conversation and has both overly active and less active day, offering sometimes more and sometimes less detail to her stories. On occasion, these span several minutes (Beatrice 3, 16:30) and include e.g. references to complex family structures and she will correctly help the Assistant remember the names and relations of family members.

Relations

Apart from an initial apprehension in the first greeting in both sessions, Beatrice engages with Telenoid almost without reservations. While she expresses her desire to end the sessions, as described above, her interaction with Telenoid is physically close as well as humorous. Beatrice never asks Telenoid where it is from, but there are several incidents in which both the Assistant and Telenoid explain what Telenoid is (Beatrice 2, 11:01), and that it is there to be *tested*. There are also several incidents in which Beatrice remembers who is talking. Here, neither the Operator nor the Assistant makes any attempt at disguising the fact that Telenoid is operated by someone she has met and who is sitting very near (Beatrice 1, 01:10). At one point Telenoid suggests singing, but Beatrice quickly rejects this, “*ohh no I don’t have a single good note in me*”, and then tells of her late husband who sang at the top of his lungs all the time (Beatrice 2, 07:10). Interestingly, Beatrice clearly does not remember Telenoid at the inception of their second session (Beatrice 2, 01:00). In her later *Post-Telenoid interaction* sessions, there is one mention of Telenoid (Beatrice 4, 00:02) and it does not appear that Beatrice remembers Telenoid in any particular detail, other than “*a white doll*”, which is often the description offered by the Assistant. In the last session Beatrice appears to laugh lightly at the Assistant’s mention of Telenoid, even before having mentioned this description (Beatrice 10, 01:30). It remains unclear if this is a result of her remembering Telenoid or a reaction to hide memory deficit.

Beatrice makes little use of the Assistant in the sessions in which Telenoid is present. Overall it appears that she acknowledges the *test-setup* and plays along with this. As such, the Assistant performs her role and mostly serves to repeat what Telenoid says when Beatrice does not hear.

In Beatrice's *Post-Telenoid-interactions*, the relationship between the Assistant and Beatrice is one of welcome and trusted conversational partner, as Beatrice frequently states that she remembers the Assistant (Beatrice 5, 07:40), but cannot remember the topics of conversation. Beatrice will frequently engage in conversation to the point that she complains of sore or dry throat, caused by her not being used to talking this much (Beatrice 3, 10:00), (Beatrice 4, 13:20). Both care-staff and the Assistant agree that this explanation is genuine.

Beatrice and the Assistant form quite a personal relationship during the course of the sessions. This is seen in the greeting in their last session (Beatrice 10, 00:20), with Beatrice greeting the Assistant with outreached hands and a warm smile and in their conversations touching on personal issues – e.g. with having children or the death of her husband, on which she elaborates greatly (Beatrice 6, 09:10).

Technical Difficulties and Limitation

In Beatrice's two sessions with Telenoid, there are no pronounced technical difficulties in the operation of Telenoid, which impair or influence the interaction. However, Beatrice does note that (Beatrice 1, 09:20) "*oh wow I think that's annoying*", in reference to Telenoid moving its head. This movement is done in an effort to animate the robot's appearance and appear more lifelike. As a result, Telenoid scales the movements down in the remaining interaction between the two.

Concluding on Beatrice's interaction with Telenoid

From Beatrice's dementia-evaluation we know that she is far from *Severe dementia* and that she retains many of her social and verbal skills. I suspect that if a Participant retains these skills, Telenoid becomes less appealing and that this is the reason for Beatrice rejection. This conclusion falls in line with the overall beliefs of the care-staff who have maintained this since the Pilot study. Simply put, Telenoid is not a tool for persons with dementia who still enjoy and seek out social interaction on their own. Indeed, Beatrice herself condenses this at (Beatrice 8, 12:15) when responding to the Assistant's explanation as to why they brought Telenoid to the facility: "*I would much rather just talk to you*".

Concluding on Interaction Script

With regard to Beatrice's interaction with Telenoid, it is evident from the sparse data collected in the two sessions that while Beatrice appears to engage gladly, she evidently did not see the point of Telenoid, and Telenoid, the Assistant and Beatrice make jokes about this on a regular basis. The conversations are not prone to irritation and anger. Despite this, Beatrice rejects interaction with Telenoid both at the end of (Beatrice 2) and later off camera to the care staff. Here she asks that conversations with the Assistant be held instead.

In Beatrice's *Post-Telenoid interaction*, she appears just as eager to engage in conversation as in the first two sessions. In the absence of Telenoid, Beatrice engages in a great deal of direct conversation with the Assistant, which causes the formation of a strong personal relationship between the two.

Concluding on Relations

Beatrice's relation to Telenoid is quite straightforward, as she often, to some extent, remembers both who is operating Telenoid and why. As a result Beatrice never suggests that the Operator join them, and laughs at the information that she is controlling Telenoid from very near when this is explained to her. Beatrice never tries to engage in any activity and does not ask Telenoid for any information. When Telenoid asks questions, Beatrice will happily respond, but as described above on interaction script, the interaction ultimately ends in a polite and indirect rejection of Telenoid in favour of conversations with the Assistant.

In Beatrice's *Post-Telenoid-interaction*, the relationship between the Assistant and Beatrice is one of welcome conversational partner. While there is some mention of strongly personal stories, these do not seem inappropriately personal to the nature of the conversation in which they are placed, i.e. they are relevant to the conversation in general, and as thus a testament to the close personal relationship formed between the Assistant and Beatrice. Interestingly, Beatrice never asks for the Assistant's name, but does touch on the subject of where she is from.

Concluding on Technical Difficulties and Limitation

It appears that Beatrice does not like constant or frequent movement in Telenoid. This may be due to her view of Telenoid as described above, or it may simply be a personal preference. In either case, it illustrates the need for understanding the participants, their preferences and circumstances before introducing e.g. Socially Assistive Robots.

5.2.3. ALICE

Alice was initially placed in the non-Telenoid group due to the staff believing that she would not find Telenoid interesting. After four sessions of interaction, which she enjoys immensely, she engages with Telenoid off-camera when the Assistant and Operator pass her in the common room on their way to another appointment. This prompts Alice to become somewhat adamant that she be introduced properly to Telenoid. Alice completes two sessions with Telenoid (Alice 5 & 6), after which she resumes sessions without Telenoid. As will be presented, Alice is immediately sceptic and rude toward Telenoid and ends up being aggressive toward it, causing her to be removed from the Telenoid-group for her own benefit.

From facility records we know that Alice joined the care-facility in late 2014, only months before joining the study. After a life working with her husband in their bike shop, Alice retired in 1990. The following years she spent doing volunteer work with the local church. She moved into the care-facility as a result of her not being able to cope with daily life in her own home. First and foremost Alice enjoys entertaining. This results in her joining others at dinner or conversations and inviting either residents or staff to her apartment for coffee in the afternoon. The staff notes that she derives great pleasure from these social activities, and it is a point that she be offered participation in as many social activities as possible. Alice is not prone to sadness or depression, but can on occasion be so in the morning. Her hearing is somewhat impaired, but her eyesight is excellent when she uses her glasses. She is able to perform most of her personal grooming herself, but apart from roaming the corridors in the evening, physically she remains inactive.

Alice does not have problems with aphasia, but has some issues with hearing (Staff interview Alice, 01:00). That being said, Alice likes being catered to by staff, as evident by her often not hearing calls to take out her plate or other attempts at having her perform small tasks meant to activate her and her abilities. This is known to staff and accepted as such. In accordance, Alice has not shown any improvement in initiative or seeking out social interaction (Staff interview Alice, 06:10). On the point of vocabulary, the staff did not see any improvement or change in her range or use and points out that while she is able to engage in conversation with multiple parties at a time, she will likely forget the topic or even the point of her own sentence as she utters it (Staff interview Alice, 11:50). As a result, Alice is acting almost exclusively on what we might call stimuli-response, in the sense that she rarely attempts to tell a story. Rather she describes what she sees or thinks of it in a form of Stream of Consciousness-talk. In line with the summary diagnosis of severe dementia, Alice displays an almost complete inability to retain new memories (Staff interview Alice, 10:15). She has some long term generic memories about her parents whom she asks for, and will occasionally have short periods of clarity in which she will pause and say *“this is wrong and something is wrong”* when talking about her parents as being alive.

With respect to the quantitative data collected, Alice shows only marginal improvement during the course of the study. On her MMSE there is no improvement with a score of 13/30 both pre and post study. The MMSE shows an improvement in *Attention and Calculation* as well as *Language, praxis and construction*, but declines in *Reading* and *writing* as well as *Orientation*. The NPI-NH shows a decrease from 0 to 12/150, showing a slight increase in Aggression. Overall the quantitative results are inconclusive.

5.2.3.1 Session Overview

The transcripts from Alice's sessions are unusual compared to other participants. Since Alice does not interact with Telenoid in (Alice 1-4 & 7-9), these sessions primarily serve as a way to create a baseline for how Alice interacts with others. In sessions with Telenoid (Alice 5-6), Rikke Krogsgaard performs the role of the Assistant with Anna-Mette Nedergaard Boch performing the role of the Operator and as the Assistant in non-Telenoid sessions. This was to continue the personal relationship, despite introducing Telenoid. Note that due to the special nature of the split between Telenoid and non-Telenoid sessions, I use the following terms to describe the three overall periods: *Pre-Telenoid interaction* for sessions (Alice 1-4), *Telenoid interaction* for sessions (Alice 5-6) and *Post-Telenoid interaction* for sessions (Alice 7-9).

Alice 1

Due to a technical issue, this session has been lost. This was a pre-Telenoid session featuring the Operator Anna-Mette and Alice in the common room.

Alice 2

During this second session, Alice is sitting in the common room sofa when the Assistant joins her. The conversation ranges over a series of topics, which Alice flows through effortlessly almost without pause, and does so without signs of aphasia or even thinking about what to say next. In doing this, she clearly makes up some of the stories she tells, as she e.g. talks about riding a bike, which she has not done for years. Alice enjoys the interaction and is clearly engaged in the conversation. She occasionally breaks into a half or full verse of singing a song when the topic of the song is relevant to the conversation. She often states that she is 84, when in fact she is 82. At one point she asks what month it is.

Alice 3

In this third session, Alice is slower in talking, when compared to (Alice 2), lacks several words and is easily distracted by what she sees and hears. She does not appear to remember the Assistant or prior conversations. The topics of conversation are still broad and Alice seems engaged and delighted but appears tired. At times Alice will change the subject and ignore what the Assistant is saying or asking, but does not seem to do this out of ill will.

Alice 4

This fourth session is the first conducted in the privacy of Alice's own apartment, and the last of the *Pre-Telenoid interaction* sessions. The Assistant has the impression that Alice hears but does not listen to what is said and 'likes to talk, but still 'lacks some words' and loses her concentration easily. Alice appears to be as active and engaged as in (Alice 3), but does not offer many topics or remarks. Both Alice and the Assistant start topics of conversation, but Alice will often not offer much about e.g. the people on photos in her room. Instead, she focuses on the porcelain figurines and describes what they are doing.

Alice 5

This is the first of two sessions in the *Telenoid-interaction* section. From the start, Alice is reluctant to engage with Telenoid and is adamant that Telenoid 'return home to bed'. The session offers no redemption to this relationship and despite physical interaction and singing, Alice is consistently rejecting Telenoid at every turn, ending in her detailing her view on Telenoid as anything but positive. As the Assistant promises the redemption of Telenoid in the following session, Alice agrees to another session, which must include 'singing and talking', which she does not find Telenoid to be capable of.

Alice 6

This is the second of two sessions in the *Telenoid-interaction* section, two days after (Alice 5). Picking up from the last session, this session includes several instances of singing. Unfortunately, Telenoid suffers from severe delay, causing severe issues with the pace in the conversation between Telenoid and Alice. This results in frequent frustration in Alice, culminating in her striking Telenoid in the chest and face seven times with the back of her hand. It is clear that while she tries to engage in singing, their failure to produce synchronous singing annoys her greatly and contributes to the deterioration of any would-be relationship. Alice continuously exhibits implicit and explicit rejection of Telenoid, ultimately leading to the termination of the Telenoid-interaction due to ethical concerns over her wellbeing.

Alice 7

This is the first session of the *Post-Telenoid-interaction* interaction sessions. Alice appears coherent and is talking with a fast pace and has no trouble finding the correct words. The Assistant notes in session logs that Alice often reverts into her verbal and practical safe-zone, but shows no sign of being annoyed or in discomfort. The session offers varied topics with Alice being virtually free-flowing from one topic to another. The Assistant initiates singing on several occasions, and Alice does not have any problem with finding the words to the songs she has sung before, but has a tendency to repeat the first verse of one particular song several times and then talk about the content of the song being "*true*" before continuing.

Alice 8

In this the eight session with Alice, we see the Assistant and Alice successfully engaging in singing several times. During the session, Alice has no issues with finding words, and we see several successful jokes from her, although she is still distracted by what she sees, resulting in a change of subject, even in mid sentence. Overall, Alice seems to enjoy the interaction, but is easily distracted. Unfortunately the frame of the video is skewed, showing only the lower part of Alice face as well as the table in front of her.

Alice 9

In this the ninth and final session with Alice, the Assistant has brought a book with lyrics from older songs, which much of the interaction revolves around. Overall, Alice is lively and humours, making several jokes and laughing greatly. She does not appear to have problems with singing new songs when having the lyrics in front of her, even as the Assistant stays silent, but she remains easily distracted.

5.2.3.2 Explication of Alice's Interaction

Alice only interacts with Telenoid in two sessions, and the circumstances of her case are almost unique. With the late inclusion in the Telenoid-group, we can evaluate *Pre-Telenoid*, *Post-Telenoid*, and actual *Telenoid-interaction*. Due to this special division of sessions, I have chosen to apply the themes from the conclusions as headings to guide the presentation of her sessions, with subheadings for each of these when appropriate. Due to her limited interaction with Telenoid, this section is naturally shorter than others.

Interaction script

Due to the split between Telenoid and non-Telenoid sessions, this section is divided into three sub-sections separately dealing with the *Pre-Telenoid interaction* of sessions (Alice 1-4), the *Telenoid interaction* of sessions (Alice 5-6) and the *Post-Telenoid interaction* of sessions (Alice 7-9).

Pre-Telenoid

In the *Pre-Telenoid interaction* found in (Alice 1-4), interaction is free flowing between Alice and the Assistant, driven at times by questions by the Assistant, but otherwise more likely to be driven by Alice describing what she sees or thinks. At times she will elaborate with related stories – e.g. (Alice 3, 02:30) when describing “*shivering bushes*” outside, and then describing how her father both “*is*” and “*was*” good at working with plants, but will often not elaborate beyond a few details in her stories (Alice 4, 17:25). Here she instead focuses on e.g. porcelain figurines and describes what they appear to do, or might elaborate on how the porcelain boy may find it difficult to put on his sweater. When asked by the Assistant if she herself finds this troublesome, she declines.

In addition, Alice often talks of children in general when referring to it being cold outside (Alice 2, 17:15), (Alice 3, 06:00), (Alice 4, 10:50). From her window she has a clear line of sight to the neighbouring kindergarten and thus children is something she sees frequently. Alice will in some cases (Alice 2) have no problem formulating sentences and following or indeed leading the conversation. There are however also sessions in which she has issues with remembering words, and will make up stores or fill in wrong words in song-lyrics (Alice 4, 15:15). Overall, she is verbally active and only rarely has periods of more than five seconds of silence and will often interrupt the Assistant with both relevant and irrelevant remarks. These, and her topics in general, are sometimes based on questions from the Assistant, but will likely shift and revolve around what she sees at the moment of conversation. As such, she can tell a story, but will likely revert into Stream of Consciousness-talk as seen in the above with the porcelain boy.

Telenoid-interaction

In the *Telenoid-interaction* found in (Alice 5-6) we see a remarkably different Alice compared to previous sessions. The introduction of Telenoid was suggested due to the care staff having observed Alice's interest in Telenoid, talking about it in a generally positive fashion, and asking the study staff what Telenoid was and if she could talk to it. Alice spontaneous reaction when faced with Telenoid (Alice 5, 01:30) is found immediately after she is first physically close to Telenoid and it says "Hello". Here, Alice reacts with an immediate negative attitude, saying "*what is that nonsense you've brought with you*" directed at the Assistant. As Telenoid then asks "*well what is that doll?*", Alice says "*I dont know*", before proceeding to saying "*I think you should return home and go to bed*", as well as "*you should go home and get some clothes on*". As Telenoid declines going home, Alice looks at Telenoid and repeats her statement with even stronger emphasis. After a later and unsuccessful attempt at singing at (Alice 5, 14:20) Alice states that "*I really don't like it. Does anyone really like it?*", and is adamant that "*he will never learn how to sing, he does not understand anything*", stressing that that is what she wants, this situation must be frustrating to her – regardless of her remembering the commitment the Assistant and Telenoid promised her.

We see the same negative posture toward Telenoid in the later session some days later when Telenoid says it wants to be wrapped in a blanket at (Alice 6, 01:25). Alice is now strongly against the idea, and while saying "*it does not matter in such a weather*", she leaves the distinct impression that the rejection is due to her not seeing Telenoid as someone in need of a blanket, and the situation and reaction is repeated some minutes later (Alice 6, 04:55) with Alice now even more adamant that Telenoid does not need a blanket.

Later attempts at redeeming the situation don't work and ultimately, at (Alice 6, 07:00) the Assistant moves Telenoid onto the armrest of the chair in which Alice sits, while explaining what she sees outside.

This results in Alice first saying “*ohh no why is that*” and, ignoring the response from the Assistant of “*because it want’s to look at the snow*”, she proceeds to strike Telenoid quite hard in the chest and face with the back of her hand seven times. Devastatingly, Telenoid then asks “*are you tickling me*”, which makes Alice even more angry, causing her to look away and remain silent until the Assistant starts talking about the weather outside. This prompts Alice to start her free-flowing talk about what she sees and thinks is happening outside, as though nothing has happened with Telenoid. As she looks outside, she appears significantly calmer than when looking at Telenoid. This precise incident caused the study staff to terminate Telenoid interaction with Alice due to ethical concerns.

Several later attempts at redeeming the relationship by singing all result in Telenoid and Alice singing at different paces, again causing Alice to adamantly state that Telenoid is both stupid, ugly and that she does not care for him/it, and that she would prefer “*real kids*” over Telenoid. Ultimately she remarks (Alice 6, 14:45) “*we can’t sing together*”, and goes on to correctly explaining that while they sing the same lyrics they do so at different paces.

Overall, the Telenoid-interaction is negative to the point of hostility on the part of Alice, and it is clear that she does not want or benefit from interaction with Telenoid. Physically, Alice almost never touches or engages with Telenoid beyond sparse investigation and her striking Telenoid. On two occasions in (Alice 6), she holds Telenoid, but to her explicit discomfort, as shown in the image below.



Image 39: Alice with Telenoid after seconds of physical interaction she now slides it away from her (Alice 5, 10:19)

Post-Telenoid

In the *Post-Telenoid* interaction found in (Alice 7-9), Alice appears in much the same way as in the *Pre-Telenoid* interaction found in (Alice 1-4) and as such I will focus on differences between these two, rather than repeating the section above.

In these final sessions, the Assistant makes it a great point to engage Alice in singing. She does this quite extensively and especially so in the final session (Alice 9), in which she brings a songbook with her, which causes Alice to engage in singing almost on her own for some five minutes from (Alice 9, 11:50). Overall, the changed dynamic of introducing singing more regularly seems to focus the interaction for Alice, causing her not to slip into her free-flowing description based talk based on what she sees, but instead focuses on the lyrics. While she does enter these states, she does so for shorter periods and less frequently. Another point of difference is Alice's humour, which seems more present in these later sessions where, e.g. at (Alice9, 07:10) Alice makes a joke, which leaves the Assistant and her in laughter for some 30 seconds.

Relations

Alice's relationship with Telenoid is based on just two sessions, but is never the less strong and consistent in its form. As presented in the above section on Interaction Script, Alice is anything but welcoming to the idea of engaging with Telenoid. Before the start of the study, we had considered Alice as a part of the Telenoid-group, but decided not to pursue this, due to Alice not showing interest in dolls or being reclusive in her overall behaviour. Due to her advances toward the study and care-staff regarding Telenoid during the study-period prior to (Alice 5-6), it was suggested that she be introduced to Telenoid, with the expectation that she would decline the interaction as un-interesting. As presented above, Alice is repeatedly and consistently negative toward the prospect of engaging in conversation with Telenoid, and becomes both angry (Alice 6, 04:55), honest but rude (Alice 6, 02:00) and strikes Telenoid (Alice 6, 07:00) when repeated attempts at singing fails due to technical difficulties and verbal delay.

Compared to the *Pre-telenoid* and *Post-Telenoid*-sessions, Alice is not as verbally active when in interaction with Telenoid. As seen in the *Pre-Telenoid* sessions Alice will generally interrupt the Assistant with relevant or irrelevant remarks. These, and her topics in general, are sometimes based on questions from the Assistant, but will, as before, likely shift and revolve around what she sees at the moment of conversation. As such, she can tell a story, but will likely revert to description-based free-flowing talk as seen in the *Pre-Telenoid* sessions, with the exception that the topic of conversation is often Telenoid's appearance. While Alice will have some periods of prolonged silence, these appear to occur as a result of irritation with Telenoid whom she finds to interrupt her repeatedly due to delay in the transmission of voice. This is with the exception of the last part of (Alice 6, 06:12) after having struck Telenoid. In this phase of the session, she poses several questions to both Telenoid and the Assistant about the nature of Telenoid.

Due to the split between Telenoid and non-Telenoid sessions and change of who performs the role of the Assistant, it is difficult to explicate this role's relation to Alice. Nevertheless, Alice's use and relation to the Assistant change significantly

with the addition of Telenoid. In the *Pre-Telenoid* and *Post-Telenoid*-interactions, the conversation is best described as Stream of Consciousness-talk with Alice responding both relevantly and at random. It is clear that the relationship, which forms in these sessions before the introduction of Telenoid is one in which Alice uses the Assistant as a conversational partner and enjoys telling the short bits of her stories that she remembers and otherwise engage in her verbal free-flowing talk. The sheer speed and dominance of Alice's engagement in these sessions suggest that she is controlling the conversation and relationship. We know from facility-records that she will strike up a conversation with almost anyone in much the same manner and offer the same kind of responses, which is in line with the Assistant noting in the session logs that she has the distinct feeling that Alice does not remember her from one session to the next. With the change of Operator in the *Telenoid-interaction-sessions*, we see both a change in who performs the role of the Assistant, but also the dynamics of how Alice uses the Assistant. Now Alice will offer the same kind of responses as before and will ask the Assistant questions about Telenoid but is also less inclined to offer stories due to the annoyance of Telenoid, which seems to impair her. That being said, the role of the Assistant is also changed, given that she now performs as interpreter and technical assistant in addition to a secondary conversational partner *in the shadow* of Telenoid. Given this new dynamic, and with the relationship between Telenoid and Alice as described above, it is natural that the relationship is changed.

