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Ethel and her Telenoid

– toward using humanoids to alleviate symptoms of dementia

Jens Dinesen Strandbech

PhD studerende

SOSU Nord Future Lab, SOSU Nord.

Institut for Kommunikation og Psykologi,
E-learning Lab, Aalborg Universitet.

Abstract

The aim and motivation for this article is to elaborate on a longitudinal study investigating if conversations with the teleoperated humanoid robot *Telenoid* can alleviate symptoms of dementia. The article initially frames Telenoid in the field of social robotics and relevant dementia-initiatives before dwelling on the emerging relationship between Telenoid and a person with severe dementia. Here it is shown how persons with severe dementia can benefit greatly from interaction with *Functionally Designed Anthropomorphic Robots* such as Telenoid as a means of providing a temporary 'conversational stepping stone', working toward improving quality of life and regaining conversational and social confidence to seek and interact socially with others. In conclusion, the article argues for the robotics community to embrace *Functionally Designed Anthropomorphic Robots* just as well as it has Zoomorphic robots. Centrally, Telenoid and other non-realistic humanoid initiatives should be further evaluated as non-pharmacological approaches to e.g. alleviating symptoms of dementia, and in relation to other user-groups.

Keywords: *Robots; Social Robots; Humanoid Robots; Teleoperated Robots; Human-humanoid-interaction; Functionally Designed Anthropomorphic Robots; Robot Assisted Therapy; Animal Assisted Therapy; Healthcare; Dementia; Telenoid*

Introduction

As affective/emotional robots become more common, it is essential to investigate the effects of prolonged interaction. In addition to studies of human-humanoid-interaction (HHI) in general, we must not overlook the prospects of applying humanoid robots in interaction with users with special needs. The perhaps most well know case for HHI involving users with special needs is 'children with autism', as first investigated in (Weir & Emanuel, 1976) and many others since. While working with autistic children poses particular challenges and rewards, results here are not always applicable to persons with special needs in general. In the following, I will elaborate on a study where the teleoperated android 'Telenoid R4' is used as a medium for conversing with persons with dementia with the purpose of investigating how participants are affected by interacting with the robot.

To fully understand the eligibility of Telenoid's use in dementia-cases, it is necessary to have a rudimentary understanding of (social) robots and dementia. To this end, the following sections will introduce a brief history and definitions in social robotics as well as the field of dementia and current interventions comparable to Telenoid. Section 3 elaborates on the conducted experiment. Lastly, Section 4 will discuss and conclude on the collected data.

On Humanoid Social Robots, Dementia and Telenoid

On Humanoid Social Robots and the problems they create

The first social robots are said to have been created in the 1940ies, having an insect-like shape and behaviour, and it is from these insect-like robots the term *Social Robot* has its origin (Fong, Nourbakhsh, & Dautenhahn, 2003). Following categorical and ontological issues with the term *Robot* and *Social Robot*, there is still 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*', ad thus a humanoid can indeed have some human-like-traits, and some traits that are distinctly not human-like, but still be *humanoid*. 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.

Interestingly, there's no one universally recognised definition to what a 'robot' or 'social robot' is. Although many follow the notion that a robot has sensors, computational power and actuators with which it can perceive, comprehend and act, so as to perform certain programmed tasks. This is interesting not in line with the ISO definition, calling for several degrees of freedom and the ability to move (ISO, 2012). Presently I will adhere to the definitions put forth in (Breazeal, 2003) and cited in its entirety later in this subsection. 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 humanoids are crated as a workforce but then rise to take control. While this depiction has fascinated pop culture for almost a century, the concept of humanoid creations has been described in many texts before. 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). We have luckily moved far from these first depictions of humanoid creations and now the concept of a humanoid companion is beginning to take a foothold in the general public, advanced by such developments as 'Pepper' (Aldebaran Robotics, 2015b) and the Geminoid's by Hiroshi Ishiguro's team (Ishiguro & Nishio, 2007). Practical implementation of humanoids are however still sparse, as developments are costly and the results fall short from the public expectations.

With Pepper and the Geminoids 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).

