Therapeutic Robots in Media Arts context

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Abstract

Therapeutic robots are a subclass of social robotics. The aim of their creation, design and functionality are adjusted to be used in a therapy with people with various impairments such as elderly persons suffering from dementia or children with autism. Observing robots in the field of media art as art objects aims, somehow, reveal all the possible stages through which these robots pass in their journey from scientific laboratories to health care facilities. Acknowledging that social robots and thus therapeutic robots, as embodiments of movable sculptures, can be considered as art objects, as any other artifacts within the field of media arts field, can be crucial to understanding their purpose and functionality.

Art, as an intermediary space, visualizes these robots' functionality in different settings, as appropriate experimental spaces in revealing the maximum potential and usability of these robots. Being inherently performative objects, robots display various forms of performance, be it physical or verbal. Accordingly, this thesis has two different approaches: firstly to reveal their artistic potential and secondly their scientific usability. From one point, the study establishes how robots perform in artistic settings, and from another perspective, it describes how the concept of performance extends to in health care and other utilitarian spaces. In both cases, the fact that robots can perform raises points of artistic and scientific inquiry that explicitly visualizes how robots embody the fuse of art and science.

While trying to balance a discussion between art historical discourse and scientific research, another aim of this thesis is to fulfill the literature gap from the media art theory perspective. Therapeutic robots are mainly discussed in scientific publications from representatives of the health care system, engineers and scientists. There are a moderate number of studies written by artists and art scholars about their experiments in theater and dance, however frequently there is scant discussion between these two approaches. Thus, this study tries to observe therapeutic robots in both settings but focus more on art perspective, especially in the media arts context.

Such kind of approach first will help to find how appropriate collaboration between art and science can be beneficial in further development of these robots and second will affect on the implementation of positive impact in their use in health care industry.

***Keywords*: robotic art, therapeutic robots, social robots, mimesis, performance**

Declaration of Authorship

I, Gohar Vardanyan
born the 19th of January, 1983 in Yerevan, Armenia
hereby declare,

1. that I have written my Master Thesis myself, have not used other sources than the ones stated and moreover have not used any illegal tools or unfair means,

2. that I have not publicized my Master Thesis in my domestic or any foreign country in any form to this date and/or have not used it as an exam paper.

3. that, in case my Master Thesis concerns my employer or any other external cooperation partner, I have fully informed them about title, form and content of the Master Thesis and have his/her permission to include the data and information in my written work.

12 August 2019

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Content

List of figures

Acknowledgement

My interaction with robots and especially with therapeutic robots started from February 2018, which was a third semester of my program in Aalborg university, Denmark. This was the first time I attended a few interesting open lectures about urgent issues in HRI and robotic art. Then one day I had the opportunity to interact with the *Telenoid* and *Paro* robots in the same university. I had an amazing sensation while holding these robots and was curious to know how they function in specific settings. All my small investigations started at that point and were expanded upon this thesis.

Thus, I want to express all the gratitude towards people who helped and supported me in realization of this amazing journey and had real, huge and indispensable impact on my writing process. I realize how lucky I am being surrounded with so many nice people, friends and supporters and how they have become an inextricable part of this thesis.

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Introduction

The growing interest towards robotic art and robots in general seems highly increased in recent years. Numerous studies, researches, tech exhibitions, demonstrations, theatrical performances, workshops - in sum many possibilities now to observe robots' actions and have a direct interaction with them. Robots are everywhere and can take different forms, from industrial to humanoid, be autonomous or tele-operated and can create confused reactions in public, from fear to admiration, from affection to uncanniness. In a desire to define what a robot is Japanese roboticist, anthropologist Jenifer Robertson brings following definition "a robot is an aggregation of different technologies - sensors, lenses, software, telecommunication tools, actuators, batteries, synthetic materials and fabrics—that make it capable of interacting with its environment, with some human supervision (through teleoperation) or autonomously" (Robertson, 2017, pp. 5-6). Interestingly for artist Simon Penny robot is powered with the ability to sense and is a "self-guiding machine tool", meaning that robots sometimes can perform already pre-programmed tasks and do not need to have further control in the process (Penny, 2016, p. 50). In this case, he mainly refers to industrial robots. Penny argues that robot is a representation of semi-biological entity and "we experience it in the way we experience animated things in the world – as something that is 'moving towards me', 'scurrying around' or 'trying to achieve a goal'" (Penny, 2016, p. 52).