Technical Difficulties and Limitations

During the two sessions featuring Telenoid, we see several examples of technical difficulties and how these impair the relationship. These are never in the form of movement or distortion, but only seen as delay in the transmission from the Operator to Telenoid. It is unclear if the same delay of sometimes up to three to five seconds occurs on the transmission of recorded audio in the room to the Operators headphones. From the video, such delays are plausible at several instances.

The delay is by far most explicit in the incidents involving singing seen in (Alice 6), but is also sporadically seen in the overall conversation between Telenoid and the Assistant. However, as Telenoid is not offered many chances to speak before being cut of by Alice, the delay does not amount to an issue in these cases.

As an example of the delay during singing, I offer (Alice 6, 02:00). Here Alice starts singing after the Assistant has started the activity, but when Telenoid joins in, Alice stops immediately. In it's singing, Telenoid is trying to match the pace of Alice, but has difficulties due to the delay and this offsets Alice's pace. As described above, Alice is at this time severely negative toward Telenoid. In the following incident Alice starts singing and Telenoid joins in with severe delay, causing Alice to be thrown off pace yet again (Alice 6, 03:00). As this happens, Alice stops singing several times, and then resumes in an effort to match Telenoid who sings at a different pace than Alice.

The result is utter chaos in synchronising the singing, resulting in Alice changing topic without warning. Seconds later, at (Alice 6, 04:55) Telenoid asks if it can borrow a blanket with Alice now becoming quite angry, asking “*what are you using that for? We **don’t** need a blanket now*”. The Assistant tries to mend the situation, but Alice remains negative toward Telenoid. As Alice is coughing, Telenoid asks if she’s okay to which she responds somewhat rudely “*from **home***”, clearly indicating that she does not want to engage with Telenoid.

In addition to the delay of voice from the Operator, we also see some examples of Alice becoming aware that the Operator is placed just outside her front door, as she hears the apparent echo between the voice of the Operator and the voice of Telenoid. This is seen at (Alice 5, 03:25) with Alice outright asking the Assistant if there is “*anyone else talking*” motioning to the front door. It is clear that she hears and reacts to the echo of the Operators voice. The Assistant explains that Telenoid is a “*phone-doll*”, which does not seem to have any effect on Alice, who responds with ‘I do not much care for this. I do not much care for her’ (Alice 5, 03:45).

Alice changes the subject to her missing a handkerchief. Telenoid tries to insert itself in the conversation by asking if this is a blouse with fake pockets, building on a prior non-recorded conversation about the topic. Alice asks ‘where is she’ and asks “*well why don’t you just join us*”, when Telenoid explains that she is operating Telenoid from behind the front door. At this point, Alice is certainly aware that Telenoid is being controlled by the Operator, and wishes to end the interaction in favour of human-to-human interaction. It is unclear if she recognises the voice of Anna-Mette who has performed the role of the Assistant in (Alice 1-4) at this time.

Concluding on Alice’s interaction with Telenoid

As mentioned, the initial plan was to include Alice in the *Non-Telenoid* group, which is seen in her first sessions. Due to her interest in Telenoid we decided to adjust the schedule and include her in the Telenoid group. While her pre-session interest in Telenoid is reported as strong, this is in no way seen in the recorded sessions with Telenoid, in which Alice appears adamant in her verbal and physical rejection of Telenoid from the very first seconds. Due to technical difficulties with delay and echo, the relationship further deteriorates to the point of Alice becoming violent toward Telenoid. In her interaction with Telenoid, Alice shows no interest in engaging in conversation or activities, and in the brief incidents in which Telenoid is allowed to speak without being interrupted, Alice responds with an often briskly formulated question of “*what is it saying?*”. While short and sobering, the interaction between Alice and Telenoid is one of great interest to this dissertation as it shows quite clearly that Telenoid is not for everyone and that technical difficulties impair or cause deterioration in relationships. While I would hesitate to define a target population who would benefit from interaction with Telenoid, it appears that the judgement of the staff that Alice would not be good fit is a good future guideline, despite interests from would-be Participants.

Concluding on Interaction Script

When comparing the three separate sections I find the *Pre-Telenoid* and *Post-Telenoid* to be significantly comparable.

In the Pre- and Post-Telenoid interactions, the interaction script between Alice and the Assistant is one of mutual interest, with Alice being partial to providing long stretches of free-flowing Stream of Consciousness-talk. These are often based on what she sees, although sometimes related to the topic of conversation in some form. Alice's interruptions are as likely to be relevant to the conversation as they are to not be, and as such the topic of conversation can change quite rapidly and without warning, causing the conversation to, in the words of the Assistant in the session log "*occur in both East and West*". It is clear that the singing in the *Post-Telenoid interaction*, and the introduction of the songbook in the last session serve to focus the session, and provides both an activity for the two to take part in, but also something Alice can cling to and feel comfortable with. As a result, the overall script goes from being conversation based, and partial to frequent shifts, to a more focused singing-activity.

Contrary to this, the *Telenoid-interaction* provides Alice with great discomfort, apprehension and, ultimately aggression due to what is likely frustration. The interaction script found here is one of Alice consistently trying to identify what Telenoid is and asking the Assistant about this, as well as asking Telenoid why the Operator does not join them.

Concluding on Relations

In terms of relations between Alice and the Assistant, it is clear that she sees the Assistant as a welcoming conversation partner in the sessions when Telenoid is not present. In these cases, the Assistant functions as someone Alice generally talks both *with* and *at*, given her tendency to engage in free-flowing descriptions of what she sees as well as her frequent interruptions. Interestingly, Alice does not ask the Assistant for her name at any point and only rarely asks for any information about where she is from, where she is going or when she leaves. Despite this, she enjoys the interaction and conversation, which seems to benefit from the focusing effect caused by singing and the songbook in the last sessions.

Alice's relationship to Telenoid is not positive. From the very first interaction she appears apprehensive and rejecting toward Telenoid. This increases over time as her annoyance with Telenoid grows due to Telenoid's perceived inability to sing or follow normal conversation. The relationship peaks in this capacity in the incident in which Alice strikes Telenoid in the face with this arguably being the most direct rejection anyone can provide. Thankfully, Alice does not seem affected by the experience in later *Post-Telenoid* interactions and only briefly mentions Telenoid once in later sessions.

Concluding on Technical Difficulties and Limitations

Overall, the technical difficulties during the sessions are persistent and cause severe interruptions. This adds to the deterioration of the relationship between Telenoid and Alice due to her emphasis on singing, which the technical difficulties render impossible. Due to the physical placement of the Operator close to Telenoid, Alice reacts to the voice of the Operator a few times. This causes further deterioration, but can be easily mended by extending the range between the two. Had Alice not known that the Operator was so close by, I am certain that she would still have reacted in the manner she did toward Telenoid, and as such this technical difficulty adds only slightly to her overwhelmingly negative relationship with Telenoid.

5.2.4. INGRID

Ingrid is severely impaired by dementia as well as primarily expressive aphasia. This causes her to reclude herself from social interaction and while she is often in the common area, she does not participate. She is mostly silent when in social interactions and is unable to understand basic requests or questions. During the course of the study, this was the primary goal and we ultimately saw little interaction in the sessions.

At the time of the study, Ingrid is in her early 80'ties. From facility records we know that she has been living at the facility for three years due to her being "*severely impaired by her dementia-diagnosis*". Ingrid suffers from severe expressive aphasia, causing a dissonance between what is said and what she understands. She does not appear to suffer from expressive aphasia and thus what she says is likely what she intends to say. Staff reports her to be persistently incapable of understanding time, place and "*own situation*". Clinically, Ingrid suffers from both severe dementia as well as depression. The goals for Ingrid's care is to improve quality of life and help her engage in the activities, which she can cope with as well as feeling safe and happy. Ingrid has several siblings as well as five children. Due to the death of her infant son, the topic of small children can cause Ingrid to become sad and withdrawn. She is particularly fond of a so-called "*dementia doll*" made by Rubens Barn which she calls "*the boy*". There is some speculation that this strong and positive relationship is related to the death of her infant son, but the topic remains taboo and thus avoided by staff, family and the research team. A typical day for Ingrid starts by getting up and in due time join other residents in the common room for breakfast. Here she remains for the duration of the day and either watches children's tv-shows or leafs through old magazines. Generally, Ingrid will only engage socially when encouraged and accompanied by staff or visited by family, which happens regularly.

An initial Barthel Index score of 40/90 suggest that she was physically impaired, and the details suggest that the issues are greatest with bathing, dressing, grooming and feeding, whereas mobility is an issue but not severely so.

A later score of 20 suggest that her condition is deteriorating. This is in line with her OERS evaluation, which suggests that while she was alert and happy before the study, this declined to her not being alert. Ingrid is unable to perform a MMSE test, resulting in a score of 0/30, which is consistent with her diagnosis of severe dementia. In regard to her OERS evaluation and NPI-NH, the overall picture is a decline of alertness and an increase in hallucinations and apathy. The EQ-5D suggests that she is in near perfect health with a score of 90/100, which interestingly does not reflect her actual observed condition by staff members.

Overall, the staff members report that Ingrid has had a *“long period of health issues”* in the preceding nine months, and that they now find her to be more engaging than before, and that a recent change in mood and behaviour may be caused by her just now recovering fully from this, but also there is no doubt that *“she is one of the participants who benefitted the most from this [study]”*. She is reported to have become more verbally active and has *“won from [the study]”* and is now showing more *“sparkling eyes than seen before and it’s definite that she’s developed”*. In addition, *“she appears to have changed her personality to a more happy, satisfied and calm person and seems to feel safe. She is easier to cooperate with physically and will now get up from her chair on her own initiative – that is definitely something new”* (Staff Interview Ingrid, 04:30-06:00). The staff also mentions that she has begun to get up earlier and, in these cases, is more self-reliant, as well as seeking social interaction by joining social interaction in the common room (Staff Interview Ingrid, 02:50). It also appears that she has had *“some kind of awakening”* with regard to her hearing, as sometimes she will eavesdrop on conversations and mumble a relevant response. The staff theorises that this is due to her becoming more aware and engaged in her social surroundings (Staff Interview Ingrid, 08:40).

The staff members report no change in Ingrid’s functional memory and she remains to *“live only in the present”*. She does appear to have a larger ability to cope with her surroundings, which they find in her improved mood and from her no longer being occupied with her *“own little world”* as she now engages with other residents. This is reported as a recent change (Staff Interview Ingrid, 14:40).

5.2.4.1 Session Overview

Ingrid 1

In this first session, Ingrid meets both the Assistant and Telenoid for the first time. During the course of the session, Ingrid remains almost completely silent and makes only a few remarks and responses to the Assistant. Telenoid is placed with Ingrid for most of the session, and Ingrid seems to enjoy the proximity but does not interact other than tapping Telenoid on the bottom in a gentle fashion. During the session Ingrid is tired and ends up falling asleep, effectively ending the session after some eight minutes of interaction.

Ingrid 2

Ingrid's second session is first and foremost characterised by severe apathy on the part of Ingrid. In the session she is both verbally inactive and while not actively avoiding interaction, she makes no attempts to engage in eye contact, touch or talk with the Assistant or Telenoid unless initiated by these, and will not end such interactions. There is only sporadic verbal activity, which is overwhelmingly directed at the Assistant.

Ingrid 3

Ingrid's third session is conducted in the common room in an attempt to provide her with a stimulating environment, which could stimulate verbal activity. The TV is on and visible to Ingrid behind Telenoid, causing her attention to drift at times. Despite this, Ingrid is overwhelmingly silent, and when speaking she is mumbling. The session contains one incident in which Ingrid attempts to interact with Telenoid nonverbally and indicates that she cares for the physical wellbeing of Telenoid.

Ingrid 4

In this the fourth session, Ingrid is verbally active to a degree, which we do not see in any other session. Throughout the session she offers short responses and offers remarks on Telenoid or the topic of conversation, and seems overall to be more accepting of Telenoid than in other sessions.

Ingrid 5

In the fifth session, the voice of the Operator is discernable throughout the session and seems at times to cause Ingrid to focus on this, rather than Telenoid. The presence of the Operator's voice on the video causes some trouble in identifying the actual sentences from Ingrid, as they are consistently at a low volume and often mumbled. We see examples of technical limitations to the design of Telenoid as well as examples of interesting interaction between the two with Ingrid appearing to be startled at Telenoid talking. Ingrid appears again with limited vocabulary.

Ingrid 6

In this sixth session, the conversation is, as before, mostly one-sided with responses from Ingrid being few, mumbled and in a low voice. Ingrid gives Telenoid a hug and calls it "*lovely*", and seems to be enjoying listening to and looking at Telenoid.

Ingrid 7

In this seventh session we, for the first time, see a session between Telenoid and Ingrid, which only contains attempts at interaction on the part of Telenoid and the Assistant. Throughout the 15-minute session, Ingrid does not respond to Telenoid and only rarely answers the Assistant's questions. From the start, Ingrid is mostly silent, still and seemingly unimpressed by both the Assistant and Telenoid and this does not change.

Ingrid 8

In this eighth session between Telenoid and Ingrid, we again, for the second time, see Ingrid in an unusually low level of interaction. She is often mumbling in a low voice, very rarely looks at Telenoid and only does so when Telenoid e.g. moves its head suddenly. Ingrid seems either exhausted or indifferent to the prospect of interaction from beginning to end of the session.

Ingrid 9

In this ninth session Telenoid suffers from severe delay, causing it to practically not engage in any conversation. When the attempt is made, it is done so in staccato-like short sentences, which again cause the actual voice of the Operator to be heard. Ingrid often notices this and then her attention drifts to this. Ingrid also notices the cameras in this session and for the first time, mentions them to the Assistant.

Ingrid 10

In this tenth incident, Ingrid is again mostly silent and passive in her interaction with Telenoid. While Telenoid suffers severe verbal delay and technical difficulties in the beginning, the final section of the session offers calls to conversation, which Ingrid does not respond to, as we have seen before. When placed in her field of vision, Ingrid will look at Telenoid, but will not look at it without provocation such as a loud sudden statement or movement.

Ingrid 11

In this 11th session, and the first session after the break, we see no recognition of Telenoid in Ingrid. Telenoid suffers from technical difficulties, making it look skewed over the shoulder of Ingrid during most of the session. When corrected, and Telenoid is moved from Ingrid to the Assistant, there is no change in interaction and Ingrid remains mostly silent or occasionally mumbling indiscernibly.

Ingrid 12

In this the 12th session, Ingrid is again mostly silent or mumbling in her interaction with Telenoid. Telenoid and the Assistant tries unsuccessfully to engage her in conversation.

Ingrid 13

In this 13th session we have a change of Operator in an effort to change the parameters of the interaction, hoping for more verbal activity in Ingrid. This however, does not occur. This session is overall silent on the part of Ingrid and with both Telenoid and the Assistant attempting to strike up conversations numerous times and failing every time. Prolonged periods of Ingrid investigating Telenoid occur several times, sometimes as long as 3:30 min. without any interruption.

Ingrid 14

In this 14th and final session, Ingrid appears to enjoy the company and close proximity to Telenoid, but is not engaging in conversation or, for the most part, eye contact, as she appears to become more and more relaxed and finally almost falls asleep with Telenoid in her lap, only to be interrupted by the Assistant closing the session.

5.2.4.2 Explication of Ingrid's Interaction

Overall, Ingrid remains silent through the majority of incidents and appears to ignore Telenoid and the Assistant when they pose questions or offer topics of conversation. Her lack of verbal activity was, and sadly remains, one of the biggest challenges for staff around her, and one I hoped at bettering through interaction with Telenoid. As I will elaborate on below, the interaction with Ingrid remains mostly based on interpretations of nonverbal activity, supplemented by occasional verbal activity. That being said, Ingrid is also mostly still in her body and facial language, which further limits the richness of the data.

Silent enjoyment

The first interaction between Ingrid and Telenoid shown below is introduced here as an example of typical interaction between Telenoid and Ingrid, throughout all 14 sessions. Overall, Ingrid's interaction with Telenoid and the Assistant consists of two states: Inactive presence or physically investigating Telenoid. It is only rarely that Ingrid engages in verbal interaction or seems affected by the presence of Either Telenoid or the Assistant. In Ingrid's first interaction with Telenoid, she does not seem to react when the Assistant places Telenoid on her lap, and she continues to look out into empty space ahead of her, even as Telenoid says "*Hello*" (Ingrid 1, 03:39). The Assistant tries to engage Ingrid in conversation and asks if she has seen Telenoid before. Ingrid's behaviour at this time (Ingrid 1, 04:00) is almost unchanged, but she does look briefly to the left of the Assistant, as though avoiding eye contact. I am unsure if Telenoid or the Assistant is the cause of this, but it is likely that Ingrid is unsure of how to respond properly to Telenoid's presence. Ingrid then first appears to change her gaze between Telenoid and the Assistant in silence, then hands Telenoid back to the Assistant, and crosses her arms in apparent aversion to Telenoid (Ingrid 1, 04:30). As Telenoid then says, "*hello, I'm quite comfortable here with you*", she smiles briefly and taps Telenoid's right arm in silence.



Image 40: Ingrid's initial reaction to Telenoid at (Ingrid 1, 04:39)

The overall script of interaction follows along the line of this first encounter with initial indifference followed by acceptance of physical contact without verbal interaction, and then a rejection or physical investigation of Telenoid. The investigation is never verbal as seen with e.g. Ethel, but always entirely physical. The theme of the sessions then shift between this *Inactive presence* by Ingrid and her short spanned physical investigations or caressing of Telenoid. At some point, the Assistant or Telenoid will offer to conclude the session due to inactivity or sleepiness on the part of Ingrid. A handful of times Ingrid will end the session with a decline of some activity, with a solemn “no”, leading to the team to asking if they should perhaps leave and come back another day, effectively closing the session.

As described above, Ingrid is overall indifferent to Telenoid in the first session, and it appears that she, in her own inactive way, is sisingup Telenoid in these first encounters. There are however examples of Ingrid rejecting interaction with Telenoid (Ingrid 1, 06:06) at times when Telenoid suggest singing, and Ingrid then offers one of her extremely rare discernable utterances in the form of a resounding “no”. Interestingly, just moments later Ingrid wipes her nose and then starts making fast paced kissing-sounds with her lips akin to those made when calling to a horse, all while looking at Telenoid. As such, the sounds are directed at Telenoid, but no one reacts to them at this time. The rejection of interaction and the subsequent intimacy shown by Ingrid appear to be in contrast, but then again may be seen as a way for Ingrid to take charge of what happens in the setting. This particular habit of making kissing sounds is displayed several times by Ingrid during her brief investigations or when caressing Telenoid.

The shifts between the Inactive presence of Ingrid and her investigation or caressing Telenoid occur following (Ingrid 2, 13:00). Here, Telenoid has been singing an Easter-rhyme to Ingrid, to which she has no verbal or physical reaction other than simply sitting silently and looking out into the empty space in front of her and between Telenoid and the Assistant while fiddling with her blouse. Then, at (Ingrid 2, 14:00) Telenoid makes an abrupt and loud movement of the neck, without saying anything. Four seconds after, Ingrid looks up from her blouse and directly into the eyes of Telenoid.

She then starts to smile and takes Telenoid's hand, caressing or investigating it lightly in silence. Ingrid now resumes making the kissing-sounds from earlier, and as the Assistant moves Telenoid closer to Ingrid's face she changes instantly from maintaining eye contact to looking away, all while remaining verbally inactive.

In the incident I believe we see a shortlived relationship between Telenoid and Ingrid as she, for about a minute, reacts intermittently to Telenoid, by holding it's hand and making the caressing kissing sounds. The rejections, which follow these short periods of investigation and attempts at interaction are often seen in Ingrid handing Telenoid back to the Assistant, or by her simply becoming indifferent to Telenoid's placement on her lap and utterances directed at her. She does this often, and sometimes, as in the examples above, it appears that an initial rejection is prolonged by the Assistant moving Telenoid closer to Ingrid, or Telenoid trying to engage in conversation. This would fall in line with Ingrid's handling of Telenoid in the above incident of (Ingrid 1 06:06) in which she declines signing, but engages in apparent intimate behaviour, if we describe these as methods of controlling the setting and interaction.

A mostly non-verbal relationship

This section collects the incidents in which we see Ingrid's reaction to and relationship with Telenoid, and emphasises how she interacts with Telenoid. As mentioned above, the vast majority of Ingrid's sessions are spent with her in silent investigation of Telenoid or her ignoring it altogether. Below, however, I will focus on the incidents in which we see actual interaction. With Ingrid maintaining a mostly silent attitude in the sessions, and in general, her verbal descriptions of Telenoid are sparse. Of the incidents we do find, there are two that stand out for their richness in interaction when compared to others.

At (Ingrid 5, 11:00) we see Ingrid responding with a casual "*oh I can do that*" to a question from the Assistant about her taking Telenoid with her as she leaves. In the subsequent incident, Telenoid suffers from technical difficulties with movement and is effectively paralysed, looking persistently somewhere over Ingrid's left shoulder. Now, with Telenoid placed in her lap, Ingrid states "*I can't understand [15 second mumble] then it looks at me [3 seconds mumble]*" and produces her fast-paced kissing sounds. Telenoid then calls Ingrid "*sweet*", to which she responds with "*I don't know*". During this, Ingrid's gaze is initially directly at Telenoid, but she then tries to adjust the position of her head to match Telenoid's gaze and ends up directing her gaze off in the distance behind Telenoid. She never attempts to reorient Telenoid's face or body, which would easily accomplish the objective of achieving eye contact. This short exchange – in the fifth session - may be the first clear example of Ingrid verbally expressing a desire to interact with Telenoid. This is followed by an interesting incident in which Ingrid is actively trying to accommodate Telenoid by attempting to gain eye contact.