This mental model exists, according to Mori, as there's a point in the progression from non-realistic to realistic replication of a living being where, at an advanced point on the non-realistic-realistic scale where even slight imperfections in an ultra realistic design become distressing to humans. In essence, a non-realistic/simplistically designed robot will be given more leniency in terms of imperfections and 'odd behaviour' that a realistic, and the expectations to a realistic robot would be higher than to that of the simplistic.

When attempting to classify a *Social Robot*, we can, according to (Fong et al., 2003), classify 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 who's design first and foremost reflect the task for which they are designed.

Anthropomorphic robots are those whom are designed to look like or at least, to some extend, are *perceived* as having human-like features. The function of these human-like features are according to (Fong et al., 2003)

> "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)".
>
> (Fong et al., 2003)

The central point here is illusion. The illusion that a humanlike robot is capable of something it is in fact not, while supporting interaction with humans. This emphasis on illusion and functionality then becomes central when evaluating Social Robots, as a key point lies not with the robots actual capabilities, but as I will adress late on, in it's *perceived* capabilities.

Zoomorphic robots are those robots that are 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 robots. As noted by Fong, avoiding the *Uncanny Valley* may be easier with zoomorphic robots, as our expectations as to what constitutes normal interaction or behaviour is not so finely tuned with animal behaviour as it is with human behaviour. With the design of the robotic seal Paro, this becomes evident as a multitude of research has supported the notion that different user groups find interaction with Paro pleasant. Many note that this can in part be contributed to the lack of first-hand close-proximity interaction with seals.

Caricatured robots are those robots that are 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, 2015a).

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 a 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.

The category of Functional robots must however not be mistaken with the categories of inspiration: The *Functionally Designed*, as opposed to the *Biologically Designed*. While both types of inspiration can lead to the design of social robots, the biologically inspired robots are born from the notion that humans are better at understanding a robot that looks and behaves like something we know. This entails that the robot indeed functions in accordance with 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 Fong states it

> *"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."*
>
> (Fong et al., 2003, p. 148)

Fong goes on stating that

> Functionally Designed Robots *"…may only need to be superficially socially competent" and "have limited embodiment [and/or] capability for interaction", that "limited social expression can help improve the affordances and usability" and that "artificial designs can provide compelling interaction."*
>
> (Fong et al., 2003, p. 148)

This focus on results allows for the inclusion of illusion and a 'design-for-purpose' in the design and use of humanoids, and pairs well not only with the *Anthropomorphic* and *Functional* robots, but also with a central core definition of a social robot by Cynthia Breazel in (Breazeal, 2003, p. 168):

> *"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."*
>
> (Breazeal, 2003, p. 168)

Because this definition is subject-dependent and not object-dependent, any design that is *perceived* as social robot, is a social robot, without having to fit the definition calling for autonomy or locomotion. It is clear that social robots are both in use and development, and the fact that the academic community is not in agreement on the matter only ads complexity to the term robot. This however does not influence the use of social robots or humanoid social robots.

A brief introduction to dementia

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). Symptoms are caused by structural and chemical changes in the brain as a result of physical diseases such as Alzheimer's disease. A dementai diagnosis 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 healthcare professionals 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 *severe dementia* is defined as:

> *"a degree of memory loss characterized by the complete inability to retain new information"* where *"only fragments of previously learned information remain"* and thus *"the subject fails to recognize even close relatives"*
>
> *(World Health Organization, 2007, p. 45).*

It is estimated that some 200 different illnesses lead to dementia, explaining the many different symptoms, types and subtypes. It is generally believed that, to date, dementia is a permanent degenerative state. 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).

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. It should be noted that 80% of persons with dementia experience on of more so-called *Behavioural and Psychological Symptoms of Dementia* (BPSD), in addition to memory-impairment (Johnson et al., 2014). 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).

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). 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. This figure is set to 115 million on a global level (Brodaty & Arasaratnam, 2012), assuming the projections are true (European Commission, 2005, 2014; EUROSTAT, 2015a, 2015b).

Telenoid and relevant dementia-initiatives

Initiatives to alleviate the symptoms of dementia can be divided into the *pharmacological* and *non-pharmacological*. As this paper focuses on the effects of conversation with a humanoid, the pharmacological initiatives are not relevant and thus omitted.

A non-pharmacological approach is often used with the goal of maintaining cognitive function or helping the brain compensate for impairments. Generally, these initiative focus on improving Quality Of Life. *Brodaty & Arasaratnam* summarise their paper stating that:

> "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, focussing on activating the body as well as different areas of the brain. The activation of the brain can be done by presenting tasks relevant for 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 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 fathom many of the central issues and symptoms persons with dementia are faced with. Thus, simple off-topic conversation can 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 proved 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 interaction 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 promising initiative in RAA is perhaps the Paro-seal used widely in international healthcare for both normal-ageing and for persons with special needs (Klein & Cook, 2012; K. Wada, T. Shibata, T. Saito, Kayoko Sakamoto, & K. Tanie, 2005; Marti, Bacigalupo, Giusti, Mennecozzi, & Shibata, 2006; Paro Robots, 2014; Pfadenhauer & Dukat, 2015). Paro is equipped with tactile, light, auditory, temperature, and posture sensors, allowing it to recognize light and dark, being stroked or beaten, or being held by the posture sensor. The audio sensor can recognize the direction of voices and specific words such as its name, common greetings, and praise (Paro Robots, 2014). One major point to Paro's advantages is it's restrained movement, as it does not react unpredictably, and moves and behaves very calmly, thus fostering a context of care and attention. For an introduction to and results regarding both AAA and RAA I encourage reading (Cevizci, Murat, Gunes, & Karaahmet, 2013; Chandler, 2012; K. Wada et al., 2005).

As a general statement, (Broadbent, Stafford, & MacDonald, 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."
>
> (Broadbent, Stafford, & MacDonald, 2009, p. 327)

In addition, the robot should "*match the human's expectations*". While the use of Paro in connection to persons with dementia or other special needs have proven to alleviate symptoms, it has some major constraints. First and foremost, while it is common to anthropomorphise IT-devices, the capability to converses 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 a 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 underway. 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.

Never the less, 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 Teleoperated 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.

One candidate fitting these parameters is Telenoid; a teleoperated 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 15 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 teleoperated, it can not do anything on its own and thus allows the operator of Telenoid to transmit movements of the neck as well as the actual voice of the operator.

The movement of the shoulders and 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 in the forehead of the robot and listen via. microphones in the ears (Geminoid.jp, 2015).Studies on the effects of Telenoid are still space and mostly preliminary, but the mediation of emotion though voice and mimicry has been investigated (Embgen et al., 2012) and further investigations as been done into the perception of basic facial expression, when elicited by humanoid robots (Becker-Asano & Ishiguro, 2011).

In addition, as (Nishio, Watanabe, Ogawa, & Ishiguro, 2012) demonstrates, the operator of Telenoid experiences a certain degree of body-transference, whereby he or she, to some degree, experiences the robot as an extension of their own self. This body-transference add to the experience of presence by interlocutors, when talking to Telenoid (Hidenobu Sumioka, 2012; Kuwamura, Minato, Nishio, & Ishiguro, 2012). Interaction with Telenoid also seems to elicit positive results on interaction with introduced to both children with and without autism-spectrum-disorder (Lee, Takehashi, Nagai, & Obinata, 2012) as well as elderly people with dementia (Yamazaki et al., 2012). As such, while Telenoid is in fact a medium for communication, interlocutors often perceive it as a free agent of interaction, even while knowing full well that it is a teleoperated robot.

Testing Telenoid in dementia care

Following on the above reasoning, persons with diminished cognitive abilities, such as dementia, will perceive a *Functionally Designed Anthropomorphic Robot* as a more manageable conversation partner, and will thus be able to engage in or maintain conversations for longer periods, with central benefits with regard to cognitive functions and ADL. While AI focused on off-topic conversation is still in it relative infancy, it should be evaluated if teleoperated robots 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. As Telenoid is relatively new, there is no existing scientific data with which to compare or build a study on. As such, the following experiment is extremely exploratory, drawing on a multitude of data collection formats and methods.

Experiment overview

In an effort to investigate the perception of *Functionally Designed Anthropomorphic Robots* in conversation with persons with dementia, we conducted a test 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.

Of the 26 citizens living at the facility, ten where deemed relevant for conversational activities, as some were either to cognitively impaired, to physically ill, or seemed to show no interest in Telenoid.