Sadly this rare attempt fails and she resumes looking out into empty space. From the interaction it is clear that Ingrid's use of "*I don't know*" and "*it looks at me*", is directed at Telenoid and its gaze, thus providing an actual and relevant response from Ingrid to Telenoid for the first time.

Subsequently, at (Ingrid 5, 15:33) when closing the session and Telenoid asks for permission to return, Ingrid's reaction to the question is a surprised look in Telenoid's direction during which she raises her eyebrows, exhales softly and produces a low sound like the one you make when shivering from cold. The Assistant's response is an immediate question of "*Oh did you get scared for a bit there*", to which Ingrid does not answer or react. Telenoid then repeats its question and receives a reluctant "*yes*" in response. After a minute, at (Ingrid 5, 16:25) as the Assistant has been preparing to close the session, she asks Ingrid to hand her Telenoid who responds with "*ohh well no thank you*" accompanied with a short smile. The closing of this session is interesting on numerous levels. First, in my interpretation of the exchange, it is clear that Ingrid does not want the interaction or close proximity with Telenoid to end, which is in sharp contrast to her shrugging at Telenoid just a minute prior. I believe that Ingrid's initial response is simply due to her being startled at Telenoid talking.

If we move on to incidents, which are not as prolonged or rich in complexity, we find examples of Ingrid recognising Telenoid when faced with it. For example we see this at (Ingrid 8, 00:27) when the Assistant enters the frame with Telenoid in hand. Despite an initial "*hello*" from the Assistant, Ingrid does not react. The Assistant then says "*I've brought the doll with me today*" to which Ingrid responds "*oh that one*" and looks at Telenoid with a soft smile. As Telenoid asks her if she is well today, she looks at Telenoid while responding with a "*yes*". Telenoid then asks about her morning and breakfast, to which Ingrid does not react and a period of apathy ensues on the part of Ingrid. In this short exchange there is some evidence that Ingrid either remembers Telenoid, or at the very least does not react with apathy or negativity to its presence.

Ingrid is predominantly indifferent and passive in her interactions. Good days such as found in (Ingrid 4) do however occur. The session starts with an encouraging amount of alertness and verbal engagement in Ingrid who offers a low mumbled utterance to Telenoid (Ingrid 4, 00:45), but then rather quickly reverts into single word responses. Despite her low verbal participation, it appears that she in this session is here more accepting of having Telenoid in her lap. The conversation progresses into a caressing investigation of Telenoid, rather than a conversation. Ingrid's verbal and nonverbal engagement in the setting understandably declines over time, with her becoming preoccupied with caressing Telenoid in silence while ignoring statements and questions from both the Assistant and Telenoid at (Ingrid 4, 14:40).

Adjectives

There are only a handful of examples of Ingrid offering statements about Telenoid in adjectives, or which indicate her view of Telenoid. Initially at (Ingrid 2, 04:15) when the Assistant asks “*what do you think of it?*”, Ingrid respond with a prompt “*NO*”, which would indicate a negative view of Telenoid at this time. Later on, at (Ingrid 5, 14:15) Ingrid starts rocking Telenoid up and down on her knees while making kissing sounds looking at the Assistant with a smile, but not saying a word to either. This is done as Telenoid is singing and it seems from the interaction that, in this incident, Ingrid identifies Telenoid as a child as both the kissing-sounds and the rocking back and forth and side-to-side are indicative of this.

While Ingrid’s reactions and use of adjectives may indicate her view of Telenoid, it is clear that this view is fluid and subject to influence from the Assistant as seen e.g. at (Ingrid 13, 06:35) when the Assistant says “*ohh it’s not ugly is it*”, which prompts the response “*ohh no*”. While this reaction may be an actual indication of Ingrid’s view of Telenoid, it may also simply be Ingrid repeating what is being said to her, as often seen in persons with dementia. For this reason, I put more faith in Ingrid’s reactions to Telenoid than her sparse verbal expressions.

Investigations and Caressing

Despite her rejections, Ingrid often caresses or investigates Telenoid physically. This is found in numerous sessions such as (Ingrid 3, 11:00) when she covers Telenoid’s lower part in her blanket, as though not wanting it to become cold; she does this without looking at Telenoid or talking. We also find examples of Ingrid placing her forehead on Telenoid’s in a caring and sometimes playful manner. This occurs, e.g. at (Ingrid 5, 07:05). Ingrid often seems to ask Telenoid something, but does this at a low volume. This causes her words to remain indecipherable. Attempts at having Ingrid repeat what is said always fail, and not even the Operator can hear what Ingrid is saying. In addition we find examples of Ingrid caressing the outline of Telenoid (Ingrid 6, 01:00) for anywhere between seconds to several minutes. The interactions’ close proximity and the almost intimate nature of the setting suggest that previous incidents depicting Ingrid as scared of Telenoid could change.

While Ingrid is often attentive toward Telenoid, however at (Ingrid 6, 05:15), she seems to be aware that Telenoid is a “*strange*” thing. Here, the Assistant is asking Ingrid if she herself has brown eyes, to which she correctly says yes, and then starts looking at the side of Telenoid, mumbling “*the strangest*”. Telenoid asks her to repeat but she mumbles to herself while touching the ventilation on the hips of Telenoid as though recognising that these are not present in other dolls or children. In this effort she loses her grip of Telenoid and it falls to one side, but caught by the Assistant. The Assistant and Ingrid then smile at this in silence. Telenoid then asks “*will you take good care of me?*” to which Ingrid says, in a normal voice and volume “*ohh yes*” while looking straight into Telenoid’s eyes with a soft smile.

Ingrid's reaction to Telenoid calling it "*strange*" is in essence natural, and despite only occurring once, we see several examples of technical difficulties causing the voice of the Operator to be heard. This is e.g. seen at (Ingrid 9, 00:13) when, at the beginning of the session, Ingrid asks for the Operator who she has seen enter the adjacent room from which she operates Telenoid. After the Assistant has explained that Telenoid is being controlled by the Operator from the adjacent room, Ingrid does not seem to react but does not mention the issue again. We see more direct mentioning of Telenoid being artificial at (Ingrid 10, 11:55) when she asks the Assistant "*Who is inside this thing?*", to which the Assistant explains that the Operator Anna-Mette is inside, and elaborates on how Telenoid is controlled and from where. Neither this explanation nor Telenoid's subsequent utterances make any impression on Ingrid.

Ingrid and the Assistant

With regard to the Assistant, we never, in any of Ingrid's sessions, see her actively ask the Assistant or Telenoid where the Assistant is from or why she is there. As before, Ingrid seems utterly indifferent to Telenoid and the Assistant's presence, and merely accepts it with only minor attempts at changing the topic of conversation or activity, and with only a handful of examples of her directing a question or statement to the Assistant or Telenoid. Instead, spontaneous, often mumbled, statements will be uttered in no particular direction as though directed to herself.

During the sessions, the Assistant will often try to engage Ingrid in conversation and ask questions or offer interpretations or comments on e.g. Telenoid's utterances or change of placement. This is e.g. seen at (Ingrid 2, 09:00) when the Assistant adjusts Telenoid's placement when with Ingrid. Previously, Ingrid has responded to remarks by either the Assistant or Telenoid, and as Telenoid has been with her for several minutes without her responding or changing from her behaviour of looking out into empty space between the Assistant and Telenoid, the Assistant adjusts Telenoid's placement while explaining this to Ingrid. This causes no reaction what so ever, as Ingrid keeps her gaze and her hands on Telenoid. This aphetic behaviour is present in most if not all interaction with Ingrid and especially toward the Assistant whom she appears to remain overall indifferent about. The exception to this is the opening or closing of some sessions (Ingrid 2, 15:00) in which Ingrid will respond with a relevant *yes* or *no* to the Assistant's questions of permission to return.

Technical Difficulties and Limitations

The purpose of this section is to elaborate on the technical difficulties and limitations, which present themselves in Ingrid's sessions. In these sessions we see remarkably less technical difficulties than in e.g. Ethel's sessions, but we do however see a participant who is more aware of the cameras. As such, this section focuses primarily on the issues arising from this aspect.

The first of these incidents occur at (Ingrid 4, 14:10) as Ingrid is looking around her apartment and notices one of the cameras. She directs a mumbled question to the Assistant who replies with an explanation of what it is and why it is there. Ingrid does not react to this. The same script occurs in session (Ingrid 5) as well as (Ingrid, 7-9), with Ingrid often merely looking at the cameras in silence.



Image 41: Ingrid looking past Telenoid and at the cameras at (Ingrid 4, 14:13)

While Ingrid's attention is mostly directed at either Telenoid or into empty space behind it, there is one example of her looking intently for over a minute at the cameras (Ingrid 7, 08:30). During this time Telenoid unsuccessfully attempts to address her and divert her attention from the camera. At times, Ingrid does offer the occasional remark that they are "ugly" (Ingrid 5, 06:40), which is a position quickly alleviated by the Assistant who, to Ingrid's visible delight, promises to take them with her when she leaves.

Delays and distortions of movement or audio are far from significant in any of Ingrid's sessions. We see some examples of verbal delay and distortion, as well as issues with movement, but as they are significant when they occur, their low frequency, mild severity and short duration amount to a mild interruption overall.



Image 42: Ingrid making eye contact at (Ingrid 2, 00:57)

The first occurrence, and one of the more significant interruptions to Ingrid is at (Ingrid 2, 01:25). Here, Telenoid exhibits a metallic scratching sound overlaying its voice, resulting in Ingrid beginning to show a somewhat scared facial expression for a few seconds, as though she is not scared of Telenoid but rather a sound that she cannot place. She makes no attempt at moving Telenoid, and continues to hold Telenoid's hand, as well as making kissing sounds.



Image 43: Telenoid displaying difficulties with movement of the head at (Ingrid 10, 00:57)

The Assistant is able to alleviate even severe distortions with remarks of Telenoid suffering from “a cold”, which appears to suffice as an explanation for verbal distortion. As the Assistant remarks this to Ingrid, she starts laughing and seems not to be affected by the metallic sounds overlaying Telenoid's voice. Ingrid does however enter a passive state in which she sits in silence looking at Telenoid as the Operator is rebooting it, ignoring attempts at small-talk from the Assistant.

As described above, this is however not special to the incidents involving technical difficulties, but is a part of the interaction script for her sessions in general. In (Ingrid 11) we see the same issues with movement, which are now not resolved, causing Telenoid to be unable to maintain eye contact. As Telenoid is moved from Ingrid to the Assistant, this causes no verbal increase in Ingrid who remains silent.

Concluding on Ingrid's interaction with Telenoid

Ingrid's interaction with Telenoid is one most fittingly described as inactive. While we see examples of her caressing Telenoid and adopting a caring attitude, this is only a small part of the overall time spent in interaction, with the remaining part being spent indifferent to the presence of Telenoid, and even more so to the Assistant.

Concluding on Interaction Script

The overall script of the interaction between Telenoid and Ingrid is thus one of initial acceptance, followed by indifference, which at times is strengthened by attempts at engaging her in interaction. On this, it is likely that, due to her daily interaction with *the boy* Ingrid is used to physical interaction as well as the lack of responses from a humanoid shape. It was therefore no great surprise that she showed interest in Telenoid when faced with it. Our hope was that, due to her familiarity with humanoid shapes, she would take the opportunity to engage verbally with Telenoid. Instead we found that, for some 90% of the time, Ingrid remains as silent as before. From the sessions it is clear that Ingrid shows interest in Telenoid, and that she is overall positive about the interaction, even if she is investigating Telenoid and the interactions are essentially non-verbal.

Concluding on Relations

Mirroring the above Interaction Script, Ingrid's relationship with Telenoid is overall one of indifference. In the cases when she interacts, she rarely speaks and offers even less insight into what she thinks of Telenoid. When she does this, the result is a fluid view of both "*a strange thing*" and an entity, which can benefit from having a blanket wrapped around it. The juxtaposition between these positions is neither unique to Ingrid nor static, and follows no progression or path, which I could define. Ingrid does not engage in conversation or participate in any activity. She does however occasionally caress Telenoid for periods of time of between seconds and minutes. This could indicate that she enjoys and wishes to prolong the interaction as a whole. This is all while we also see incidents in which she is reluctant to engage with Telenoid, and seems not to engage at all.

With regard to Ingrid's relationship with the Assistant, Ingrid remains overall indifferent to her presence and only very rarely engages in conversation, and when doing so, only rarely asks questions or remarks about any information; in essence, accepting her presence without engaging or attempting to change it.

It is necessary to factor in that Ingrid suffers from impressive aphasia, meaning she is likely to misunderstand or misinterpret what is being said. Examples of this are seen in the dissonance between questions posed to her and her responses. Due to her overall low verbal activity, examples are sparse, but seen at e.g. (Ingrid 7, 10:30) when the Assistant asks if Ingrid finds Telenoid's eyes to be pretty. She does not answer but instead mumbles something to the Assistant, which cannot be heard on the video. The Assistant responds with "*ohh well, we'll help you get back out there so you can have some coffee*", suggesting that she did not respond relevantly to the Assistant's question, for whatever reason. This weighs to the notion that Ingrid enjoys the physical aspect of the interaction, and is perfectly content with the interaction being non-verbal. Obviously, for both health care professionals, family members and researchers, respecting that this is her preferred form of interaction is vital, if the goal is truly to provide her with the best possible quality of life, and not just apply our own notions of what constitutes a good life onto her situation. While speculative, I cannot but wonder if the death of Ingrid's infant son, at some unconscious level, contributes to her emotional connection to the doll who she calls "*the boy*", and if this emotional relationship impairs her relationship with Telenoid. In essence, she is used to, and comfortable with, sitting with the non-responsive *boy*, for whatever reason, and when substituted for Telenoid, she does not seem to engage, despite her showing clear signs of enjoying the interaction. The technical difficulties in Ingrid's sessions mostly pertain to Telenoid's movement and the delay of audio. While both are causes of disruption to the interaction, they are so to a mild degree, also alleviated by the Assistant.

The interaction between Telenoid and Ingrid shows her to improve somewhat in attentiveness toward Telenoid, but it does not appear that she enjoys or benefits more from engaging with Telenoid than she does *the boy*. Given that we see numerous examples of Ingrid appearing to be scared or apprehensive in interaction with Telenoid, I surmise that the interaction with Telenoid is, while not harmful to Ingrid's well-being, not the right way to encourage conversation in Ingrid's case.

Concluding on Technical Difficulties and Limitations

In Ingrid's sessions, it is clear that the overall largest issue is not the one of her noticing the cameras. It is clear that if the cameras were more inconspicuous or perhaps removed, the distraction would also be removed. While the camera is not at present a severe impairment to the relationship forming between Ingrid and Telenoid, it is present in the data and seems to be of some concern on the part of Ingrid. Other forms of technical difficulties in Ingrid's sessions appear insignificant overall. While there are a few examples of technical difficulties, these are mostly related to movement and when occurring they are often alleviated by the Assistant or result in no apparent change in behaviour from Ingrid.

5.2.5. BENNY

At the time of the study, Benny is 76 years old and has lived at the care facility for some 18 months. Due to Benny's increasing hallucinations and delusions, his wife made the decision to move him to the facility. He has always been physically active, having participated in recreational sports and worked in farming for most of his life. As a result, he still needs to perform physical tasks and this seems to calm him. He also enjoys engaging in social interaction, and is known throughout the facility as a warm and humorous presence and he reacts with increasing frustration when these needs are not met. Benny is not violent, but when severely frustrated he may become angry and increasingly delusional. The staff thus emphasises engaging him in different forms of social interactions as well as participation in different household tasks such as setting or clearing tables. Benny is partial to depression and crying when remembering both good and bad times and enjoys talking about his feelings.

After reviewing some session videos, the staff notes that the interaction Benny has with Telenoid is centred on past experiences (Staff interview Benny, 23:00). This is in contrast to their, and his family's interaction with Benny, which almost always revolves around present experiences. Given that Benny has a tendency to over focus on body language and facial expressions of anyone he can see, the staff postulates that Telenoid's simplistic appearance provides Benny with a conversational partner whose appearance does not "*clutter his mind and attention*" (Staff interview Benny, 20:00, 45:20).

From Benny's quantitative data we see a significant improvement from 6-13/30 points on his MMSE test, which however both indicate severe dementia. It is interesting that the improvement is seen in the sections *Language, praxis and construction*, as well as *Recollection* which are the MMSE-sections most associated with off topic conversation and social interaction. From (Staff interview Benny, 16:15) the staff notes no change in Benny's use of language. The Barthel index evaluation and NPI-NH both indicate that Benny suffer from pain, aggression and mood swings after a fall he had during the study period.

5.2.5.1 Session overview

Benny 1

In this first interaction, Benny's first reaction is positive, calling Telenoid "nice" and referring to it once as "John". Unfortunately, the audio is extremely low and the conversation is fragmented beyond this initial greeting. The session features long conversations between Telenoid and Benny, with the Assistant appearing to be answering questions at times.

Benny 2

In this the second session, Benny is seated in the common room when Telenoid and the Assistant enters. As in (Benny 1) the audio is low, and in addition Benny is mumbling, making deciphering the conversation difficult. The interaction is not interrupted, but Benny appears tired, making this a short session of some 9 minutes, with Benny being mostly silent.

Benny 3

In this third session, Benny is mostly silent and somewhat sceptical about Telenoid. While he does not reject Telenoid, he appears apprehensive, causing the Assistant to describe the nature of Telenoid. Benny responds to some questions, but does not appear talkative other than for a brief intermezzo where he talks about his late dog.

Benny 4

This fourth session is conducted in Benny's apartment, causing audio quality to be improved. Benny still mumbles in most of his speech, but is actively engaged in conversation throughout the session. The Assistant noted in her logs that Benny appeared to be talking to another adult in his use of words and tone, and that the topics revolved around life on the farm and the animals in particular.

Benny 5

In this fifth session, Benny is overall engaged in the conversation with Telenoid and pays little attention to the Assistant sitting by his side. While the conversation progresses steadily, he seems tired and the session ends with Benny asking for a nap. Benny asks several questions, but mostly he offers stories or information based on questions and has a tendency to enjoy sharing.

Benny 6

In this sixth and final session we see an initial positive reaction from Benny to Telenoid's presence, as well as a clear recognition of the praxis of the interaction and the conversation taking place. At this time, both the interaction script and relations between the two seem to have stabilised, with conversational topics revolving around life and animals at the old farm and stray stories about his family.

5.2.5.2 Benny's interaction with Telenoid

It was the hope that Benny's willingness to engage in conversation could be strengthened with the use of Telenoid as a manageable conversational partner. With six sessions, Benny's interaction is comparatively short when compared to other participants who have interacted with Telenoid for the full duration of the study. Benny's first three sessions are recorded in the common room, and unfortunately a combination of his tendency to mumble and speak at a low volume, technical difficulties with the camera equipment and ambient noise has caused the audio in (Benny 1-3) to become almost entirely indecipherable. While the following three sessions were recorded in his apartment, the spoken words are literally heard as a mumble on the video. Coupled with Benny's largely stationary body language and mimicry, the available data from the sessions is severely limited. As a result, this section is very limited and I have purposely chosen not to apply the term Explication Of Participant Interaction due to the limited data.

Interaction Script & Relations

Benny's initial response to Telenoid is one of delight and interest (Benny 1, 00:26). Interestingly, Benny's reaction when seeing Telenoid is to look from the Assistant to it and ask "*are you well today?*", and then moving on to calling it "*John*", and saying "*you are nice*", as the Assistant hands Telenoid to him. While I am sure he compliments Telenoid more than on the rare occasion which is heard, these are not available on the video due to his low voice. The overall interaction script is physically close, with Benny engaged in conversation while holding Telenoid in his lap and only rarely moving beyond wiping his nose or looking briefly to the Assistant. At one point he leans forward and places his nose on Telenoid's (Benny 10:48). This is accompanied by speech that cannot be heard, and a smile to Telenoid and the Assistant.



Image 44: Benny placing his nose on Telenoid's at (Benny 3, 10:48)

Other than the start and end of sessions, as well as the occasional technical difficulty or repetition of a question from Telenoid to Benny (Benny 4, 06:40), the Assistant remains inactive in the conversation. Benny does not pay particular attention to the Assistant in the sessions, but does clearly form some connection to her as seen in the closing of (Benny 4, 22:30) where Benny offers to help her out the door and gives her a caring hug. Interestingly, Benny does not appear to ask the Assistant for her name other than in the conclusion of the final session (Benny 6, 16:40), and does so somewhat off hand on his way out the door.

Those snippets of conversation, which we can hear, deal mostly with the weather or handball, which Benny enjoys tremendously and has practiced for most of his life (Benny 3, 01:20). Then, after typically one minute, the conversation turns to his life and work on the farm as well as his family. The nature of the conversation appears to be of short questions to Benny who responds either briefly or at length.

In the early sessions (Benny 3, 01:20) Benny seems more interested in *that* Telenoid is talking, as opposed to *what* is being said. This causes Benny to be somewhat silent, stalling in his responses. This leads to the only incident in which we see some indication of rejection. Here, at (Benny 3, 04:15), after several minutes of conversation, Telenoid suffers some verbal delay, which causes Benny to start looking at the Assistant instead of Telenoid and not responding to Telenoid's questions. As the Assistant explains the technical aspect of the setup Benny remains unaffected. Following this, Benny mumbles something to Telenoid about "*cheating me*" with a smile and appears to notice the artificial nature of the conversation (Benny 3, 09:30). He remains unchanged as Telenoid responds with "*I promise not to cheat you too much*". As their relationship progresses in the following sessions, Benny's responses lengthen. This entails Telenoid becoming more and more inactive in the conversation, only supplementing Benny with questions and allowing him to further detail his stories or focus on a related aspect. Overall, the nature of the conversation turns from casual off-topic conversation, as was intended, to a somewhat interview-style conversation with Telenoid not offering information about itself or being posed a single question.

This is best exemplified in the final session (Benny 6, 08:00) where Benny can be heard describing how to harvest beets, providing details of season and methods as well as life on the farm in general in good detail. He then pauses for some time, looking intently at Telenoid in silence before talking at a slower pace than before as though both talking and remembering something. Then at (Benny 6, 11:00) he starts telling a story detailing the birth of what appears to be his child. He does this with his usual low voice, which results in most of the story being a mumble of words not available on the video. The Assistant helps the story along by asking "*are you okay?*" after recognising that Benny is visibly emotional. The incident spans some 10 minutes and culminates in Benny concluding the story, leaning somewhat back and appearing to be silently remembering.