The experiment focussed on identifying positive and negative effects of conversing with Telenoid. To this end, the ten participants where divided into two groups, and invited to two personal sessions of 15-20 minutes per week with either Telenoid (T) or a human (H). The Human-group was established to form a baseline comparison to Telenoid-conversations, and measure the effects of conversations in general but are not included further in this paper.

This 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 pr. week. With very few exceptions, all sessions where held in the comfort of the participants own apartment.

For the Telenoid–group, the Participant, Assistant, and Telenoid are present in the apartment. The Assistants role was to provide comfort and assist in maintaining a fluent conversation, as well as assist on technical issues in the event of malfunction. The Operator was placed in an adjacent room due to technical restraints, and thus her voice is sometimes noticeable. On few occasions, an Observer would join the Operator in the adjacent room. With this setup, we documented effects of first-hand first-time experiences with Telenoid and the development of this experience and relationship over time, as well as the effects of conversations in general.

Week	**Action**
-2	Pre-test: NPI-HN, Mini Mental State Evaluation, The Barthel Index, Observed Emotional Rating Scale
-2 to12	Daily NPI-HN overview questions (Continues through week 12)
1 to 4	Two weekly sessions, 15-20 minutes each (Continues through week 4)
6	Post-test: NPI-HN, MMSE, The Barthel Index, OERS. Interview with staff.

Table 1: Timeline with actions and data collection

In all sessions with Telenoid, an Assistant presented the robot as a 'telephone-doll', using concepts familiar to the participants. In addition to the videorecordings, we employed a multitude of quantitative tools.

These are outlined in the timeline below but otherwise omitted, as they provided no relevant results in this context. As seen in the table below, the participants have a broad variety of diagnosis. Participant age ranged from 75 years to 93, and averaged at 85,6 years. Two participants switched group as one participant in the human-group repeadetly whished to interact with Telenoid, and one showed signs of discomfort when interacting with the robot.

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

Table 2: Anonymised participant overview

With seven females and three males, the population reflects the gender distribution at the test- facility. It should be noted that we maintain comparing participant- or diagnosis-results to other participants or diagnosis is at best problematic and subject to uncertainty. As such, this article elaborates on a single key participant whom experienced a positive development during the experiment. Other participants experienced positive developments, but as the data is not yet full analysed we will restrain this article to this one key participant.

Over the course of the study it has become clear to everyone involved that tasks of the Operator and Assistant cannot be fulfilled without specialised training. For the present purposes, both roles was undertaken by personnel with decades of theoretical and first-hand-experiences in dealing with persons with dementia, and even then they felt ill-equipped to adequately decode and convey emotions, utterances and context 'feel'. Still, defining specific competencies for these remain a puzzling matter.

Participant presentation

From facility records, we know that the participant, let's call her Ethel, moved there one year before the experiment. Diagnosed with Alzheimer's disease, she moved because she and her husband where unable to take care of her 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 as she typically dines by herself, or finishing meals in a hurry, if enjoyed in the company of residents or staff in the common areas. If staff is not sitting 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 watching a movie in the common area, five meters from her apartment door.

Ethel enjoys showing pictures of family to staff and visitors, and 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. 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*'.

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. Just inside the door is the kitchenette, which is never in use. Another meter inside, Ethel has placed a small table by which she enjoys her solitary meals and looks through magazines or photo albums. Further inside is a two-person sofa, an armchair, and a sofa table, flanked by a side table and a tall dresser placed back to back with four closets and decorated with paintings, photos and plants. 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 view to the bathroom, is her bed, over which two landscape-paintings are hung.

A relationship emerges

In this section, I will elaborate on results drawn from video-data, session-notes and exit-interviews. I will start by paraphrasing the interaction between Telenoid in the first four sessions and move to note significant changes over a period of five weeks. The descriptions focuses on mood, verbal activity, alertness, and the participant's denomination of Telenoid.

Ethel's first encounter with Telenoid is unique, in the sense that Telenoid for the most part, does not work. Despite this malfunction, Ethel's first reaction to Telenoid is one of wonder and investigation, as she picks up Telenoid from the arms of the Assistant, asking 'What is his name?'. She then proceeds to play and tickle Telenoid, which does not move or react. With the exception of one use of 'her', Ethel maintains to verbally identify Telenoid as a 'he', throughout the session. After the first seconds of interaction, Ethel incomprehensibly addresses Telenoid, due to aphasia.

Then she starts caressing Telenoid, asking 'Would you' followed by mumblings, and, laughingly, 'such an old witch' [kælling, in Danish], presumably talking jokingly about herself. During the course of this 12-minute session, Ethel often enter brief periods of silence after having addressed Telenoid, despite the Assistant's comments that '*Telenoid does not work today*'. This may be due to Telenoid not responding to her, leaving her calls to interact without a reaction. She does however return to a joyful state after a short while, playing with how Telenoid is positioned and tapping it's nose lightly and placing her forehead on Telenoid's forehead. The assistant notes that Ethel's tonality and handling of Telenoid resembles that of 'a mother caring for at child', and that Ethel is reluctant to hand Telenoid to the Assistant when she is leaving.

Ethel's second encounter, two days later, is a 13 minute long session and the first between Ethel and Telenoid in which Telenoid is functioning correctly. As the Assistant finishes setting up and moves toward Ethel, she transitions from a passive presence, sitting slumped in the sofa or leaned back, armes crossed, mumbling to herself, avoiding eye contact, to a leaned-forward active presence, looking directly at Telenoid's head, as trascribed below:

#	Time	Actor	Transcription
1	00:23	Assistant	This is the one, do you remember it? ((While walking toward the sofa))
2	00:24	Ethel	((Looks to Telenoid, rubs her hands)
3	00:27	Ethel	(h,)YE(h)e:s (0.2) Can you
4			[((Smiles, caresses Telenoid's face, then body, then face))
5	00:29:	Assistant	Do you remember it, Ethel?=
6	00:30	Telenoid	HelLO Ethel!=
7		Ethel	=Ye(h):s (1,5) can you?
8	00:33	Telenoid	[Why hello there=
9	00:34	Ethel	=((Smiling, surprised, look to Assistant, then to Telenoid))
10	00:36		((Hello=wha's your name? ((in old-fashioned local dialect)) ((Smiling))

Table 3: Transcription excerpt A from Ethel's Second session

In these first few seconds of interaction, transcribed using (Jefferson, 2004), it is clear that not only does Ethel desperately try to communicate something to Telenoid, but she also has an immediate positive reaction to the presence of Telenoid. We see this in lines number 3-4 with the repetition again in line 7-8, and the general positive emotional response in the laughter and smiling, seen multiple places in the transcript and image below.

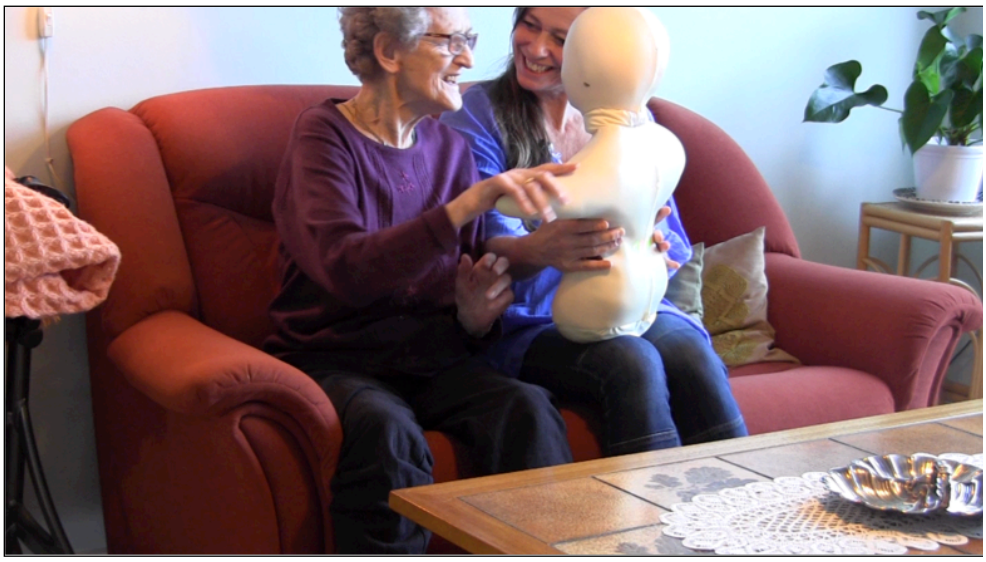

Image 1. Ethel with Telenoid and The Assistant in Ethel's apartment

When asked if Ethel wants to hold Telenoid, she immediately reaches out and places it on her lap, maintaining eye contact, and smiling when Telenoid states "it is nice to be held by you".Ethel often laughs, and enters a playful demeanour, padding Telenoid on the forehead, backside and placing her forehead on the forehead of Telenoid.