Technical Difficulties and Limitations

As described above, there were some issues with the audio and quality of the recording in the first two sessions, which were recorded in the common room. This is seen almost throughout (Benny 1 & 2), as exemplified at (Benny 1, 15:00) when Benny appears to be engaged in pleasant conversation and seems to smile, but the conversation remains inaudible due to mumbling and ambient noise.

In addition, there were some minor technical difficulties with distortion and delay of audio, as seen at (Benny 5, 01:00) when Telenoid greets Benny and a lively conversation is about to start, but as Telenoid's voice is distorted, the Assistant decides to leave the room and solve the issue with the help of the Operator. This has no effect on the following conversation and while the Assistant is away, Benny remains silent, looking out into empty space as he often does.

Other technical difficulties include the delay of audio from the Operator to Telenoid, as seen e.g. at (Benny 4, 05:20) when Telenoid is placed in Benny's lap and engaged in conversation. Here, the delay becomes severe and Benny notices the echo-feedback between the Operator and Telenoid to a degree that he looks to the room in which the Operator is placed, causing the Assistant to explain the issue to him.

Concluding on Benny's interaction with Telenoid

As detailed in the introduction he engages in frequent conversations about his present life, but does not engage in the same form of storytelling from his past life with the staff as seen in his interaction with Telenoid. Overall it is clear that Benny enjoys the interaction and engages in the conversation.

Concluding on Interaction Script and Relations

Benny's interaction script and relation to Telenoid is clearly positive and centres on him telling stories about his life and family. Benny's reaction to Telenoid, showing one mild sign of rejection, which is overcome with humour and then abandoned, is first and foremost understandable. As their relationship gradually progresses from off topic conversation to the casual interview style presented above, Benny's stories appear to become increasingly more detailed, personal and even emotional, but ultimately elude us due to his low speaking volume. In understanding the development of the relationship, which forms I refer to the session logs of the Assistant, in which she details some of the topics as well as her impression of their relationship.

Compared with other participants, Benny is known for showing and talking about his emotions so this is not significant in that sense, but it is interesting that he refrains from doing this with anyone beyond family and a few staff members who he appears to trust. Knowing Benny to believe in the importance of accepting his own feelings and talking about them, I believe that Benny's appropriation of

Telenoid in this manner is a sign that he uses Telenoid to fill a unfulfilled need. It remains interesting that the *trusted* staff-members note that the stories they hear are often of present events, and only rarely about past events and the feelings they bring. This is in sharp contrast to the events and stories offered in the sessions with Telenoid, and suggests that Benny either views Telenoid entirely differently, or that its appearance causes him to engage in more memory based conversation.

While the Assistant remains inactive in the vast majority of sessions, I believe she introduces some familiarity to the situation, causing Benny to relax. While we have not conducted sessions without the Assistant present, I believe removing her would cause Benny to become overly conscious of the artificial nature of the interaction and thus be diverted from the primary purpose of talking and remembering.

After some initial confusion over the nature of Telenoid, Benny becomes gradually more and more invested in his conversations with Telenoid. He progresses from offering short responses to offering longer responses and even deeply personal stories. Benny's sharing and show of emotion is not unnatural for him, but is typically not offered to anyone beyond the staff who he appear to have a closer relationship to than other residents.

Concluding on Technical Difficulties and Limitations

Overall the technical difficulties pose only minimal disruption to the interaction as their severity, duration and frequency are all low, with the Assistant only occasionally stepping in. With regard to the setup in the first two sessions, the placement in the common room was clearly not ideal and caused the conversation to be mostly lost. This could have been avoided with the use of a more advanced body-worn microphone than what was used, but overall the ambient noise in the room was loud at the time.

5.2.6. ISABELLA

At the time of study, Isabella is 94 years old and has lived in progressively more assistive housing for the last nine years and has been wheelchair bound for some years. She lived at the facility for six months and died shortly after the conclusion of the study. In interacting with Isabella it was extremely important to involve her in the details of the help she was provided, upcoming activities and questions about her wishes. This was to be done in as short and simple sentences as possible and with respect to Isabella's long latency between perceiving, understanding and responding to both what she saw and heard. Isabella was partial to becoming over-stimulated due to sensory overload, partially due to this latency. She enjoyed social interaction, but suffered from both severe dementia and being manic-depressive, causing her to appear either severely depressed or manically joyful for anything from a period of minutes to several hours. Isabella was found to almost always utter what is known as unconscious self-stimulation. This was heard as an almost deafening sound, which was either a steady or changing tone or a growl, which would be repeated in no particular pattern, and according to the staff, did not appear to correspond to her mental state. According to staff Isabella expressed this either very frequently or almost constantly, but it would be significantly less pronounced in volume when she was in conversation with others. Due to her dementia she suffered from not having a filter between what she thought and what she said, and as such would often supplement her *howling* with a near constant stream of consciousness based on external stimuli. As a result, other residents often reacted to her by moving farther away from her or leaving her alone. As such her wheelchair was, at best, placed some meters away from others due to their well being, or in her own apartment when the utterances were too loud to manage in other ways. Due to her particular needs she was prone to becoming stressed when not apprehending what was occurring in the room, but when placed here was prone to becoming stressed due to sensory overload. As such, her daily routine was frantic and lonely, which only served to further deteriorate her mental state. It is clear that the chief task for staff was to provide Isabella with a structured and predictable routine and it was hoped that conversation with Telenoid could provide a conversational partner less prone to cause over-stimulation.

Isabella's quantitative data reflects a person with severe dementia and severe cognitive impairment. She was unable to perform the MMSE test, thus providing a score of 0/30. The Barthel Index evaluation was irrelevant due to Isabella being wheelchair-bound, and while NPI-HN showed a significant decrease in symptoms from 85-40/120, this decrease in symptoms was a result of Isabella being less actively present, as evident by her OERS, which showed a decrease from 4-2/5 and thus less in interaction with staff. In the (Staff interview Isabella, 20:30), the staff members closest to Isabella reported that they did not see any change during the course of the study, but found that the sessions they were show did display a close relationship between Telenoid and Isabella at times.

5.2.6.1 Session overview

Isabella 1

In this first session the Assistant introduces Isabella to Telenoid in her own apartment. Isabella appears distraught at first, but over the course of the some 15 minutes of interaction, her self-stimulation and Stream of Consciousness decreases from somewhat frantic to a more manageable level. She does however still engage in her stream of consciousness, and rarely answers questions posed by the Assistant. Telenoid is active in the conversation for some 60 seconds in total and is never addressed directly by Isabella who denotes it as both boy, girl, man, sweet, nice and beautiful several times during the session.

Isabella 2

This second session encompasses two separate recordings, made some 10 minutes apart. In the first, the Assistant tries repeatedly to introduce Telenoid to Isabella who remains silent and barely looking away from her breakfast. In the second recording the breakfast is now gone, but Isabella remains just as unimpressed with Telenoid or the Assistant and she remains silent.

Isabella 3

In this third session Isabella remains almost entirely silent, with regard to self-stimulation, conversation and Stream of Consciousness. She repeatedly reads from the cover of a magazine on the table in front of her saying *"I'm getting married"*, but does not engage with Telenoid and only answers the Assistant twice with one word answers. Overall she displays no interest in interaction.

Isabella 4

In this fourth session, Isabella remains silent and does not exhibit any self-stimulation or Stream of Consciousness. Despite numerous attempts at questions, remarks, humming and singing, Isabella remains in complete silence and does not appear to react to the Assistant or Telenoid. She barely moves and only takes Telenoid in her hands with the help of the Assistant who guides her hands.

Isabella 5

During this fifth session Isabella is engaged in Stream of Consciousness-talk and self-stimulation throughout and extremely rarely responds to questions. Her gaze is directed at Telenoid and the Assistant at all times, and she appears to accept and enjoy the physical connection to Telenoid, calling it all manner of positive adjectives and changing pronouns. There is however only a sliver of conversation in the session, and Telenoid is never given time to respond to the three questions Isabella poses to it before moving on in her self-stimulation and Stream of Consciousness-talk.

Isabella 6

Isabella's sixth session is comparable to (Isabella 4) in that Isabella remains silent and does not exhibit any self-stimulation or Stream of Consciousness. Despite numerous attempts at questions, remarks, humming and singing, Isabella remains in complete silence and does not appear to react to the Assistant or Telenoid. The session is some seven minutes long.

Isabella 7

In this seventh session, Isabella is verbally active and responds to questions with Stream of Consciousness-talk, which centres on her parents as well as children. This is in line with her often commenting on Telenoid's appearance, describing it continuously as a five-year-old boy. She applies general positive terms, but also rejects holding or touching Telenoid when asked, or after several minutes of physical interaction. Isabella does not address Telenoid, which is overall inactive in this 15 minute long session.

Isabella 8

In this eighth and final session, Isabella remains entirely silent, apart from a short sequence in which she mentions a boy. While Isabella accepts Telenoid in her lap, she looks away and to the Assistant, who tries to engage her in conversation and activities. The Assistant notes that while verbally inactive and looking away from Telenoid, Isabella appears to be smiling at her more than usual.

5.2.6.2 Isabella's interaction with Telenoid

Perhaps due to Isabella's diagnosis of manic-depression her sessions unfold in two distinct ways, with three *active* sessions and five *passive*. In her five passive sessions (Isabella 2,3,4,6 & 8) Isabella appears passive and does not speak or engage in self-stimulation or Stream of Consciousness-talk. Here she will often sit idly and not produce any sounds, mimicry and very limited bodily movement. As a result most of her sessions offer very little data to analyse. As a result, the following is restricted to but a few pages of analysis.

I have chosen to omit Isabella's self-stimulation and Stream of Consciousness-talk in the below, unless in those incidents where they are significant in their own merit.

Interaction Script & relations

In Isabella's passive sessions (Isabella 2,3,4,6 & 8) she will as mentioned sit completely idle and not produce any sounds, mimicry and very limited bodily movement. When addressed by the Assistant she is as likely to proceed with looking at the Assistant as she is to shift her gaze to somewhere in the room and less likely to look at Telenoid. She rarely responds beyond a garbled and incomprehensible sound and there is no apparent pattern to these answers.

While Isabella will accept that Telenoid is placed with her she does not engage with Telenoid beyond a few instances of her investigating or caressing Telenoid on the shoulder.



Image 45: Isabella's natural facial expression in most incidents. (Isabella 4, 03:33)

On the other hand, she appears somewhat active in the remaining three sessions (Isabella 1, 5 & 7). Here, her Stream of Consciousness is best described as a verbal continuous stream describing what she sees and hears, intertwined with thoughts. It should be noted that even in these active sessions, Isabella's level of verbal activity is generally low with long periods of silence.

In these active sessions, Isabella will likely not respond to questions and she will often talk of children, or specifically five-year-old boys when seeing Telenoid. This is seen in (Isabella 1, 04:15) when she states that "*Isabella has slept well*" and "*that boy is the best boy in the world*", while looking at Telenoid. The Assistant then tells Isabella that Telenoid is not a boy, trying to establish its artificiality. Telenoid asks Isabella if she has any *funny stories* to which she says "*No. I suppose you have a white bunny*". The Assistant takes this a sign that Isabella thinks Telenoid looks like a bunny, and ask if this is correct, but she does not. Later in the session, we find another example of how Isabella's Stream of Consciousness can overtake her ability to engage in conversation when she poses and answers questions in rapid succession (Isabella 1, 09:20). This appears to be the result of overstimulation as Isabella seems almost manically active in this first session and less so in the other two active sessions. This may be a reaction to Telenoid's odd appearance, but on the other hand Isabella's generally changing demeanour and level of participation in sessions may entirely account for her behaviour here.

Isabella poses only a handful of questions to Telenoid and allows it to respond to one. This is seen at (Isabella 5, 02:20) when she calls Telenoid “*the small boy*” before asking it “*do you have a cold as well?*”. Telenoid responds and Isabella remarks “*then you won’t get home today*”. The Assistant asks if Isabella remembers that they sang the last time they were there to which she says “*This one, he lives in Aalborg and he has two kids and a...*”. before making self-stimulation and starting to mumble. Here Isabella’s denotation of Telenoid as “*he*”, and her interest in him being cold could indicate that she views Telenoid as something, which can indeed become cold and therefore animate. The description mirrors her depiction of Telenoid as a five-year-old boy, which is established and mostly maintained from early in the first session. Here, Isabella’s initial reaction is a loud utterance when seeing Telenoid for the first time at (Isabella 1, 00:27) saying “*is it a man... the girl.... That little boy, he does not want to go back to dad*”, all in the span of five seconds. There are however examples of Isabella denoting Telenoid as a “*girl*” (Isabella 8, 06:40) as well as an example of Isabella lifting Telenoid close to her face and saying “*it looks like a rabbit*” (Isabella 1, 06:31).

Isabella generally does not appear affectionate toward Telenoid. However, at (Isabella 7, 03:15) she starts self-stimulation intertwined with short utterances and periods of silence. She then touches Telenoid’s face and neck and settles on holding the shoulders in an investigative and almost caressing manner and asks “*are you here today when we are going home to [the city she is in]*”. She then calls Telenoid “*soft*” and “*a small boy*” and starts talking incoherently about “*mom and dad coming to the hotel*”. Later on at (Isabella 7, 05:10) she asks if Telenoid is coming back and says “*it is nice sitting here together*” and again calls Telenoid “*a nice little boy*”. In this incident there appears to be an emotional connection forming, and Isabella is certainly able to engage with Telenoid, albeit for a short while and sometimes uttering sentences, which do not seem to make much sense.



Image 46: Isabella investigating or caressing Telenoid at (Isabella 7, 04:05)

Technical Difficulties and Limitation

Pertaining to technical difficulties we see one significant incident when at (Isabella 7, 09:12) the Assistant and Telenoid start singing a song. At this point Isabella has been quiet for some time and just at they start singing, she mentions her mother and father in several short garbled remarks. While the Assistant notices this, Telenoid does not and as a result the remarks fade as Telenoid continues to hum.

Concluding on Isabella's interaction with Telenoid

We know that Isabella is prone to becoming over-stimulated, and as a result will self-stimulate, causing further overstimulation, which starts a spiral of increasing frustration in her. It was hoped that Telenoid's physically simplistic appearance would provide a means for her to cope with a conversational partner, but not be over stimulated. Based on the sessions of active interaction, this is not confirmed.

Concluding on Interaction Script & relations

Isabella's interaction and relations with and to Telenoid are severely impaired by her manic-depressive state, which I suspect at least contributes to her being active in conversation in only three of eight sessions.

In these sessions she only rarely addresses Telenoid and while her questions to Telenoid are all relevant, she only allows it to respond once. While she responds to some questions from the Assistant, she does so mostly with Stream of Consciousness-talk, which must often be creatively interpreted before any meaning can be extracted. In addition we never hear her tell stories or offer personal information beyond her name, and there is no development in the relationship and no clear script.

In the five inactive sessions she barely moves and keeps the same facial expression for entire sessions, appearing to deem neither Telenoid nor the Assistant as something worth her notice. If we examine all sessions, it appears that she responds somewhat more positively in the incidents in which Telenoid moves, but does not speak; as opposed to moving and speaking. The indication is slim and perhaps best seen in the final session (Isabella 8), and is included here as an afterthought, recognising that this dissertation examines the effects of having Telenoid present as an initiator of conversation rather than a topic.

With regard to Isabella's self-stimulation we see the first sign of this in her third session at (Isabella 3, 09:40). While Isabella engages frequently in self-stimulation, the data does not correspond with the staff's reports that her self-stimulation is present "*Very often*". I am hesitant to attribute this discrepancy to Telenoid or the effects of conversation in general and as the Assistant notes in her session logs, Isabella may be reacting to the physical presence of someone who doesn't speak.

Applying Telenoid as an animate artefact serving as a topic of conversation between the Assistant and the Participant may be interesting and resemble the use of PARO if the audio is removed. This setup may provide Isabella or other participants with the comfort needed to calm them in an otherwise over-stimulating environment. On the other hand, the silent social interaction with another person, as suggested by the Assistant in her session logs may be a better and more cost effective setup.

Concluding on Technical Difficulties and Limitations

With regard to the single technical difficulty in the sessions, I suspect that due to the poor quality of the video available to the Operator, she is simply not able to see or hear that Isabella has starting speaking. The incident was recorded before the implementation of the head-camera and exemplifies one of the central reasons why this adjustment is crucial when engaged in conversation with persons who have a tendency to speak at low volumes.

5.3. EXPLICATION OF TELENOID INTERACTION

As described above, this section treats all six Explications of Interaction as one dataset and thus focuses on characterising the overall interaction with Telenoid when accounting for all included data. As the conclusion to this section in many ways serves to answer the research questions of this dissertation, these are found in the next chapter.

Due to the many references to different Participants in this chapter, I offer the below table which provides a description which can help identify each Participant.

Participant	Overview description
Ethel	Verbally very active and provides lengthy descriptions. Appropriates Telenoid and takes on the role akin to teacher and paces Telenoid in singing. Does not engage with the Assistant.
Beatrice	Verbally very active but remains uninterested in Telenoid in her two sessions with it. Favours conversation with the Assistant. Asks about Telenoid at times but does so out of a humorous view of the situation.
Alice	Verbally manically active due to description-based Stream of Consciousness-talk. Persistently negative toward Telenoid due to a perception of it interrupting her and not being able to sing. Eventually strikes Telenoid in the face.
Ingrid	Almost completely silent but does appear to enjoy the close proximity to Telenoid. Clearly cares for Telenoid's wellbeing.
Benny	Verbally mildly active, mumbles and is physically stationary, appears to enjoy close interaction. Eventually tells complex personal stories and forms a close relationship to the Assistant and perhaps also Telenoid.
Isabella	Remains mostly entirely passive but will occasionally engage in Stream of Consciousness-talk. At times investigates Telenoid, does not offer views on Telenoid beyond the occasional adjective or personal pronoun, which is often "he".

Table 16: Participants and overview descriptions for comparison

From the explications of interaction it is clear that there is no such thing as a common set of traits in the symptoms and behaviours of all the participants. While some participants, such as Ethel or Benny, are talkative, engaging and progressively more open toward Telenoid, we also see reactions such as the persistent rejection from Alice, or the silent but pleasant interaction Telenoid has with Ingrid. Finally, Beatrice sees through the setting and play along until laughingly asking just to talk to the Assistant alone.

The change in most participants is remarkable. Naturally, the data pertaining to the verbally active participants such as Ethel is the richest, and thus more detailed analyses are done in these cases. Here we also have the most examples of change, but not always the strongest and despite the positive notions presented in this dissertation, there remains a hidden effect of Telenoid not shown in the data. This is best seen in the comments from the staff on Ingrid having “*won the study*” and becoming more verbally active; something which is not seen directly in her otherwise mostly silent interaction with Telenoid.

5.3.1. INTERACTION SCRIPT

While there does not appear to be a common script between all participants, it is clear that the initial reaction of the Participant is telling of their overall reaction to Telenoid. With examples such as Ethel who claps her hands, or Benny who immediately asks Telenoid “*how are you?*”, there is a sharp contrast to e.g. Alice who is sceptical, Beatrice who remains humorously indifferent to Telenoid, or Ingrid who remains silent but in close proximity. Ingrid is initially indifferent, and then accepts Telenoid rather than seeking it, and then often cycle between indifference and caressing Telenoid before rejecting it. This is in contrast to Ethel who from the very first interaction is verbally engaged in Telenoid and who over time displays an increasingly positive attitude toward Telenoid and is eagerly awaiting it at the start of sessions. Where Ingrid will cycle between interaction and rejection, Ethel occasionally rejects Telenoid, but often not for long.

This fluctuation between conversation with Telenoid and subsequent investigations, which occasionally lead to a short-lived rejection, is a frequent sighting in the data. With Ethel, the fluctuations between these two positions are frequent, but mostly mild in nature, as she places Telenoid with the Assistant both as a way for her to regain control of the situation by limiting anxiety, and, apparently, as a way for her to engage the Assistant in the activity. The same is seen in Benny, who after some initial confusion over the nature of Telenoid, becomes gradually more and more invested in his conversations. He progresses from short responses to offering longer responses and even deeply personal stories.

In the case of Ethel, the interaction is mostly verbal, but it appears that with Benny, Ingrid and Isabella the positive effect of the interaction stems more from the close physical proximity to Telenoid, and in some cases hinges on Telenoid being silent. This discovery came as somewhat of a surprise as the initial notion of the study was to provide a manageable and encouraging environment in which the Participants could engage in verbal activity.

With Ethel, Ingrid, Benny and Isabella there are clear signs of recognition when seeing Telenoid again after the initial session. This is seen in the form of outstretched arms and calls to engage in the activities of previous sessions, as well as a familiarity with the general handling of Telenoid and activities associated with it. This is seen most clearly with Ethel after seven sessions and with Beatrice or Isabella in their verbal relations to Telenoid.

Despite the clearly positive indications detailed above, the cases of Beatrice, Isabella and Alice must be taken into account. While there are overall positive signs, there are also significant considerations to the implementation of Telenoid in dementia-care, as evident in these cases. With Beatrice, the use of Telenoid remains uninteresting to her during the two sessions, and with Isabella, the use of Telenoid is either irrelevant or at best optimal when it does not move. Alice however has a persistently and thoroughly negative reaction to Telenoid, which does not contribute positively to her wellbeing in any discernable way. In these cases the Participant's appropriation or reaction to Telenoid does not match the preconception by the team when setting up the study, and it is clear that Telenoid cannot be applied successfully in all cases of severe dementia.

5.3.2. RELATIONS

As with the script of interaction, the relations between the Participants, Telenoid and the Assistant develop over time. In the below I focus on the roles of Telenoid, the Assistant and of the Operator. In addition to insights from the data I present recommendations to how these roles should be adapted in future studies.

5.3.2.1 The role of Telenoid

From the study overview, the overall role of Telenoid is that of a conversational partner who collects funny stories. With an emphasis on facilitating conversation on topics of interest to the Participant, Telenoid is not primarily the topic of conversation, although this was certainly seen as a possibility.

With Ethel being by far the most verbally active Participant, it comes as no surprise that it is here we find the most adjectives and descriptions of what Telenoid is thought to be. With Ethel we see a predominant tendency to describe Telenoid with the use of "*he*", "*she*", "*It*" or "*Kirk*".

There is a predominant use of “*he*” as well as a description of Telenoid looking like a “*child*” or even “*small boy*” in most Participants. With Isabella we see a definitive description of mostly “*it*”, and sometimes a description of Telenoid being “*rabbit like*”, which most likely relates to Telenoid’s white appearance. Alice and Beatrice are both clear in their descriptions of Telenoid as either “*not looking like anything*”, “*ugly*” or even less flattering adjectives. While Benny is not as vocal in the session, he does view Telenoid consistently as a boy, which is not seen in any other Participant. This is in line with his unique initial reaction to Telenoid, as he is the only Participant who greets Telenoid rather than the Assistant, and who engages in conversation with it without the Assistant having introduced it.

All Participants engage in some form of investigation of Telenoid during the course of their sessions, and often repeat their individual actions and interactions with Telenoid. With Isabella the investigations occur once and take the form of carefully caressing Telenoid’s shoulders, indicating a form of nurture toward it as well as a question to which a response has no effect. With Benny we see fragmented questions as to Telenoid’s origin, which are then abandoned at the response.

Ingrid is heard mumbling that Telenoid is “*a strange thing*” but is also seen wrapping a blanket around it in a caring fashion and will on occasion caress Telenoid. The juxtaposition between these positions are, as mentioned, not unique to Ingrid, and she will apparently change her categorisation of Telenoid fluidly in no particular pattern. This could indicate that she enjoys the interaction and wishes to prolong the interaction as a whole. This is all while we also see incidents in which she is reluctant to engage with Telenoid, and seems to not engage at all.

Beatrice engages in somewhat of an investigation of Telenoid, but this is more due to her identifying Telenoid as artificial, “*weird*” and her wanting to engage with the Assistant rather than Telenoid. Her posture toward Telenoid is likely caused by her retaining most of her social and verbal skills, and her overall level of dementia being low, as indicated by her MMSE score of 19-20/30 as well as from general description from the staff. As indicated in her explication, I suspect that if a Participant retains these skills, Telenoid becomes less appealing. This conclusion falls in line with the overall beliefs of the care-staff who have maintained this position since the Pilot study. Simply put, Telenoid appears not to be applicable as a tool for persons with light or moderate dementia who still enjoy and seek out social interaction on their own. Indeed, Beatrice herself condenses this at (Beatrice 8, 12:15) when responding to the Assistant’s explanation as to why they brought Telenoid to the facility: “*I would much rather just talk to you*”.

Ethel's investigation of Telenoid seems to suggest that her view of what Telenoid is, is under development, and this view is seen in several incidents with most Participants who engage in descriptions of Telenoid. This is not surprising in itself, but it is interesting that it appears that, overall, she is more prone to relate to Telenoid as an artefact in times of technical difficulties.

Over the course of the sessions, Ethel appropriates Telenoid and moulds the interaction by increasingly taking charge of the setting and activities that occur and taking on the role akin to teacher in sessions of singing as well as beyond. This is not unique to Ethel, but in her case we see a definite change in overall initiative, which is unique to her. In this manner it is found that Telenoid is appropriated by Ethel to fill a social need, which has otherwise been left unanswered. We see the same form of behaviour in Benny who normally converses about his present life, but avoids stories from his past life. This is reversed in the sessions with Telenoid where he will focus mostly on general knowledge of farming, but include increasingly personal stories as their relationship develops. As mentioned in his explication, I believe that Benny's appropriation of Telenoid in this manner is a sign that he uses Telenoid to fill an unfulfilled need. It is interesting that the trusted staff-members note that the types of stories shared by Benny to Telenoid are only heard rarely by them or by family members. This suggests that Benny either views Telenoid entirely differently, or that its appearance causes him to engage in more memory-based conversation than usual.

Furthermore, due to the amount of verbal interaction in Ethel's sessions we are able to investigate the positive improvement in her ability to engage in conversation over time. As described above, I claim to see a positive tendency in her functional vocabulary during especially aphasic episodes, and in her ability to *work through* them. Specifically we see that over time, the episodes appear less frequently and when they do appear she is more likely to keep trying as well as succeed in producing meaningful speech, as compared to earlier in the session where she would stall and then stop in the attempt. This appears to influence her overall ability and willingness to engage in conversation, both inside Telenoid-sessions and in interaction with other residents.

5.3.2.2 The role of the Assistant

In the case of most participants, the frequency of technical difficulties entail that the Assistant is occupied with relaying the status of Telenoid to the Operator, as well as maintaining the relationship with the Participant despite this. We see this in several incidents across all Participants when the Assistant explains verbal distortion or delay with words such as *'Telenoid having a toad in the throat'*, or *'being sick'*. Indeed, as seen with Ethel, it is highly doubtful that the level of positive relations between Ethel and Telenoid would be archived if the Assistant had not been present to function as an interpreter and social support.

With the varied appropriation and relations to Telenoid detailed above, it is interesting that none of the Participants are overly concerned with the identity and motivations of the Assistant (or Telenoid) for visiting. While Ethel engages in frequent investigation of “*the Lady*”, she addresses Telenoid with these statements of the Lady being present, and appears to implicitly call on Telenoid to inform her about the nature of the Assistant. Despite this, Ethel’s relationship with the Assistant does not seem to develop and she remains overly joyed at seeing Telenoid again, and somewhat pleased at the presence of the Assistant. Beatrice’s reaction is however extremely different from other Participants and here we see a close personal relationship forming during the course of the session. While she engages with Telenoid for just two sessions, the removal of Telenoid seems to significantly improve the pace of development between the Assistant and Beatrice. Despite this, Beatrice never asks for the Assistant’s name, and only once touches on the topic of where she is from.

5.3.2.3 The role of the Operator

As with the Assistant, the role of the Operator was performed by expertly competent staff with first hand knowledge of interaction and communication with persons with dementia. For obvious reasons, the role of the Operator is essential to the use of Telenoid, and we found that while technical training in the use and operation was needed, it did not compare to real-world application and interaction with persons with dementia. While the training prepared the Operator for the Voice and Movement delay, and previous experiences prepared her for how to address and analyse subtle cues and changes in behaviour that signalled a change in attention or thought processes, the combination was overwhelming to begin with. After some 5-7 sessions, the Operator had reached a level of competence that made her more comfortable with her role and function.

5.3.3. TECHNICAL DIFFICULTIES AND LIMITATIONS

From the interactions seen in this study, it is clear that there are a number of different technical difficulties that limit the use and effect of Telenoid. I have chosen to arrange these in the broad categories of either software and interaction, or hardware and location.

5.3.3.1 Software and interaction

When reviewing the sessions of the Participants, it is clear that, overall, the frequency, duration and level of disruption caused by technical difficulties often produce significant disturbances to the interaction and that on several occasions these contributed greatly to the deterioration of the relationships.

When these technical difficulties occur, Participants are generally prone to lose focus and start investigating Telenoid physically by turning it over, fiddling with its features or generally adopting a posture indicating that they view Telenoid as an artefact. There are incidents of verbal investigation where the Participants ask the Assistant about Telenoid as seen with e.g. Ethel.

The most common technical difficulty is that of verbal distortion and delay from Operator to Telenoid. The transmission of movement from the Operator to Telenoid was found to be changing over time, but generally the Operator chose not to make use of Telenoid's ability to move during sessions, so evaluation of this is not possible. As presented in the above sections, there are several instances of both shorter and longer periods of time where Telenoid simply does not move when directed to do so by the Operator. From the video we are not able to pinpoint the delay from Telenoid to the Operator, but from anecdotal comments from the Operator, they are described a mostly between 1-2 seconds during all sessions unless accompanied by other technical difficulties. The total loss of function was seen a few times during the study. In these cases, Telenoid's inability to function at a stable level results in serious reservations as to the implementation of Telenoid in wider settings and uses due to the complex nature of sorting out what is the cause of the error and how to fix it. It should be noted that the software has been updated since the study and is now far more stable.

5.3.3.2 Hardware and Locations

While most of the technical difficulties are related to the delay and distortion of Telenoid's voice, there are also negative implications in the interaction as a result of the hardware and the location used. As seen as angle "C" on Image 19 on page 90, the video presented to the Operator was far from ideal in the early sessions. As described in the cases of Isabella and Alice, there are incidents in which we know that the angle and quality of the video has caused the Operator to identify the interaction wrongly, causing her to interrupt or anger Participants. With the introduction of the head-mounted camera seen in later sessions this issue is largely alleviated. In addition, the extension of the range between the Operator and the Participant caused the echo between Telenoid and the Operator to become less pronounced. In an effort to provide passive Participants with a stimulating environment the sessions were at times conducted in the common-areas of the care-facility. With several Participants, the analysis of sessions has revealed that while the Participants overall are more active, serious considerations are necessary to limit overstimulation. In most cases the Participant will appear to engage slightly more in conversations but their attention will also drift and their focus shift from the interaction to e.g. the TV, other residents or the weather. In addition, as seen in the case of Benny's first three sessions, there are also sessions in which the recordings of audio and interaction are in very poor condition, even with the use of a body-worn microphone and after sound editing.

CHAPTER 6. CONCLUSIONS AND FUTURE DIRECTIONS

The purpose of this chapter is to detail the conclusions found in this dissertation as well as my recommendations for the future directions of research and application of Humanoid and Zoomorphic Robots in the domain of Health and Welfare. The chapter is separated into three sections.

First, I will conclude on the Explications of Interaction focusing on the information obtained from across the different Explications of Participant Interaction presented in the previous chapter.

Secondly, I will present a section that evaluates and reflects on the applied Grounded Theory Method.

Finally, I will present a section on the final remarks of the dissertation and point to future directions of research.

6.1. CONCLUDING ON EXPLICATIONS OF INTERACTION

As detailed in Chapter 1, the purpose of this dissertation is a twofold aim to characterise the interaction between Telenoid and elderly persons with dementia, and evaluate to what degree this interaction can alleviate symptoms of dementia in these persons. To this end the study was conducted, data collated and analysed in detail.

With respect to the evaluation of to what degree this interaction can alleviate symptoms of dementia in these persons it is overall found that while a multitude of quantitative methods were applied there was no coherent pattern of decrease or increase in the presented symptoms of dementia. While some tools such as the MMSE show an increase in e.g. the sub-section of Language or similar sub-sections, this dissertation finds more value in the analysis of the qualitative data and forming Explication of Participant interaction based on this. The qualitative data suggest that Telenoid can indeed perform as a tool for health and welfare within the domain of elderly persons with severe dementia. The following passages clarify the specific findings of the dissertation as well as suggestions for improvements.

6.1.1. CONCLUDING ON INTERACTION SCRIPT WITH TELENOID

With some Participants remaining sceptical throughout the study, others appear to appropriate Telenoid and take control of the nature of interaction, steering the conversation and often directing Telenoid to e.g. sing. This dissertation finds that between the six participants, there is no common script of interaction in which Telenoid is naturally placed. Instead the Participants routinely and consistently appropriate Telenoid to their own desire. Interestingly, this appropriation causes Telenoid to be included in various activities and topics of conversation that the Participants do not normally engage in.

It is therefore found that Telenoid has the possibility to function as a tool of Health and Welfare, which is appropriated by the Participants themselves and to function in diverse roles which they, staff and family members can help define. From there Telenoid can hopefully serve as a tool for using, training and maybe improving abilities or social competencies such as verbal activity through singing and conversation, as well as social interaction in general. Interestingly, these activities are often mentioned in the facility records of the Participants as activities they enjoy, but interviews show that they do not engage in these with the staff or family members. As such, Telenoid seems to fill a role with each of the Participants, which allows them to engage in activities they enjoy but cannot find interlocutors for in their daily life.

6.1.2. CONCLUDING ON THE ROLE OF TELENOID

During the course of the study, Telenoid has been subject to several less flattering descriptions. With all Participants, the descriptions given do not change greatly during the course of the study, and as such descriptions of Telenoid “*looking like a rabbit*” or “*being ugly*” do not change to a more positive connotation. While the use of “*he*” and “*she*” varies even within the same incident for many Participants, the view of Telenoid as an agent is predominant in these cases, but not constant. As such, many Participants at times see through the deception, and describe Telenoid as “it”, and investigate it in these incidents. When this occurs, there is often a short-lived rejection of I with the Participant placing I with the Assistant and often asking about the nature of I and the interaction. It is found that short-lived rejections should be welcomed as they serve to keep the Participant in the present and actual world as well as engaged in conversation.

The specific roles given to I by the Participants are often akin to a child and often as the recipient of some form of training, such as singing or conversation in general. Other roles include that of a conversational partner as opposed to an interviewer, and as these roles appear to be fluid, the Participants are likely to apply different roles during the course of a session and develop new roles over the course of several sessions, which may suggest changing needs or abilities in the Participant. This suggests that the use of I in some ways help the Participants train some ability, and while this is an appealing notion in line with current findings in conversational therapy, I will not claim the causality based on the available data. However, we must recognise the change in willingness to engage in social interaction as well as ability to “*work through*” aphasic episodes seen in some of the more verbally active Participants.

Furthermore, given the reaction of Beatrice, Alice and Ingrid, it is clear that Telenoid is not for everyone, and that while pre-study assessments by care staff and experts can help define probable Participants who would likely benefit, these are not always correct. Thus, further study into the application of Telenoid in dementia care is needed before arriving at a firm Participant-description.

6.1.3. CONCLUDING ON THE ROLE OF THE ASSISTANT & OPERATOR

The Assistant is a significant resource in creating a nurturing setting for the interaction and as such this dissertation finds that the use of an Assistant should be continued in future deployment. There may, however, be settings or other Participant-groups within the domain of Health and Welfare where the use of an Assistant is unwanted. This dissertation finds that at all times, either the Operator or an Assistant-type staff-member should be able to be on location within some 30 seconds, in the event of unforeseen events.

In addition it is found that both the roles of the Assistant and the Operator must be performed by expertly competent staff with first hand knowledge of interaction and communication with persons with dementia, as well as some clinical knowledge on the progression of dementia. As training does not compare with real-world experience in regard to the operation of Telenoid, it is advised that in future comparable studies, the Operator should have some at least three hours of experience with persons comparable to study-participants, as well as considerable experience with the technical aspects of setting up the equipment, before starting actual data-collection.

6.1.4. CONCLUDING ON TECHNICAL DIFFICULTIES AND LIMITATIONS

With the varied appropriation of Telenoid there is a great difference in what the individual Participant may find to be *normal interaction* as seen by some engaging in frequent singing, some telling Telenoid stories from their past and some seeking quiet physical contact. In all cases the technical difficulties cause the expectations of the individual Participant to become unmet. These expectations are built over the course of the sessions as a whole, and when Telenoid does not perform as expected by e.g. not responding, moving or making unnatural noises, the Participants react with anywhere from a change in mood or focus to scepticism, fright, frustration or indeed violence. In wider deployment of Telenoid, situations like this must over all else be avoided because of the long-term negative implications this could have on the Participants.

It appears that delays cannot be cast aside with explanations from the Assistant or Telenoid itself, as these are immediately perceived as rude interruptions or lacking social skills. When the technical difficulties appear as a complete lack of speech in sessions where the Participant indeed wants to engage in conversation, this causes significant frustration comparable to that of delayed speech. In contrast only the distortions are accepted with the explanation of Telenoid '*having a toad in the throat*', which often causes laughter. As the synchronous speech not only serves to avoid deterioration of the relationship, but makes interaction far easier, free flowing and reduces irritation on the part of the Participant, it is likely that the overall amount of verbal engagement will increase with the improvement of this feature.

In addition, it is found that it is necessary to provide the Operator with both a wide-angle situational camera and the head-mounted directional camera, which allow the Operator to be aware of the body language of the Participant as well as enable eye contact.

6.2. EVALUATING THE GROUNDED THEORY

On page 117 I presented several criteria for Grounded Theories that should not be rigorously adhered to, but rather aspired to achieve. On the point of *Credibility* I note the limitations of this dissertation with respect to the population size. This causes the findings to be indicative and not final, as evident by the breath of the different findings, even between the six Participants included here. Within the scope of the study I claim to have found adequate data to support my findings, and I hope that the presented descriptions and explications of interaction provide the necessary logical links between my findings and their conclusions. As mentioned, several sections have been merged, refocused or deleted in an effort to achieve adequate detail and evidence, without providing repetitious presentations.

As presented in the review, it is generally found that Socially Assistive Robots are able to serve elderly with dementia as a means to engage in emotionally engaging situations such as conversation or story-telling. While this domain is the by far best saturated, the collected works are at best indicative of the results presented. There appears to be no clear core of methods for researching HRI in this domain, and the results are generally not directly verifiable. With the use of Grounded Theory and a population of six Participants, this dissertation cannot claim to have cleared itself of the critique of Socially Assistive Robotics-research brought forward in the above section on scientific rigour on page 59. This however was not the main concern of this dissertation, as it accepts the limitations of the setup in favour of adding to prevalent out-dated paradigm of techno deterministic research found in most Socially Assistive Robotics research. Instead, the purpose was to characterise the interaction between Telenoid and elderly with severe dementia, and it does this by providing a comprehensive qualitative explication of interaction, which not coincidentally was sought by several researchers as presented on page 61. The need for this approach is evident when comparing the explications and result presented, with the review of methods applied in the existing research on HRI with elderly persons with dementia on page 104. It is apparent when noting that most of the elements apply quantitative data and reach quantitative results, and that the few elements that presented either qualitative or mixed data as well as a qualitative or mixed analysis are not as comprehensive as what is presented, and that many of the elements include this techno deterministic approach.

I have already noted the similarities between my own work and that of (Chang et al., 2013; Gustafsson et al., 2015; Ryuji Yamazaki et al., 2014) on page 107, and these elements should be acclaimed for their view and scope. However, within the review I claim to be the first to analyse interaction in the presented degree between a *Functionally Designed Humanoid Socially Assistive Robot* and elderly with severe dementia by means of Grounded Theory. Thus I claim a speck of *Originality* by adding to the existing body of knowledge.

In doing so, this dissertation does not claim to provide final methodological results, but rather methodological inspirations to future research, as well as results that by themselves add to the current body of research on the application of Humanoid Socially Assistive Robots in Health and Welfare. Thus, this dissertation should hopefully be *Useful*, by providing if not a full and exhaustive description, then a comprehensive description on possible reactions, outcomes and perspectives on the use of Socially Assistive Robots in interaction with elderly with dementia.

While the results of this dissertation are Credible, Original and Useful in offering an alternative to the technocentric development of robotics, its insight into the characterisation of interaction between Telenoid and elderly persons with severe dementia is limited. Due to the limited population in the study, the specific results can likely not be applied to other similar Participants but should be seen more as a contribution of qualitative explications, which provide insight into the effects of conversation with Telenoid, rather than a theory detailing the interaction script or relations in studies on interaction with Telenoid or his kin.

6.3. FINAL REMARKS AND FUTURE DIRECTIONS

The finding that some Participants react positively to a moving but silent interaction with Telenoid mirrors what is found with e.g. PARO. As brought forward in the review of the application of Socially Assistive Robots in Health and Welfare, I maintain that while the present findings suggest a positive reaction, the application of Telenoid or PARO in such a way, does not constitute improved interaction. From the findings it is clear that both Beatrice and Isabella benefit greatly, but they do so in terms of being *calmed*, not *engaged in conversation* or *interaction*. While effects on conversation is said by staff to be present in Beatrice beyond the sessions themselves, this result alone cannot justify the currently prevalent notion that the application of PARO, or any non-communicating Socially Assistive Robot, directly improves interaction in persons with dementia. However, this is not to say that silent interaction with a non-communicating Socially Assistive Robot is not valuable to e.g. persons with severe dementia or that this for of interaction cannot serve as a temporary stepping-stone towards relearning the social skills needed to engage in verbal interaction with other humans. This exact line of development is in fact suggested by the results seen in Ethel as she progresses from a passive presence to an outgoing active presence who engages and seeks out social interaction on her own. As such the study finds that interaction with Telenoid has proved successful in promoting social and verbal interaction in elderly with severe dementia, both in Human-Robot-Interaction and beyond. While the positive effects of interacting with Telenoid can be found in many Participants, we must also acknowledge that despite ample data on the symptoms of dementia, there is no quantitative indication that these were alleviated as a result of the interaction.

It is also found that persons with severe dementia who retain verbal and social skills are not included in the primary user group, as they do not find conversation and interaction with Telenoid appealing. Furthermore, Telenoid was not found to be able to conduct conversations without an Assistant present.

Both the present and other research on Telenoid conclude that it and other Socially Assistive Robots like it, appear to be possible tools for specialised tasks within e.g. dementia. These tasks are conversational and interactional in nature, and the study finds that letting the Participants appropriate Telenoid and decide the precise role and activity to engage in is likely to elevate the quality of interaction. The roles are likely to change over time and within reason the application of Telenoid should reflect and adapt to the changing wants of the Participant. The one common trait across all Participants who appropriate Telenoid is that while they were always able to engage in activities such as singing, prolonged conversation, or a conversational focus on the past, they had either not engaged in these activities for a long time or the frequency and duration of the activities have increased.

Comparing the Participants' interactions with Telenoid to those often seen with plush dolls such as Ruben's Barn dolls, it is interesting that there appears a need to be both cared for by others, and to care for others yourself. We see strong indications of this in most Participants who engage with Telenoid as though it was a small child, nurtures it and caresses it; clearly caring for it. As a life with severe dementia often requires constant and elaborate care, the change of social dynamics for the Participant to care for someone; and more importantly to care for someone who responds and engages in interaction, must be welcome and engaging.

However, despite these positive notions and applications for Telenoid, the cost of Telenoid as well as the cost of initial and continued training of staff does not appear to justify the positive results found in the present study or in the review, due to the availability of these results by other, cheaper, means. In addition to these severe limitations to the potential user group, as well as the incoherence in symptoms of dementia overall, the tools needed to engage elderly with severe dementia in conversation must be agile and readily mouldable to the individual user to be of best use. While this dissertation finds Telenoid to bring about positive change in Participants interaction, it is not an agile tool in its deployment. While Telenoid does promote social interaction in persons with severe dementia I must acknowledge the use of e.g. a Ruben's Barn doll in dementia-care facilities, which is often fed and affectionately cared for despite their obviously caricatured humanoid appearance and inability to interact. I must therefore argue for the further investigation and development of these as opposed to the development of robotics per se. In this aspect I generally recommend the future study on the use of Humanoid robots in dementia care.