At 3:30, a moment of confusion turns the conversation into spontaneous singing, as both Ethel, the Assistant and the Operator do not hear what the others are saying, partly due to aphasia, partly technical difficulties. This does not seem to bother Ethel, as she keeps smiling and enjoying the interaction. At one point, Ethel picks up a handkerchief, and proceeds to tap Telenoid on the nose, saying "Its Ethel that'll come and get you", this sparks Telenoid to resume singing, and Ethel joins in. This demeanour continuous sporadically the following nine minutes, interrupted by short periods of silence, utterances like "it is remarkable" which presumably is in reference to the technological achievement in Telenoid. Ethel is predominantly using 'you' when referring to Telenoid, although she once uses both 'her' and the Danish male name 'Søren'. Although often informed of Telenoid's name, she never uses 'Telenoid'. At times, Ethel acts as though she cannot cope with the interaction, and either becomes somewhat silent or hands Telenoid to the Assistant.

Then she resumes the interaction as though with renewed energy, often laughing, smiling or addressing Telenoid directly with questions or statements like 'you are nice! You are so nice!'. When asked if the Assistant is allowed to return with Telenoid, the response is a big smile and a clear 'You would do that?' underpinning the notion that she enjoys the interaction, even if it seems overwhelming at times.

Ethel's vocabulary is in almost constant use, and she continues to talk, or try to talk, to Telenoid. She is severely aphasic at times, but tries to conduct a conversation with no regard to this. Most often she gives up, with the aphasic mumblings never forming actual words or sentences. At times, she looks silently at the Assistant when she presumably does not hear or understands what is being said. The Assistant reports that she clearly feels like a 'third wheel' in the conversation, but that her presence is needed to help Ethel cope with the interaction at times.

Ethel's third encounter is almost 19 minute long and held six days after the first. It starts with Ethel being seated in her sofa, hands folded behind her head, looking at the Assistant setting up the cameras. When the Assistant first holds Telenoid in view of Ethel, she chuckles, smiles and ask 'Who's that guy?''. As the Assistant is sitting down, she asks Ethel if she remembers 'it'. It is unclear if she in fact does, but it is clear that Ethel reaches to hold Telenoid in the same way as in their second session, almost identically resuming their interaction, addressing it as 'you', laughing, and smiling.

After 40 seconds, Telenoid experiences technical difficulties, and the audio becomes distorted. Ethel does not react to the distortion of the voice, which at times presents itself at a rather loud metallic noise, and proceeds to ask Telenoid 'What do you want to sing?'.

When the Operator stops talking and attempts to fix the issue, Ethel quickly repeats, start by herself, and proceeds to ask 'just a little more, please?'. With the help of the Assistant, Telenoid is placed cheek-to-cheek with Ethel, bringing her to smiles and laughter. Later, after a short period where Telenoid's voice is normal, the voice becomes distorted again, during it singing an old tune. This prompts Ethel into laughter and she looks away both laughing and smiling.

Generally, when these issues arise, the Assistant will interpret the voice of Telenoid, but Ethel will remain in eye contact with Telenoid, even when asking or answering questions or statements originally from Telenoid, but relayed by the Assistant. Despite major technical difficulties impairing the capabilities of Telenoid, and, quite frankly, making it somewhat scary, Ethel maintains conversation with Telenoid, and is largely not looking at the Assistant, despite her mostly not understanding Telenoid's utterances.

Ethel seems to enjoy helping Telenoid overcome its difficulties talking, and when the distortion disappears, following a remark from Ethel 'try again', she will laugh or smile as though enjoying her success in helping Telenoid. At 14:00, Ethel becomes very calm following singing and old children's song. This is something we have seen in other participants, as well as in later sessions with Ethel. It is unclear if it is the result of short 'memory sparks' or something else entirely, but it always seems to be a positive experience.

In *Ethel's fourth session*, recorded eight days after the first, we see her sitting eagerly awaiting the Assistant and Telenoid as they are setting up the cameras. As they sit down, Ethel addresses Telenoid with mumbled/aphasic remarks ending in '…you are cold!' and caressing Telenoid on the body and head. Ethel quickly resumes both the praxis and a playful demeanour of session 2-3, with Ethel continuing to smile and address Telenoid firstly in short sentences but then progressing to longer sentences. After a period of singing, an activity that is initiated by Ethel but otherwise left to Telenoid, Ethel quickly utters 'more (0.3) more', and begins to hum along Telenoid's singing. She is at no point able to start singing without Telenoid starting first, and while Ethel is able to sing or hum several melodies, she does not do so without Telenoid doing so first. She will at times repeat melodies or stanzas from songs that have been sung before, but never from other songs. One melodic children's word-game, in which you rhyme a specific sequence of facial parts, Ethel seems to remember only the conclusion, but before it is acted and sung. This prompts a conversation between the three in which there are several references from Ethel to content from sentences that are 90-120 seconds in the past. While this might not seem significant, it should be noted that elderly persons with moderate-severe to severe dementia have all but lost the ability to retain any new information. As such, the fact that Ethel is able to recall events from (very) short-term memory is a notable achievement.

Overall Ethel is clearly more verbally active than in earlier sessions. Familymembers and staff report that this fourth session shows her in a happier mood and with a larger, more active vocabulary than usual, as well as more physically active and less troubled by aphasia. When impaired by aphasia, she would historically try to 'talk through it' as described in session one, giving the impression of repetition of mumbled words or sounds, and would mostly fail in producing words rather quickly. In this fourth session, she attempts for longer and succeeds in producing words and sentences at least on two occasions. In addition, she takes on a more active role, asking more questions and adopting a more lively intonation and body language than seen in earlier sessions. The Assistant as well as Staff notes that Ethel 'takes up more space in the sofa', and 'no longer hides along the walls'.

Discussion & Conclusion

In summary, both video and staff-reports show a clear relationship forming between Ethel and her Telenoid. During these first four sessions, and developing further as time passes, Ethel becomes increasingly active and both family and staff reports her to be more verbally and physically active, as well as more kind, engaging and socially inclined. Staff reports Ethel to be both accepting *and* initiates social interaction with others, which was something of a rarity before. Familymembers report that Ethel described both the appearance of Telenoid, and the activity of singing between them, three days after the eighth visit. In addition, she remembered the name of the Assistant as well as a few other details. Again, for someone with dementia at this stage, this is a remarkable achievement, which has not been seen in Ethel before. Familymembers continue to stress that Ethel's vocabulary and body language has significantly changed both during and shortly after the five-week intervention period. In addition familymembers report her to be constructing longer sentences with fewer instances of aphasia, and when these occur she can often work successfully through it.

While Ethel enjoys the company of Telenoid, we assume that these results could be achieved with the use of a human interlocutor, instead of a teleoperated humanoid robot. However, 'Telenoid' has the ability to connect to persons with dementia who human-human-interaction overwhelming, and for these persons Telenoid could be a 'conversational steppingstone', providing much needed 'conversational confidence' and an environment where conversational skill can be rehabilitated, before used face-to-face in a real-world context.. Without addressing the need for more a 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 *Functionally Designed Anthropomorphic Robots*, lead to an understanding of humanoid robots, teleoperated and otherwise, that accept a non-realistic design as the best solution for certain contexts and user groups.

As *Functionally Designed Anthropomorphic Robots* aim to be sufficiently realistic for a given context or task, as a category they seem ideally suited to engage with persons with cognitive impairments such as dementia, whom are placed in overwhelming social interaction situations when engaging face-to-face with humans. As these persons will perhaps talk to them selves or the robot in the presence of Zoomorphic robots such as Paro, this setup will not fulfil the full potential of conversational therapy. The robotics community should therefore embrace *Functionally Designed Anthropomorphic Robots* as it has Zoomorphic robots and further evaluate these as non-pharmacological approaches to e.g. alleviating symptoms of dementia and in relation to other user-groups.

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