Specifically I also recommend further research on the application of a Telenoid-like humanoid that includes a head-mounted camera, a situational camera, a microphone, loudspeaker and means of providing voice communication with an Operator as well as a tactile vibration. This design would contain all interaction-modalities found in Telenoid, apart from the movement of the head and arms that would be reduced to a vibration. I believe that this design captures the essence of positive traits found in Telenoid, but presumably at a lower production cost.

With the novel setting of interaction between elderly with severe dementia and Humanoid Socially Assistive Robots, the findings are limited to that setting and may inform, in some way, the general life of persons with severe dementia. It is clear that Participants react differently to Telenoid, for better or worse, than they do to regular humans. This dissertation finds that the use of Telenoid reveals several positive developments in the Participants in terms of behaviour and symptoms of dementia as well as other aspects of the Participant life, which likely adds to their quality of life. The dissertation also finds that there are several limitations to these findings. Chief among these are the limited user-group, the cost and the degree of the effects.

While it is argued that the degree of positive effects found in this dissertation at present can be achieved by other means, it is my distinct conviction that this should not discourage further research into the application of Humanoid and Zoomorphic Socially Assistive Robots in the domain of Health and Welfare. The technical difficulties and limitations to Telenoid and *his kin* will with effort be alleviated soon, and this dissertation finds that, even despite these, he, in some cases, is better than his human counterparts at fostering a interaction space in which verbal activity is easier for persons with severe dementia. Even if nothing else, Telenoid is thus a specialised tool capable of engaging persons with severe dementia in social activities they did not engage in before.

REFERENCES

- AAU. (n.d.-a). Ethiske retningslinjer. Retrieved 26 November 2017, from <http://www.kommunikation.aau.dk/etik>
- AAU. (n.d.-b). Good scientific practice. Retrieved 26 November 2017, from <http://www.en.hum.aau.dk/research/Good+scientific+practice>
- Aldebaran Robotics. (2015). Who is Pepper? [Aldebaran.com]. Retrieved 15 July 2015, from <https://www.aldebaran.com/en/a-robots/who-is-pepper>
- Alzheimer Europe. (2011a). Ethics of dementia research. Retrieved 26 November 2017, from <http://www.alzheimer-europe.org/Ethics/Ethical-issues-in-practice/2011-Ethics-of-dementia-research>
- Alzheimer Europe. (2011b). Ethics of dementia research - Informed consent to dementia research. Retrieved 26 November 2017, from <http://www.alzheimer-europe.org/Ethics/Ethical-issues-in-practice/2011-Ethics-of-dementia-research/Informed-consent-to-dementia-research>
- Alzheimer's Disease International. (2009). *World Alzheimer Report 2009*. Alzheimer's Disease International. Retrieved from <https://www.alz.co.uk/research/files/WorldAlzheimerReport.pdf>
- Alzheimer's Society. (2007). *Dementia UK - A report into the prevalence and cost of dementia*. London: Alzheimer's Society. Retrieved from http://alzheimers.org.uk/site/scripts/download_info.php?fileID=2
- Andersen, H. C. (2016, March 18). The Nightingale. Retrieved 18 March 2016, from http://www.andersen.sdu.dk/vaerk/hersholt/TheNightingale_e.html
- Aphasia.org. (2016). Aphasia Definitions. Retrieved 12 December 2016, from <http://www.aphasia.org/aphasia-definitions/>
- Asimov, I. (1995). *The complete robot* (Paperback ed). London: HarperCollins.
- ATR Hiroshi Ishiguro Laboratory. (2017). Geminoid.jp. Retrieved 19 May 2017, from <http://www.geminoid.jp/en/index.html>
- Banks, M. R., Willoughby, L. M., & Banks, W. A. (2008). Animal-Assisted Therapy and Loneliness in Nursing Homes: Use of Robotic versus Living Dogs. *Journal of the American Medical Directors Association*, 9(3), 173–177. <https://doi.org/10.1016/j.jamda.2007.11.007>

Bemelmans, R., Gelderblom, G. J., Jonker, P., & de Witte, L. (2012). Socially Assistive Robots in Elderly Care: A Systematic Review into Effects and Effectiveness. *Journal of the American Medical Directors Association*, *13*(2), 114-142. <https://doi.org/10.1016/j.jamda.2010.10.002>

Bemelmans, R., Gelderblom, G. J., Jonker, P., & de Witte, L. (2015). Effectiveness of Robot Paro in Intramural Psychogeriatric Care: A Multicenter Quasi-Experimental Study. *Journal of the American Medical Directors Association*, *16*(11), 946–950. <https://doi.org/10.1016/j.jamda.2015.05.007>

Beran, T. N., Ramirez-Serrano, A., Vanderkooi, O. G., & Kuhn, S. (2015). Humanoid robotics in health care: An exploration of children's and parents' emotional reactions. *Journal of Health Psychology*, *20*(7), 984–989. <https://doi.org/10.1177/1359105313504794>

Bernd, T., Gelderblom, G. J., Vanstipelen, S., & Witte, L. de. (2010). Short Term Effect Evaluation of IROMEC Involved Therapy for Children with Intellectual Disabilities. In S. S. Ge, H. Li, J.-J. Cabibihan, & Y. K. Tan (Eds.), *Social Robotics* (pp. 259–264). Springer Berlin Heidelberg. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-17248-9_27

Berque, A. (1986). *Le sauvage et l'artifice: les Japonais devant la nature*. Paris: Gallimard.

Bertel, L. B. (2016). *PEERS: persuasive educational and entertainment robotics - a design-based research approach to social robots in teaching and learning* (Vol. 2016). Aalborg, Denmark: Aalborg University Press.

Bijker, W. E., Hughes, T. P., & Pinch, T. J. (Eds.). (2012). *The social construction of technological systems: new directions in the sociology and history of technology* (Anniversary ed). Cambridge, Mass: MIT Press.

Bluefro Robotics.com. (2016). Buddy : The Companion Robot Accessible To Everyone. Retrieved 4 February 2016, from <http://www.bluefrorobotics.com/en/buddy-your-companion-robot/>

Bowen, G. A. (2008). Naturalistic inquiry and the saturation concept: a research note. *Qualitative Research*, *8*(1), 137–152. <https://doi.org/10.1177/1468794107085301>

Breazeal, C. (2003). Toward sociable robots. *Robotics and Autonomous Systems*, *42*(3), 167–175. [https://doi.org/10.1016/S0921-8890\(02\)00373-1](https://doi.org/10.1016/S0921-8890(02)00373-1)

- Brender, J. (2005). *Handbook of Evaluation Methods for Health Informatics*. Burlington, MA: Academic Press.
- Broadbent, E., Stafford, R., & MacDonald, B. (2009). Acceptance of Healthcare Robots for the Older Population: Review and Future Directions. *International Journal of Social Robotics*, 1(4), 319–330. <https://doi.org/10.1007/s12369-009-0030-6>
- Brodaty, H., & Arasaratnam, C. (2012). Meta-analysis of nonpharmacological interventions for neuropsychiatric symptoms of dementia. *The American Journal of Psychiatry*, 169(9), 946–953. <https://doi.org/10.1176/appi.ajp.2012.11101529>
- Broekens, J., Heerink, M., & Rosendal, H. (2009). Assistive social robots in elderly care: a review. *Gerontechnology*, 8(2). <https://doi.org/10.4017/gt.2009.08.02.002.00>
- Bucks, R., & Radford, S. (2004). Emotion processing in Alzheimer's disease. *Aging & Mental Health*, 8(3), 222–232.
- Burnham, H., & Hogervorst, E. (2004). Recognition of Facial Expressions of Emotion by Patients with Dementia of the Alzheimer Type. *Dementia and Geriatric Cognitive Disorders*, 18(1), 75–79. <https://doi.org/10.1159/000077813>
- Capek, K., & Playfair, N. (1961). *Rossum's Universal Robots (R.U.R.)*. (Selver, P, Trans.). USA: Oxford University Press.
- Cevizci, S., Murat, H., Gunes, F., & Karaahmet, E. (2013). Animal Assisted Therapy and Activities in Alzheimer's Disease. In I. Zerr (Ed.), *Understanding Alzheimer's Disease*. InTech. Retrieved from <http://www.intechopen.com/books/understanding-alzheimer-s-disease/animal-assisted-therapy-and-activities-in-alzheimer-s-disease>
- Chan, J., & Nejat, G. (2010). Promoting engagement in cognitively stimulating activities using an intelligent socially assistive robot. In 2010 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM) (pp. 533–538). <https://doi.org/10.1109/AIM.2010.5695806>
- Chandler, C. K. (2012). *Animal Assisted Therapy in Counseling* (2. ed.). New York, NY: Routledge.

Chang, W.-L., Šabanović, S., & Huber, L. (2013). Situated Analysis of Interactions between Cognitively Impaired Older Adults and the Therapeutic Robot PARO. In G. Herrmann, M. J. Pearson, A. Lenz, P. Bremner, A. Spiers, & U. Leonards (Eds.), *Social Robotics* (pp. 371–380). Springer International Publishing.
https://doi.org/10.1007/978-3-319-02675-6_37

Charmaz, K. (2006). *Constructing Grounded Theory: A Practical Guide through Qualitative Analysis* (1 edition). London ; Thousand Oaks, Calif: SAGE Publications Ltd.

Cummings, J. (2009, January 6). Neuropsychiatric Inventory Nursing Home Version (NPI-NH). Retrieved from <http://www.manad.com.au/wp/wp-content/uploads/2013/07/NPI-NH-assessment-tool1.pdf>

Danmark, & Uddannelses- og Forskningsministeriet. (2014). *Danish code of conduct for research integrity*. Ministry of Higher Education and Science.

Devshi, R., Shaw, S., Elliott-King, J., Hogervorst, E., Hiremath, A., Velayudhan, L., ... Bandelow, S. (2015). Prevalence of Behavioural and Psychological Symptoms of Dementia in Individuals with Learning Disabilities. *Diagnostics*, 5(4), 564–576. <https://doi.org/10.3390/diagnostics5040564>

Ekman, P. (2007). *Emotions Revealed, Second Edition: Recognizing Faces and Feelings to Improve Communication and Emotional Life* (2nd edition). New York: Holt Paperbacks.

europa.eu. (2017). European Regional Development Fund. Retrieved 19 May 2017, from http://ec.europa.eu/regional_policy/en/funding/erdf/

European Commission. (2005). STAT-05-48_EN. Retrieved from http://europa.eu/rapid/press-release_STAT-05-48_en.htm

European Commission. (2014). *Population ageing in Europe: facts, implications and policies : outcomes of EU-funded research*. Luxembourg: Publications Office. Retrieved from <http://dx.publications.europa.eu/10.2777/60452>

EUROSTAT. (2015a, February 3). Population Projections. Retrieved 16 July 2015, from <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tps00002>

EUROSTAT. (2015b, February 3). Proportion of population aged 65 and over. Retrieved 16 July 2015, from <http://ec.europa.eu/eurostat/tgm/table.do?tab=table&plugin=1&language=en&pcode=tps00028>

Feil-Seifer, D., & Mataric, M. J. (2005). Defining socially assistive robotics. In *9th International Conference on Rehabilitation Robotics, 2005. ICORR 2005* (pp. 465–468). <https://doi.org/10.1109/ICORR.2005.1501143>

Fitzgerald, C. (2013). Developing baxter. In *2013 IEEE International Conference on Technologies for Practical Robot Applications (TePRA)* (pp. 1–6). <https://doi.org/10.1109/TePRA.2013.6556344>

Flandorfer, P. (2012). Population Ageing and Socially Assistive Robots for Elderly Persons: The Importance of Sociodemographic Factors for User Acceptance. *International Journal of Population Research, 2012*, 14. <https://doi.org/10.1155/2012/829835>

Fogg, B. J. (2002). *Persuasive Technology: Using Computers to Change What We Think and Do* (1 edition). Amsterdam ; Boston: Morgan Kaufmann.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). “Mini-mental state”: A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*(3), 189–198. [https://doi.org/10.1016/0022-3956\(75\)90026-6](https://doi.org/10.1016/0022-3956(75)90026-6)

Fong, T., Nourbakhsh, I., & Dautenhahn, K. (2003). A survey of socially interactive robots. *Robotics and Autonomous Systems, 42*(3–4), 143–166. [https://doi.org/10.1016/S0921-8890\(02\)00372-X](https://doi.org/10.1016/S0921-8890(02)00372-X)

Frennert, S., & Östlund, B. (2014). Review: Seven Matters of Concern of Social Robots and Older People. *International Journal of Social Robotics, 6*(2), 299–310. <https://doi.org/10.1007/s12369-013-0225-8>

Geminoid.jp. (2015). Telenoid. Retrieved 11 August 2015, from <http://www.geminoid.jp/projects/kibans/Telenoid-overview.html>

Glaser, B. G., & Strauss, A. L. (1966). *Awareness Of Dying*. Transaction Publishers.

Glaser, B. G., & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Aldine Publishing Company.

Gulmann, N. C. (2001). *Praktisk gerontopsykiatri* (3rd ed.). Kbh.: Hans Reitzel.

Gustafsson, C., Svanberg, C., & Müllersdorf, M. (2015). Using a Robotic Cat in Dementia Care: A Pilot Study. *Journal of Gerontological Nursing*, 41(10), 46–56. <https://doi.org/10.3928/00989134-20150806-44>

Heath, C., Hindmarsh, J., & Luff, P. (2010). *Video in qualitative research: analysing social interaction in everyday life*. Los Angeles: SAGE.

Ishiguro, H., & Nishio, S. (2007). Building artificial humans to understand humans. *Journal of Artificial Organs*, 10(3), 133–142. <https://doi.org/10.1007/s10047-007-0381-4>

ISO. ISO 14155:2011 - Clinical investigation of medical devices for human subjects - Good clinical practice, 14155 § (2011). Retrieved from <https://www.iso.org/standard/45557.html>

ISO. (2012). Robots and Robotic Devices - ISO 8373:2012. In *ISO* (Vol. 2012). ISO. Retrieved from <https://www.iso.org/obp/ui/#iso:std:iso:8373:ed-2:v1:en:term:2.6>

Jibo.com. (2016). Jibo. Retrieved 4 February 2016, from <http://www.jibo.com>

Joranson, N., Pedersen, I., Rokstad, A. M. M., & Ihlebaek, C. (2015). Effects on Symptoms of Agitation and Depression in Persons With Dementia Participating in Robot-Assisted Activity: A Cluster-Randomized Controlled Trial. *Journal of the American Medical Directors Association*, 16(10), 867–873. <https://doi.org/10.1016/j.jamda.2015.05.002>

Jordan, B., & Henderson, A. (1995). Interaction Analysis: Foundations and Practice. *Journal of the Learning Sciences*, 4(1), 39–103. https://doi.org/10.1207/s15327809jls0401_2

Jst.go.jp. (2015, March 8). Erica. Retrieved 11 August 2015, from <http://www.jst.go.jp/pr/announce/20150803-2/>

K. Wada, T. Shibata, T. Saito, Kayoko Sakamoto, & K. Tanie. (2005). Psychological and Social Effects of One Year Robot Assisted Activity on Elderly People at a Health Service Facility for the Aged. In *Proceedings of the 2005 IEEE International Conference on Robotics and Automation, 2005. ICRA 2005* (pp. 2785–2790). <https://doi.org/10.1109/ROBOT.2005.1570535>

Kachouie, R., Sedighadeli, S., Khosla, R., & Chu, M.-T. (2014). Socially Assistive Robots in Elderly Care: A Mixed-Method Systematic Literature Review. *International Journal of Human-Computer Interaction*, 30(5), 369–393. <https://doi.org/10.1080/10447318.2013.873278>

- Kaplan, F. (2004). Who is Afraid of the Humanoid? Investigating Cultural Differences in the Acceptance of Robots. *International Journal of Humanoid Robotics*, 01(03), 465–480. <https://doi.org/10.1142/S0219843604000289>
- Kendon, A. (1990). *Conducting Interaction: Patterns of Behavior in Focused Encounters*. Cambridge ; New York: Cambridge University Press.
- Kendon, A. (1990). Spatial organization in social encounters: The F-formation system. In *Conducting Interaction: Patterns of Behavior in Focused Encounters* (Vol. 1990, pp. 209–238). Cambridge ; New York: Cambridge University Press.
- Kendon, A. (2010). Spacing and Orientation in Co-present Interaction. In A. Esposito, N. Campbell, C. Vogel, A. Hussain, & A. Nijholt (Eds.), *Development of Multimodal Interfaces: Active Listening and Synchrony* (pp. 1–15). Springer Berlin Heidelberg. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-12397-9_1
- Kidd, C. D., & Breazeal, C. (2008). Robots at home: Understanding long-term human-robot interaction. In *IEEE/RSJ International Conference on Intelligent Robots and Systems, 2008. IROS 2008* (pp. 3230–3235). <https://doi.org/10.1109/IROS.2008.4651113>
- Kidd, C. D., Taggart, W., & Turkle, S. (2006). A sociable robot to encourage social interaction among the elderly. In *Proceedings 2006 IEEE International Conference on Robotics and Automation, 2006. ICRA 2006* (pp. 3972–3976). <https://doi.org/10.1109/ROBOT.2006.1642311>
- Kimura, R., Miura, K., Murata, H., Yokoyama, A., & Naganuma, M. (2010). Consideration of physiological effect of robot assisted activity on dementia elderly by electroencephalogram (EEG): Estimation of positive effect of RAA by neuroactivity diagram. In *Proceedings of SICE Annual Conference 2010* (pp. 1418–1422).
- Klein, T., Gelderblom, G. J., de Witte, L., & Vanstipelen, S. (2011). Evaluation of short term effects of the IROMEC robotic toy for children with developmental disabilities. In *2011 IEEE International Conference on Rehabilitation Robotics (ICORR)* (pp. 1–5). <https://doi.org/10.1109/ICORR.2011.5975406>
- Kozima, H., Nakagawa, C., & Yasuda, Y. (2005). Interactive robots for communication-care: a case-study in autism therapy. In *IEEE International Workshop on Robot and Human Interactive Communication, 2005. ROMAN 2005* (pp. 341–346). <https://doi.org/10.1109/ROMAN.2005.1513802>

Kramer, S. C., Friedmann, E., & Bernstein, P. L. (2009). Comparison of the Effect of Human Interaction, Animal-Assisted Therapy, and AIBO-Assisted Therapy on Long-Term Care Residents with Dementia. *Anthrozoös*, 22(1), 43–57.
<https://doi.org/10.2752/175303708X390464>

Kristoffersson, A., Coradeschi, S., & Loutfi, A. (2011). Towards evaluation of social robotic telepresence based on measures of social and spatial presence. Presented at the Human Robot Interaction. Retrieved from <http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A542612&dswid=-3985>

Lakoff, G. (1990). *Women, Fire, and Dangerous Things* (1 edition). Chicago: University Of Chicago Press.

Laustsen, J. (2013). *Risikovurdering: Telenoid R3b v.1.1*. Teknologisk Institut.

Lawton, M. P., Van Haitsma, K., & Klapper, J. (1999). Observed emotion rating scale. *Journal of Mental Health and Aging*, 5(1), 69–81.

Leite, I., Martinho, C., & Paiva, A. (2013). Social Robots for Long-Term Interaction: A Survey. *International Journal of Social Robotics*, 5(2), 291–308.
<https://doi.org/10.1007/s12369-013-0178-y>

Libin, A., & Cohen-Mansfield, J. (2004). Therapeutic robot for nursing home residents with dementia: Preliminary inquiry. *American Journal of Alzheimer's Disease and Other Dementias*, 19(2), 111–116.
<https://doi.org/10.1177/153331750401900209>

Løgstrup, K. E. (2010). *Den etiske fordring*. Århus: Klim.

Lorish, C. D., & Maisiak, R. (1986). The face scale: A brief, nonverbal method for assessing patient mood. *Arthritis & Rheumatism*, 29(7), 906–909.
<https://doi.org/10.1002/art.1780290714>

Mahoney, F. I., & Barthel, D. W. (1965). Functional Evaluation: The Barthel Index. *Maryland State Medical Journal*, 14, 61–65.

Marshall, P., Rogers, Y., & Pantidi, N. (2011). Using F-formations to Analyse Spatial Patterns of Interaction in Physical Environments. In *Proceedings of the ACM 2011 Conference on Computer Supported Cooperative Work* (pp. 445–454). New York, NY, USA: ACM. <https://doi.org/10.1145/1958824.1958893>

- Marti, P., Bacigalupo, M., Giusti, L., Mennecozzi, C., & Shibata, T. (2006). Socially Assistive Robotics in the Treatment of Behavioural and Psychological Symptoms of Dementia. In *The First IEEE/RAS-EMBS International Conference on Biomedical Robotics and Biomechatronics, 2006. BioRob 2006* (pp. 483–488). <https://doi.org/10.1109/BIOROB.2006.1639135>
- Marti, P., Pollini, A., Rullo, A., & Shibata, T. (2005). Engaging with Artificial Pets. In *Proceedings of the 2005 Annual Conference on European Association of Cognitive Ergonomics* (pp. 99–106). Chania, Greece: University of Athens. Retrieved from <http://dl.acm.org/citation.cfm?id=1124666.1124680>
- Marx, M. S., Cohen-Mansfield, J., Regier, N. G., Dakheel-Ali, M., Srihari, A., & Thein, K. (2010). The Impact of Different Dog-related Stimuli on Engagement of Persons With Dementia. *American Journal of Alzheimer's Disease and Other Dementias*, 25(1), 37–45. <https://doi.org/10.1177/1533317508326976>
- Mordoch, E., Osterreicher, A., Guse, L., Roger, K., & Thompson, G. (2013). Use of social commitment robots in the care of elderly people with dementia: A literature review. *Maturitas*, 74(1), 14–20. <https://doi.org/10.1016/j.maturitas.2012.10.015>
- Mori, M. (1970). Bukimi No Tani [The Uncanny Valley]. *Energy*, 7(4), 33–35.
- Mori, M. (2012, December 6). The Uncanny Valley. Retrieved 5 December 2013, from <http://spectrum.ieee.org/automaton/robotics/humanoids/the-uncanny-valley>
- Moyle, W., Cooke, M., Beattie, E., Jones, C., Klein, B., Cook, G., & Gray, C. (2013). Exploring the Effect of Companion Robots on Emotional Expression in Older Adults with Dementia: A Pilot Randomized Controlled Trial. *Journal of Gerontological Nursing*, 39(5), 46–53. <https://doi.org/10.3928/00989134-20130313-03>
- Moyle, W., Jones, C., Cooke, M., O'Dwyer, S., Sung, B., & Drummond, S. (2013). Social robots helping people with dementia: Assessing efficacy of social robots in the nursing home environment. In *2013 The 6th International Conference on Human System Interaction (HSI)* (pp. 608–613). <https://doi.org/10.1109/HSI.2013.6577887>
- Norris, S. (2004). *Analyzing multimodal interaction: a methodological framework*. New York, NY: Routledge.
- Okita, S. Y. (2013). Self-Other's Perspective Taking: The Use of Therapeutic Robot Companions as Social Agents for Reducing Pain and Anxiety in Pediatric Patients. *CyberPsychology, Behavior & Social Networking*, 16(6), 436–441. <https://doi.org/10.1089/cyber.2012.0513>

Oreck, A. (2015, July 15). The Golem. Retrieved from <https://www.jewishvirtuallibrary.org/jsource/Judaism/Golem.html>

Osaka-u.ac.jp. (2016). Intelligent Robotics Laboratory (Ishiguro Lab.). Retrieved 17 February 2016, from <http://eng.irl.sys.es.osaka-u.ac.jp/>

Pinch, T. J., & Bijker, W. E. (2012). The Social Construction of Facts and Artefacts. In W. E. Bijker, T. P. Hughes, & T. J. Pinch (Eds.), *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Anniversary ed, pp. 11–44). MIT Press.

Pollick, F. E. (2009). In Search of the Uncanny Valley. In P. Daras & O. M. Ibarra (Eds.), *User Centric Media* (pp. 69–78). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-12630-7_8

Rabbitt, S. M., Kazdin, A. E., & Scassellati, B. (2015). Integrating socially assistive robotics into mental healthcare interventions: applications and recommendations for expanded use. *Clinical Psychology Review*, *35*, 35–46. <http://dx.doi.org/10.1016/j.cpr.2014.07.001>

Randolph, J. J. (2009). A Guide to Writing the Dissertation Literature Review. *Practical Assessment, Research & Evaluation*, *14*(13).

Region Nordjylland. (2012, April). Forsøgspersoners rettigheder i et sundhedsvidenskabeligt forskningsprojekt. Retrieved 26 November 2017, from http://www.rn.dk/Sundhed/Til-sundhedsfaglige-og-samarbejdspartnere/Forskning/Den-Videnskabsetiske-Komite-for-Region-Nordjylland/Anmeldelse/~media/Rn_dk/Sundhed/Til%20sundhedsfaglige%20og%20samarbejdspartnere/Forskning/Videnskabsetisk%20komite%C3%A9/Anmeldelse/Fors%C3%B8gspersoners%20rettigheder%20i%20et%20sundhedsvidenskabeligt%20forskningsprojekt.ashx

Region Nordjylland. (2014, November). Tillægsprotokol. Retrieved 25 November 2017, from <http://www.rn.dk/sundhed/til-sundhedsfaglige-og-samarbejdspartnere/forskning/den-videnskabsetiske-komite-for-region-nordjylland/anmeldelse/tillaegsprotokol>

Region Nordjylland. (2017, November). Den Videnskabsetiske Komité for Region Nordjylland. Retrieved 25 November 2017, from <http://www.rn.dk/sundhed/til-sundhedsfaglige-og-samarbejdspartnere/forskning/den-videnskabsetiske-komite-for-region-nordjylland>

Roberts, C., & Sarangi, S. (2005). Theme-oriented discourse analysis of medical encounters. *Medical Education*, 39(6), 632–640. <https://doi.org/10.1111/j.1365-2929.2005.02171.x>

Robins, B., Dautenhahn, K., & Dickerson, P. (2009). From Isolation to Communication: A Case Study Evaluation of Robot Assisted Play for Children with Autism with a Minimally Expressive Humanoid Robot. In *Second International Conferences on Advances in Computer-Human Interactions, 2009. ACHI '09* (pp. 205–211). <https://doi.org/10.1109/ACHI.2009.32>

Robinson, H., MacDonald, B. A., Kerse, N., & Broadbent, E. (2013). Suitability of Healthcare Robots for a Dementia Unit and Suggested Improvements. *Journal of the American Medical Directors Association*, 14(1), 34–40. <https://doi.org/10.1016/j.jamda.2012.09.006>

Robinson, H., MacDonald, B., & Broadbent, E. (2015). Physiological effects of a companion robot on blood pressure of older people in residential care facility: A pilot study. *Australasian Journal on Ageing*, 34(1), 27–32. <https://doi.org/10.1111/ajag.12099>

Šabanović, S. (2010). Robots in Society, Society in Robots. *International Journal of Social Robotics*, 2(4), 439–450. <https://doi.org/10.1007/s12369-010-0066-7>

Sabanovic, S., Bennett, C. C., Chang, W.-L., & Huber, L. (2013). PARO robot affects diverse interaction modalities in group sensory therapy for older adults with dementia. In *2013 IEEE International Conference on Rehabilitation Robotics (ICORR)* (pp. 1–6). <https://doi.org/10.1109/ICORR.2013.6650427>

Sakairi, K. (2004). Research of robot-assisted activity for the elderly with senile dementia in a group home. In *SICE 2004 Annual Conference* (Vol. 3, pp. 2092–2094).

Schraube, E. (2005). Torturing things until they confess: Günther Anders' critique of technology. *Science as Culture*, 14(1), 77–85. <https://doi.org/10.1080/09505430500041983>

Shamsuddin, S., Yussof, H., Ismail, L. I., Mohamed, S., Hanapiah, F. A., & Zahari, N. I. (2012). Humanoid Robot NAO Interacting with Autistic Children of Moderately Impaired Intelligence to Augment Communication Skills. *Procedia Engineering*, 41, 1533–1538. <https://doi.org/10.1016/j.proeng.2012.07.346>

Shaw-Garlock, G. (2009). Looking Forward to Sociable Robots. *International Journal of Social Robotics*, 1(3), 249–260. <https://doi.org/10.1007/s12369-009-0021-7>

Shibata, T., Inoue, K., & Irie, R. (1996). Emotional robot for intelligent system-artificial emotional creature project. In , *5th IEEE International Workshop on Robot and Human Communication, 1996* (pp. 466–471).
<https://doi.org/10.1109/ROMAN.1996.568881>

Shibata, T., Wada, K., Ikeda, Y., & Sabanovic, S. (2009). Cross-Cultural Studies on Subjective Evaluation of a Seal Robot. *Advanced Robotics*, *23*(4), 443–458.
<https://doi.org/10.1163/156855309X408826>

Sony. (2015). Sony Aibo ERS-7 | Sony Aibo. Retrieved 26 January 2016, from <http://www.sony-aibo.com/aibo-models/sony-aibo-ers-7/>

sosunord.dk. (2017). SOSU Nord. Retrieved 19 May 2017, from <http://www.sosunord.dk/>

Strandbech, J. D. (2015). Ethel and her Telenoid: Toward using humanoids to alleviate symptoms of dementia. *Læring Og Medier (LOM)*, *8*(14). Retrieved from <http://ojs.statsbiblioteket.dk/index.php/lom/article/view/21990>

Sundheds- og Ældreministeriet. Bekendtgørelse om information og samtykke og om videregivelse af helbredsoplysninger mv., 665 BEK § (1996). Retrieved from <https://www.retsinformation.dk/forms/r0710.aspx?id=21075>

Sundheds- og Ældreministeriet. Bekendtgørelse om medicinsk udstyr, Pub. L. No. BEK nr 1263, 1263 BEK (2008). Retrieved from <https://www.retsinformation.dk/Forms/R0710.aspx?id=122694#Kap4>

Sundheds- og Ældreministeriet. Lov om videnskabsetisk behandling af sundhedsvidenskabelige forskningsprojekter, Pub. L. No. 593, LOV (2011). Retrieved from <https://www.retsinformation.dk/Forms/R0710.aspx?id=137674>

Sundheds- og Ældreministeriet. GCP-bekendtgørelse - Bekendtgørelse om god klinisk praksis i forbindelse med kliniske forsøg med lægemidler på mennesker, 695 BEK § (2013). Retrieved from <https://www.retsinformation.dk/forms/r0710.aspx?id=152402>

Sundheds- og Ældreministeriet. Bekendtgørelse af lov om videnskabsetisk behandling af sundhedsvidenskabelige forskningsprojekter, 1083 LOV § (2017). Retrieved from <https://www.retsinformation.dk/Forms/R0710.aspx?id=192671>

Sung, H.-C., Chang, S.-M., Chin, M.-Y., & Lee, W.-L. (2015). Robot-assisted therapy for improving social interactions and activity participation among institutionalized older adults: A pilot study. *Asia-Pacific Psychiatry*, *7*(1), 1–6.
<https://doi.org/10.1111/appy.12131>

- Tanaka, M., Ishii, A., Yamano, E., Ogikubo, H., Okazaki, M., Kamimura, K., ... Watanabe, Y. (2012). Effect of a human-type communication robot on cognitive function in elderly women living alone. *Medical Science Monitor : International Medical Journal of Experimental and Clinical Research*, 18(9), CR550-CR557. <https://doi.org/10.12659/MSM.883350>
- Tapus, A., Tapus, C., & Mataric, M. J. (2009). The use of socially assistive robots in the design of intelligent cognitive therapies for people with dementia. In *IEEE International Conference on Rehabilitation Robotics, 2009. ICORR 2009* (pp. 924–929). <https://doi.org/10.1109/ICORR.2009.5209501>
- The Alzheimer's Association. (2014). 2014 Alzheimer's Disease Facts and Figures, 10(2).
- Thomson Reuters. (2016). Web Of Science. Retrieved 19 January 2016, from webofknowledge.com
- Transana.com. (2017, January 4). Transana.com. Retrieved 14 April 2017, from <https://www.transana.com>
- Valentí Soler, M., Agüera-Ortiz, L., Olazarán Rodríguez, J., Mendoza Rebolledo, C., Pérez Muñoz, A., Rodríguez Pérez, I., ... Martínez Martín, P. (2015). Social robots in advanced dementia. *Frontiers in Aging Neuroscience*, 133. <https://doi.org/10.3389/fnagi.2015.00133>
- Vlachos, E. (2015). *Sustaining Emotional Communication when Interacting with an Android Robot*. Aalborg Universitetsforlag. Retrieved from [http://vbn.aau.dk/da/publications/sustaining-emotional-communication-when-interacting-with-an-android-robot\(df8a1eb8-6f48-41a0-87d8-3b67c390f242\).html](http://vbn.aau.dk/da/publications/sustaining-emotional-communication-when-interacting-with-an-android-robot(df8a1eb8-6f48-41a0-87d8-3b67c390f242).html)
- Wada, K., & Shibata, T. (2008). Social and physiological influences of robot therapy in a care house. *Interaction Studies*, 9(2), 258–276. <https://doi.org/10.1075/is.9.2.06wad>
- Wada, K., Shibata, T., & Kawaguchi, Y. (2009). Long-term robot therapy in a health service facility for the aged - A case study for 5 years -. In *IEEE International Conference on Rehabilitation Robotics, 2009. ICORR 2009* (pp. 930–933). <https://doi.org/10.1109/ICORR.2009.5209495>
- Wada, K., Shibata, T., Saito, T., & Tanie, K. (2006). Robot assisted activity at a health service facility for the aged for ten weeks: an interim report of a long-term experiment. *Proceedings of the Institution of Mechanical Engineers Part I-Journal of Systems and Control Engineering*, 220(18), 709–715. <https://doi.org/10.1243/09596518JSCE159>

Wada, K., Shibata, T., Sakamoto, K., Saito, T., & Tanie, K. (2005). Analysis of utterance in long-term robot assisted activity for elderly people. In *2005 Ieee/Asme International Conference on Advanced Intelligent Mechatronics, Vols 1 and 2* (pp. 31–36). New York: Ieee.

World Health Organization. (2007). *The ICD-10 Classification of Mental and Behavioural Disorders*. Geneva: World Health Organization. Retrieved from <http://www.who.int/classifications/icd/en/GRNBOOK.pdf>

Yamazaki, R., Nishio, S., Ogawa, K., Matsumura, K., Minato, T., Ishiguro, H., ... Nishikawa, M. (2013). Promoting Socialization of Schoolchildren Using a Teleoperated Android: *International Journal of Humanoid Robotics*, *10*(1). <https://doi.org/10.1142/S0219843613500072>

Yamazaki, R., Nishio, S., Ishiguro, H., Nørskov, M., Ishiguro, N., & Balistreri, G. (2012). Social Acceptance of a Teleoperated Android: Field Study on Elderly's Engagement with an Embodied Communication Medium in Denmark. In S. S. Ge, O. Khatib, J.-J. Cabibihan, R. Simmons, & M.-A. Williams (Eds.), *Social Robotics* (pp. 428–437). Springer Berlin Heidelberg. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-34103-8_43

Yamazaki, R., Nishio, S., Ishiguro, H., Nørskov, M., Ishiguro, N., & Balistreri, G. (2014). Acceptability of a Teleoperated Android by Senior Citizens in Danish Society. *International Journal of Social Robotics*, *6*(3), 429–442. <https://doi.org/10.1007/s12369-014-0247-x>

Yamazaki, R., Nishio, S., Ogawa, K., & Ishiguro, H. (2012). Teleoperated android as an embodied communication medium: A case study with demented elderlies in a care facility. In *2012 IEEE RO-MAN* (pp. 1066–1071). <https://doi.org/10.1109/ROMAN.2012.6343890>

Yamazaki, R., Nishio, S., Ogawa, K., Ishiguro, H., Matsumura, K., Koda, K., & Fujinami, T. (2012). How Does Telenoid Affect the Communication Between Children in Classroom Setting? In *CHI '12 Extended Abstracts on Human Factors in Computing Systems* (pp. 351–366). New York, NY, USA: ACM. <https://doi.org/10.1145/2212776.2212814>

Yamazaki, R., Nishio, S., Ogawa, K., Matsumura, K., Minato, T., Ishiguro, H., ... Nishikawa, M. (2013). Promoting Socialization of Schoolchildren Using a Teleoperated Android: *International Journal of Humanoid Robotics*, *10*(1), 1350007. <https://doi.org/10.1142/S0219843613500072>

APPENDICES

Appendix A: Overview of elements in the literature review.

Appendix B: Documentation of Ethical approval incl. informed consent template.

APPENDIX A: OVERVIEW OF ELEMENTS IN THE LITERATURE REVIEW

This appendix is offered as an annotated overview of the elements in the review presented in section 2.3 from page 36 as well as section 4.1 from page 104. Bibliographic information is included in the list of references for the dissertation as a whole.

The Domain of Elderly with Dementia

Robot	Purpose or Aim	Details on Participants	Details on Intervention & Interaction	Synthesis of results	Citation
[No name given]	Pilot study investigating if a humanoid SAR can engage persons with dementia in musical-therapy.	Nine elderly persons with dementia	One on one interaction, 10-20 min once per week for six months	Results indicate that the robot can successfully engage persons with dementia in musical therapy.	(Tapus et al., 2009)
[No name given]	To provide further empirical evaluation of the effectiveness of animal-assisted therapy in nursing home residents with dementia.	56 elderly persons with dementia	One time in common area for an approx. 15 minutes	Residents were engaged the longest with the puppy video followed by the real dogs, the robotic dog, the plush dog, and the dog-colouring activity.	(Marx et al., 2010)
AIBO	Investigate the effects of AIBO in relation to persons with dementia.	Eight elderly with dementia	One time interaction of 30 minutes in a participants private room	Using only MMSE scores, interaction with AIBO was found to improve MMSE scores and verbal activity	(Sakairi, 2004)
AIBO	To compare the effects of visitation by a person, a person accompanied by a live dog, and a person accompanied by an AIBO, on behavioural indicators of social interaction among female nursing home residents with dementia	18 elderly persons with dementia	One on one 3 min visit, once a week for three weeks.	Analysis rests on reformatting video-data to statistical data. While all three types of visits stimulated nursing home resident social interaction, the success of the robotic dog in stimulating social interaction by dementia residents suggests that it may provide a viable alternative to live animal visitations and in some cases be the preferred choice.	(Kramer et al., 2009)
AIBO	Evaluating the effects of AIBO with EEG.	15 elderly with dementia	Groups of 6-7 interacting once for 30 minutes	From EEG readings there is shown a slight improvement in all participants, and especially in three participants with severe dementia.	(Kimura et al., 2010)

JustoCat	To evaluate effects of interaction with JustoCat in persons with dementia, and improve usability based on interviews with formal and informal caregivers.	Four elderly with dementia	ABA setup with free use for the robot for eight weeks in a common room	Using mixed methods, analysis indicated less agitated behaviour and better quality of life for individuals with dementia. Interviews showed positive effects by providing increased interaction, communication, stimulation, relaxation, peace, and comfort to individuals with dementia.	(Gustafsson et al., 2015)
NeCoRo	Comparing the benefits of a robotic cat and a plush toy cat as interventions for elderly persons with dementia	Nine elderly persons with dementia	One time 10 min. free use with both a plush toy and NeCoRo.	Based in video data, statistical analysis "... finds that AAT or RAT produces comparable results with no decreasable difference" between NeCoRo and a live cat.	(Libin & Cohen-Mansfield, 2004)
Paro	Evaluate change in utterances from interacting with Paro in elderly with dementia	Five elderly with dementia	Two days per. week for 12 months	Significant improvement in utterances to Paro over a one year period.	(Wada et al., 2005)
Paro	Comparing questionnaire responses on Paro from different countries.	1854 questionnaire responses	Questionnaire responses based on a one time free use up to 30 min, in-group in exhibition hall.	Positive indications, although the data presented here does not match the high number of respondents. The data presented seems to be cherry-picked.	(Takanori Shibata et al., 2009)
Paro	To evaluate effects of interaction with an active vs. an inactive Paro in elderly with both dementia and without special needs.	23 elderly with either no special needs or dementia.	Group-sessions of one participant, staff and experimenter, 20 minutes once every two weeks for four months.	Using mixed methods it is determined that 1/3 will have one sided conversations with PARO, others will have positive experiences and the presence of Paro will instigate social interaction between participants, even without the presence of e.g. staff.	(Kidd et al., 2006)
Paro	Investigate changes in mood and interaction from interacting with Paro.	One elderly with dementia	Continuous use for five years. Mostly free use in a common room	Case study of one elderly participant with MCI. Very positive results in terms of improvement in mood.	(Wada et al., 2009)
Paro	Investigation of the behavioural effects in person with dementia in and after interaction with Paro in various setups	One Elderly with dementia and severe neuropsychiatric disturbances	Case study of a six months free use setup.	Paros presence found to reduce symptoms of anxiety.	(Marti et al., 2006)
Paro	Compare the effect on emotion in persons with dementia when interacting with Paro or in an interactive reading group.	18 elderly with dementia	45 minutes, three afternoons per week, for 5 weeks with groups of nine.	Using quantitative methods and analysis, Paro is found to have a positive influence on participants' quality of life and pleasure scores compared to the reading group.	(Moyle, Cooke, et al., 2013)
Paro	Evaluating the effects of Paro for persons with dementia in an eldercare facility.	Seven elderly with varying forms of dementia	30-45 minutes pr. week for seven weeks in group, with focus on one on one interaction	Using video to perform a quantitative analysis, Paro was found to increase social interaction and activity between subjects and duration of attention to interaction.	(Sabanovic et al., 2013)
Paro	Describing observational findings regarding the specific behavioural, contextual, and personal factors that contribute to	10 elderly with dementia	40 min in-group, 8 times during a eight week period.	From video-recordings, narratives and statistical analysis reveal that Paro facilitates interaction between groups people, and not between Paro and a single user.	(Chang et al., 2013)

effects of interacting with Paro.					
Paro	Evaluate the outcomes of Paro interventions in psychogeriatric care.	71 elderly with dementia	ABAB test for 4 months with alternating setups of Paro or Non-Paro. 15 minutes per interaction, unclear as to the frequency of interventions.	Using quantitative data, this study shows Paro is clearly effective for interventions aiming at a therapeutic effect regarding mood and goal attainment, if applied in a well thought-out manner and tailored to the individual situation of the elderly.	(Bemelmans et al., 2015)
Paro	To examine effects on symptoms of agitation and depression in nursing home residents with moderate to severe dementia participating in a robot-assisted group activity with the robot seal Paro.	53 elderly with dementia	Multiple locations. Group sessions with Paro took place in a separate room at nursing homes for 30 minutes twice a week over the course of 12 weeks	Using quantitative methods Paro was found to have a long-term effect on depression and agitation in activity groups for elderly with dementia. Paro might be a non-pharmacological treatment for neuropsychiatric symptoms and considered as a tool in clinical practice.	(Joranson et al., 2015)
Paro	Evaluate psychological and social effects of Paro in elderly with dementia	12 elderly with dementia, video data on interaction for everyone present during testing.	Free use 1-3 days pr. week for five weeks in a common room	Overall time spend in interaction is increased from 5 to 6 hours. Time spend in interaction without Paro is decreased from 4:30 to 2 hours. Paro is present in approx. 3:45 hours. May suggest that participants become dependant and seek Paro, while cutting off interaction with others.	(Wada & Shibata, 2008)
Paro & Giraff	Comparing the feasibility of Giraff over that of Paro in relation to persons with dementia.	Two groups of nine elderly with dementia either in an interactive reading group or in interaction with Paro	Group sessions of 45 minutes three times a week for five weeks.	Using unstructured observations, finds positive attitude toward the use of robots but cooperation is needed if development and implementation is to be successful.	(Moyle, Jones, et al., 2013)
Paro & Guide	To investigate, compare and improve the suitability of "Guide" to Paro for people with dementia and their caregivers.	Ten elderly persons with dementia, 11 relatives and five staff members	One time, one hour, one on one interaction	Paro's sounds could be modified to be more acceptable to persons with dementia. The design and software of Guide could be reviewed and the software application could be simplified and targeted to people with dementia.	(Robinson et al., 2013)
Paro & Nao	Investigate and compare the effects of interaction with Paro, Nao and a live dog in elderly with dementia	101 /110 elderly with dementia depending on phase of experiment	Groups of 9-15 in 40 min interventions, two days a week for three months	Patients in both robot groups showed the same level of improvement in apathy. Patients in NAO group showed a decline in cognition as measured by the MMSE scores. Patients in Paro group showed increase in Quality Of Life as measured by QUALID score. Improvement in NPI scores was found, but not observed at follow-up.	(Valenti Soler et al., 2015)

Telenoid	Pilot study investigating the effects of Telenoid on elderly persons with dementia	10 elderly with dementia	One time one on one interaction for 20 min.	Based in video-analysis, the study finds that Telenoid elicited positive images and interactive reactions from the elderly with both mild and severe dementia. 9/10 viewed the Telenoid as a child. In contrast to their typical demeanour, many where verbally active.	(R. Yamazaki, Nishio, Ogawa, et al., 2012)
Telenoid	To investigate the effects on elderly persons without special needs in interaction with Telenoid	Two elderly; one with dementia and one with no special needs	Two sessions of two hours with one on one conversation in a private room at a care-facility, with an assistant present.	Highly explorative with no clear method of evaluating. Highlights positive reaction and interactions between the participants and the operators, heightened interaction and participation on the part of the participant over time.	(Ryuji Yamazaki et al., 2014)

The Domain of Adults and Elderly with No Special Needs

Robot	Purpose or Aim	Details on Participants	Details on intervention & Interaction	Synthesis of results	Citation
AIBO	To investigate if AAT with AIBO decrease loneliness and, if so, how does this compare with that of a living dog?	37 Elderly with no special needs. Divided in three groups (Control, Dog, Aibo)	One weekly interaction of 30 minutes pr. week for eight weeks in a private room	Study found that interaction with live or robotics dogs have same effect on loneliness, and that those who are more lonely will gain the most.	(Banks et al., 2008)
Autom	Evaluate the effects of HRI with regard to weight loss-training programs in adults compared to virtual or no help.	45 adults and elderly with no special needs	Free use at home for six weeks	Participants using the robot did so for significantly longer than other conditions. As expected, the weight lost was minimal, "due to short period of time".	(Kidd & Breazeal, 2008)
Brian 2.0	To develop intelligent socially assistive robots as therapeutic aids designed to maintain and improve, the residual social, cognitive and affective functioning in persons with dementia.	Six healthy adults	One time one on one interaction for 20 minutes	Some indications that participants engaged in cognitive therapy with the robot. It should be noted that participants were not persons with dementia.	(Chan & Nejat, 2010)
Kabochan Nodding Communication Robot	Investigate if communication with a robot can improve cognitive functions in elderly women living alone.	34 elderly with no special needs	Free use at home for eight weeks	MMSE scores marginally improved after 8 weeks of free use of a communications robot.	(Tanaka et al., 2012)
Paro	Evaluation of Paro in an eldercare facility, with emphasis on communications and interaction skills as well as in participation in social interaction.	12 elderly with no special needs	One on one interaction for 30 min twice a week for 4 weeks in a common room	Improvement in communications and interaction skills as well as in participation in social interaction	(Sung et al., 2015)
Paro	Investigate if interaction with PARO elicit a reaction on blood-pressure in elderly with no special needs.	17 elderly with no special needs	One time session with measurements three times.	Interacting with Paro has a physiological effect on cardiovascular measures, which is similar to findings with live animals.	(Robinson et al., 2015)

The Domain of Adults with Pervasive Developmental Disorders

Robot	Purpose or Aim	Details on Participants	Details on intervention & Interaction	Synthesis of results	Citation
Paro	Evaluating Paro in interaction with adults with Downs-syndrome	Three adults with Downs-syndrome	One on one interaction for one hour pr. week for three months.	Very limited improvement in mood.	(Marti et al., 2005)

The Domain of Children with No Special Needs

Robot	Purpose or Aim	Details on Participants	Details on intervention & Interaction	Synthesis of results	Citation
Nao	To investigate if NAO can serve as a non-pharmacological method of distraction for children during their annual flu vaccination.	57 Children (age 0-12) with no special needs	One time session during flu vaccination at their private doctors offices.	Compared to the control protocol, children smiled more often with the robot, but they did not cry less. Parents indicated that children held stronger memories for the robot than for the needle, wanted the robot in the future, and felt empowered to cope.	(Beran et al., 2015)
Paro	The study examined whether complementary therapy using robotic companions as social agents reduced pain and emotional anxiety in paediatric patients.	18 girls age 6-16 admitted to paediatric hospital wards	One on one interaction, two times of 30 minutes.	Paro can alleviate pain in children if it is in use when a parent is present.	(Okita, 2013)
Telenoid	Can schoolchildren fully participate in groups-interaction when one is present through a teleoperated humanoid robot?	28 children with no special needs	two days of 90 min. interactions in groups of six.	While not without issues, Telenoid can mediate presence to include non-present children in group work.	(Yamazaki et al., 2013)

The Domain of Children with Pervasive Developmental Disorders

Robot	Purpose or Aim	Details on Participants	Details on intervention & Interaction	Synthesis of results	Citation
IROMECC	Evaluating effects of the IROMECC robot toy in supporting play at an occupational therapy intervention for children with intellectual disabilities.	Three children with PDD	One on one with an assistant, 30 min 1-2 times a week for 7 weeks, 12-14 sessions total	"The qualitative evaluations of the robot intervention were positive about the robot and its appreciation for both child and therapist, but less positive about the therapeutic added value for the involved children".	(Klein et al., 2011)
IROMECC	Evaluating effects of the IROMECC robot toy in supporting play at an occupational therapy intervention for children with intellectual disabilities.	Three children with PDD	One-on-one with an assistant, 30 min 1-2 times a week for 7 weeks, 12-14 sessions total	"The qualitative evaluations of the robot intervention were positive about the robot and its appreciation for both child and therapist, but less positive about the therapeutic added value for the involved children".	(Bernd et al., 2010)

HUMANOID ROBOTS FOR HEALTH AND WELFARE

KASPAR	Investigate effects of Kaspar in children with autism.	Three children	Mixed and unclear citing duration as "several months" in a school setting.	Humanoid robots found to increase interaction with peers and others in children with autism. Increasing comfort around kaspar from all participants and increased interaction with others as well.	(Robins et al., 2009)
Keepon	Report on the effects of Keepon in relation to children with autism.	Children with PDD and with no special needs.	Multiple setups or varying lenght and specifications	Keepon relaxes children with Autism and Pervasive Developmental Disorders (PDD) and often facilitates inclusion of other children in their play with Keepon, unlike with other toys.	(Kozima et al., 2005)
Nao	Investigation of "initial behaviour of autistic children of moderately impaired intelligence when exposed" to Nao	Five children with moderate autism	One time for 14 minutes	4/5 exhibited positive improvement in communications skills.	(Shamsuddin et al., 2012)

APPENDIX B: DOCUMENTATION OF ETHICAL APPROVAL INCL. INFORMED CONSENT TEMPLATE

The PhD-committee is offered encrypted access to the classified materials pertaining to the Participants for the purpose of evaluation of the dissertation. This includes: Video recordings, post-study interviews, session logs, quantitative data, facility records, care-centre reports, ethical approval documentation and informed consent templates. Due to privacy concerns some of these are not made otherwise available. As mentioned page 77, the data pertaining to the Participants will be destroyed after the review of this dissertation, but the video material may be stored and used by SOSU Nord for educational purposes or in subsequent research under the same consent form as described in the original consent form.

The following pages feature

1. The response on the project resume from the Regional Ethical Committee, 1 page
2. The submission project resume sent to the Regional Ethical Committee, 3 pages
3. The informed consent template and written information about the project, 2 pages.

Fra: **Videnskabetisk Komité** vek@rn.dk
Emne: SV: Forespørgsel om anmeldelsespligt
Dato: 14. november 2014 kl. 10.10
Til: Jens Vilhelm Dinesen Strandbech jedi@SOSUnord.dk



Kære Jens Dinesen Strandbech

Du har ved mail af 17. september 2014 forespurgt Den Videnskabetiske Komité for Region Nordjylland om anmeldelsespligt at dit planlagte projekt.

På baggrund af de fremsendte oplysninger – undersøgelse af demente ældres interaktion med en humanoid robot. Undersøgelsen foregår ved samtale med den demente via robotten - er det komitéens opfattelse, at projektet *ikke* er omfattet af komitélovens (lov nr. 593 af 14/6/2011.) definition på et sundhedsvidenskabeligt forskningsprojekt og derfor ikke skal anmeldes til og godkendes af komitéen, jf. komitélovens § 14, stk. 1, jf. §2, nr. 1-3.

Projektet kan iværksættes uden yderligere tilbagemelding fra Den Videnskabetiske Komité for Region Nordjylland.

Klagevejledning: afgørelsen kan, jf. komitélovens § 26, stk. 1, indbringes for Den Nationale Videnskabetiske Komité senest 30 dage efter, afgørelsen er modtaget. Den Nationale Videnskabetiske Komité kan, af hensyn til sikring af forsøgspersoners rettigheder, behandle elementer af projektet, som ikke er omfattet af selve klagen. Klagen samt alle sagens dokumenter sendes til: Den Nationale Videnskabetiske Komité – DKetik@DKetik.dk

Afslutningvist skal den sene besvarelse af din henvendelse beklages mange gange.
Med venlig hilsen

**SEKRETARIATET for DEN VIDENSKABETISKE KOMITÉ for REGION
NORDJYLLAND**

Niels Bohrs Vej 30
9220 Aalborg Ø
Tlf. 97 64 84 40
vek@rn.dk
www.vek.rn.dk

Fra: Jens Vilhelm Dinesen Strandbech [mailto:jedi@SOSUnord.dk]
Sendt: 17. september 2014 14:11
Til: Videnskabetisk Komité
Emne: Re: Forespørgsel om anmeldelsespligt

Kære Janni /VEK

Tak for hurtigt svar.

Som tidligere nævnt kommer her et resume af et forslået eksperiment.
Lad mig det endelig vide hvis I mangler informationer for at behandle forespørgsel om anmeldelsespligt.

Venlig hilsen / Kind regards
Jens

Jens Dinesen Strandbech
Ph.d. Student & Project Lead
SOSU Nord Futurelab
M: (0045) 3164 7337

Longitudinal Telenoid experiment

Purpose

I wish to conduct an experiment in which elderly persons with dementia interact with the humanoid robot “Telenoid® R3b” (Telenoid, Fig. 1), while a person with extensive dementia knowledge is controlling it. This is to investigate if the Telenoid can alleviate some of the symptoms that are typically contributed to dementia. Specifically we aim to better understand if interaction can improve the symptoms of verbal aggression, anxiety and depressive/reclusive behaviour, but will possibly include more Behavioural and Psychological Symptoms of Dementia (PBSD) if beneficial to the study and in accordance with the participants’ best interest.



Fig. 1 Telenoid R3b

The Technology

Telenoid® R3b (Fig. 1-3) is a Japanese humanoid robot with a simple androgynous face, developed by Osaka University and ATR Hiroshi Ishiguro Laboratory. It is approx. 50 cm tall and is not capable of independent movement or operation, as it needs constant operation by a person over e.g. Wi-Fi. This allows for mediation of the operators presence and thus allows for interesting experiments in relations to this novel communications-platform and the perception of presence. The operator can move the robots head and arms.

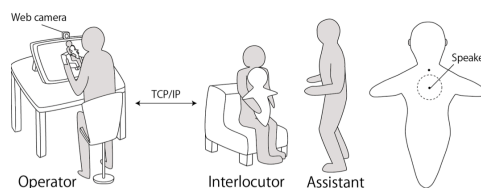


Fig. 2 Conceptual diagram of Telenoid system



Fig. 3 Telenoid system in a care facility

Setup

The experiment will include 10-20 participants, divided into a test group and a control group. All participants will be residents at an eldercare facility for elderly people with dementia. The test group will be invited to sessions with the Telenoid 3 times a week for 2-4 months. Each session will take approx. 15-20 minutes.

The control group will be invited to sessions where the operator of the Telenoid will talk to participants face-to-face 3 times a week for 2-4 months. The topic of the conversation is aimed at being pleasant, and will take its point of origin in the participant’s life-journal and the care-staffs knowledge of the participant. The nature of the session is not an interview, but a pleasant conversation with an interested stranger who is visiting.



By Jens Dinesen Strandbech, jedi@sosunord.dk, 16.09.2014
SOSU Nord FutureLab

All sessions will take place in either a common room with only the participant and a moderator, or in the privacy of the participants own room. The participants will not be left alone to converse with the robot at any time.

All participants must be at least 50 years of age and have been diagnosed with moderate to severe dementia – preferably with the use of imaging technologies (E.g., CT scan). Participants are excluded if they have other neurological symptoms or illnesses such as Parkinson's or schizophrenia. In addition, all participants must be verbally active and able to maintain a simple conversation for 15-20 min.

During the intervention period, the Telenoid will be an addition to any other forms of activity for the participants, and therefore, the participants will not be excluded from their usual social and rehabilitative activities, during their participation in the experiment.

Data

1. The sessions will be videotaped for later analysis in terms of nonverbal and verbal responses to the Telenoid.
2. The participants' daily behaviour, especially in problematic situations (i.e. BPSD ?), will be videotaped in a shared living room for comparison before and after the whole experiment. Any non-participants will be anonymised in these recordings.
3. The care staff will answer questions about the pronounced selected symptoms (BPSD) of each respondent. This is to create a view of the symptoms over time.
4. Before and after the intervention period: A series of non-invasive screening tests will be performed by trained staff to assess the participants' levels of dementia as well as their abilities. These tests are conversational in nature and will require participants to perform simple tasks to assess their capabilities in a simple and recognised fashion. All tests are used in Danish or international dementia-care. Proposed tests are: MMSE (Cognitive function), Barthel Index (ADL), FAST (Severity), NPI-NH (BPSD), Observed Emotion Rating Scale and QOL-D.
5. During the sessions, participants are equipped with a GSR-reader (similar device to a pulse-reader) that allows for non-invasive measuring of biometric data such as sweat conductivity that indicate stress level).
6. The participants may in addition carry a pedometer to monitor anxiety related restless walking, before, during and after the interviews with the Telenoid.

Timeline

Pre-intervention

1. Collecting baseline data
2. Selecting participants (totally 10-20 persons)
3. Informed consent
4. Non-invasive screening tests on test and control groups
5. Daily behaviour, especially in problematic situations (i.e. BPSD), will be videotaped in a shared living room for comparison over a period of 1-2 week.

Intervention

1. Sessions of 15-20 min, 3 times a week for 3-4 months for both groups. Interaction with either the Telenoid (test group) or face-to-face (control group) with the same person as either operator or interlocutor. Sessions are video-recorded. During sessions, the participants wear a GRS-meter. Healthcare professionals with knowledge of the participants answer daily questionnaires on pronunciation of BPSD symptoms.

Post-intervention

1. Non-invasive screening tests on test and control groups
2. Daily behaviour, especially in problematic situations (i.e. BPSD), will be videotaped in a shared living room for comparison over a period of 1-2 week.

During all three interventions, the participants may wear a pedometer.

Vedr. ERDFN-13-0136 – Projekt Telenoid støttet af Erhvervsstyrelsen og EU's Regionalfond

Samtykkeerklæring for forsøgsdeltagere

Projekt: Menneske Robot Interaktion Telenoid

Undertegnede bekræfter hermed, at jeg er blevet informeret om ovennævnte projekt såvel mundtligt som skriftligt, og at jeg enten indvilger i at deltage i projektet eller afgiver stedfortrædende samtykke på en andens vegne.

Jeg er informeret om, at det er frivilligt at deltage i projektet, og at jeg/deltageren på et hvilket som helst tidspunkt kan trække sig ud af projektet, uden nogen konsekvens. Jeg er ligeledes indforstået med at deltagelse ikke kompenseres på nogen vis.

Jeg giver samtykke til, at deltageren indgår i ovennævnte forsøg og at de oplysninger, der indhentes om mig i forbindelse hermed må deles mellem alle projektets partnere så længe det kun er til forskningsmæssige og formidlende formål. Disse informationer indbefatter eksempelvis forsøgsdeltagerens pleje og omsorgsplan og videooptagelser af samtalen med Telenoid-robotten. Herunder indhentes også sundhedsinformationer om neurologiske lidelser og evt. tidligere scanninger foretaget ifm. demens-diagnose/pleje. Jeg er indforstået med at dele af de indsamlede data må gengives i anonymiseret form med henblik på undervisning/formidling af forskningsresultater, samt at data der er afgivet her må genbruges til andre forskningsformål uden yderligere samtykke, men under de vilkår der fremgår her.

Jeg har fået udleveret en kopi af denne samtykkeerklæring samt det skriftlige materiale "Information til forsøgsdeltagere i 2. forsøg vedr. Menneske Robot Interaktion Telenoid" der beskriver forsøget i større detalje.

Forsøgsdeltagers navn

Navn på person der afgiver stedfortrædende samtykke

Relation til forsøgsdeltageren

_____ Dato: _____

Underskrift

En kopi af de overordnede forsøgsresultater tilbydes alle deltagere og værgere. Kontakt forsøgslederen.

Forsøgsleder: Jens Dinesen Strandbech, SOSU Nord. Tel. 3164 7337, jedi@sosunord.dk

.....

Undertegnede medarbejder bekræfter herved at have informeret om ovennævnte projekt såvel mundtligt som gennem det skriftlige materiale "Information til forsøgsdeltagere i 2. forsøg vedr. Menneske-Robot-Interaktion Telenoid" der er udleveret til deltager eller afgiver af stedfortrædende samtykke.

Medarbejders navn: _____ Dato: _____



Vi investerer i din fremtid

Information til forsøgsdeltagere i 2. forsøg vedr. Menneske-Robot-Interaktion Telenoid

Formålet med forsøget, er overordnet at undersøge i hvilken grad interaktion med den menneskelignende robot Telenoid kan virke lindrende på visse af de adfærdsmæssige og psykologiske symptomer som personer med demens lever med. Der er ikke tale om behandling eller diagnosticering af demens eller andre sygdomme/tilstande, men udelukkende undersøgelse af de effekter som interaktion med menneskelignende robotter kan have.

Forsøget indebærer samtaler 2-3 gange om ugen i op til fire måneder hvor deltageren interagerer med en anden person enten gennem robotten Telenoid eller ansigt til ansigt uden robotten. Robotten kan ikke selv kan agere eller kommunikere og derfor udelukkende fungerer som et medie. Vores formodning er, at samtaler med robotten kan gøre personer med demens gladere og øge lysten til at indgå i samvær med andre og det er dette vi ønsker at efterprøve. Vi forventer ikke at der er nogle negative bivirkninger ved deltagelse i forsøget.

Samtalerne vil tage udgangspunkt i deltagerens interesser, livshistorie og journal der er indhentet af personalet på de deltagende plejehjem. Samtalen har derfor ikke noget direkte formål, udover at omhandle den ældres liv, interesser og velbefindende. Samtalen udføres af kompetent personale fra SOSU Nord og er monitoreret af plejehjems-personale med kendskab til den enkelte deltager, for at sikre at samtalen undgår emner der ikke er i deltagerens bedste interesse. Forsøget afbrydes hvis samtalen bevæger sig i en retning der gør deltageren oprørt eller berøre følsomme emner, minder, etc. Samtalerne sker på deltagerens præmisser på deres plejehjem, i omgivelser de er vant til. For at fastholde resultaterne uden at forstyrre samtalen bliver samtalen og rummet video- og lyd-optaget. Hvis deltageren tillader det vil denne blive udstyret med et GSR-apparat på størrelse med et armbåndsur der sidder på overarmen og måler mængden af sved. Dette kan give indikationer på hvor rolig deltageren er under samtalerne og kan give vigtige oplysninger ift. robotens effekt.

Før og efter perioden med samtaler foretages en række evalueringer af deltagerens færdigheder og demensniveau. Dette sker hhv. ved brug af anerkendte værktøjer og udføres af kompetent personale og observationer af deltagerne henover et par timer for at få et billede af en 'normal dag' i deres liv. Under perioden med samtaler vil personale på Ådalscenteret dagligt besvare spørgsmål relateret til deltagerens dagligdag og funktionsniveau, for at skabe et billede af deltagerens liv og udvikling gennem perioden. Herunder indhentes også sundhedsinformationer om neurologiske lidelser og evt. tidligere scanninger foretaget ifm. demens-diagnose/pleje.

Opbevaring og behandling af indsamlet data

Alle de indsamlede data (videooptagelser, noter, lyd og billeder og gsr-målingerne, mv.) hjælper til at dokumentere forsøgene og deres resultater, og vil derfor blive optegnet og opbevaret af SOSU Nord på forsvarligt vis. Indsamlet data vil ikke blive delt med virksomheder eller personer udenfor projektet. Til at illustrere forsøget i eksempelvis undervisnings eller forskningssammenhænge er det nødvendigt at offentliggøre begrænsede dele af det indsamlede data. I de tilfælde vil data blive anonymiseret således det ikke er identificerede for deltageren. Dog vil videooptagelser ikke blive sløret hvad angår ansigt, stemme og lokale. Offentliggørelse af video/billeder i andre sammenhænge, eksempelvis til pressen, sker kun med særskilt tilladelse.

Projektpartnere

Projektet koordineres af SOSU Nord med støtte fra EU's Social- og Regionalfonde gennem Region Nordjyllands Vækstforum. En tidssvarende liste over projektdeltagere kan altid oplyses af forsøgslederen.

Tak for din deltagelse eller stedfortrædende samtykke.

Hvis du har spørgsmål eller kommentarer er du velkommen til at tage kontakt

Venlig Hilsen

Jens Dinesen Strandbech
Forsøgsleder, Ph.d. Studerende
jedi@sosunord.dk
SOSU Nord FutureLab



DEN EUROPÆISKE UNION

Den Europæiske Fond
for Regionaludvikling



Vi investerer i din fremtid

SUMMARY

This dissertation takes an exploratory approach to investigating the interactions between the Functionally Designed Socially Assistive Robot Telenoid in interaction with elderly persons with severe dementia. Initially, the dissertation reviews the current state of research into Humanoid Socially Assistive Robots in the domain of Health and Welfare. Then a Constructivist Grounded Theory Method is applied to characterise and explicate the interactions between six Participants with severe dementia and Telenoid. The following qualitative analysis of interactions reveals both specific and general Participant interaction scripts, appropriations and point of improvement. In addition the conclusions and discussions adds to the body of knowledge on the application of these robots by revealing some of the roles, challenges and opportunities Humanoid Socially Assistive Robots can adopt to, create and fulfil in the Health and Welfare system of tomorrow