In this scope worth to mention that these robots can be human-like, zoomorphic or anthropomorphic. They can also be assigned gender. In fact, female robots are called *gynoids* and male robots are named *androids* (Robertson, 2017, p. 6). For this research the interest is geared towards humanoid robots, which appeared in the 1970s and currently have more than twenty prototypes (Laumond, 2016, p. 78).

Nowadays, the number of robots is growing increasingly. Japan is widely considered to be a "homeland" of robots, where Japanese culture with its spiritual and animistic view somehow blurs borders of perceiving robots as only machines. Jennifer Robertson's observations of robots' situation in Japan's socio-political environment are a useful starting point in opening a discussion about social robots. As Robertson asserts robot in Japan is considered as a machine "whose shapes and functions are inspired by biology and diverse life-forms" (Robertson, 2017, p. 5). The actual approach to them is more based on the trust and on the idea that robots are part of the society. Researchers Fiammetta Ghedini and Massimo Bergamasco think that because of this animistic view Japanese society perceives the robots as living objects on a same level as humans and animals. In their view this is the reason that in Japanese culture robots are perceived as supporters of humans and very much appreciated in a care industry (Ghedini and Bergamasco, 2010, p. 734). Robotic scholar Cynthia Breazeal notices that "humanoid robots are a particularly intriguing technology for interacting with people, given the robots' ability to support familiar social cues" (Breazeal, 2002, p. xii) and poses the importance of building the robots as intelligent as humans, so the interaction can be on the same level and help to understand the human intelligence. Basically, Breazeal's approach is that robots and especially humanoid robots can help humans to better understand themselves. Similar thought can be observed in anthropologist Lucy Suchman's theories which will be discussed in subsequent chapters.

While social media tries to exaggerate the negative impact of robots existence in terms of their prevailing power upon humans and the fear that they will replace humans in a job market, many research efforts try to show beneficial aspects of robots' activities. One of such studies is focused on creation of assistive robots and their use for therapeutic purposes. Therapeutic robots grow in popularity and MIT Professor Sherry Turkle even thinks that "among the most talked about robotic designs are in the area of care and companionship" (Turkle, 2011, p. 2). Turkle also mentions how in Japan the need for robots in caring industry is raised. She explains this with non-balanced demographic condition in Japan, because there are not enough young people to take care for elderly and robots are more preferable companions than foreigners (Turkle, 2011, p. 105). Thus, the interest towards therapeutic robots spreads from Japan to European continent and lot of health care and educational facilities started to test these robots in their settings to observe the advantages of interaction and beneficial results from them.

So far, the functionality and the use of therapeutic robots has been mainly observed in the context of scientific experiments. This thesis tries to implement another approach, to observe them from an art perspective, especially in the media art context. This can reveal new possibilities of understanding and interacting with these robots having in mind also further anticipation of implementing new ideas and approaches of their development and wider use. Some of these robots are quite famous now in the media art field, mostly because of their participation in various media art festivals, for example, *Paro* and *Telenoid* robots' presentation in Ars Electronica festival. Such kind of entrance into the commercial world sustains not only growing interest from the research facilities but also artists, who try to make interesting projects, exhibitions, performances and art works by and with the participation of robots and even with therapeutic robots.

The purpose of this thesis is to cross the borders of researching these robots as only therapeutic entities and try to understand their multi-functionality. Certainly, the questions of agency and embodiment will be prioritized for the discussion and they will create another level of analyzing issues of mimesis and imitation, which is central to the study of embodied robots. However, the main accent is on the notion of performance and its presentation in different settings and contexts. How therapeutic robots perform in the media art field as art objects and how they perform in scientific labs and health care facilities as therapeutic tools. In both cases they need to be pre-programmed, scripted, tested, experimented and developed. This will help to visualize the differences and similarities of these far contexts and to understand how they will help to encourage interaction with humans in a positive way.

Besides, this research tries to observe therapeutic robots in the scope of artistic performances in order to discuss their embodiment and functionality in and out of scientific labs and health care facilities. The artistic approach helps to open multi-dimensional views and evaluate experiences in interaction with these robots. As Penny names it "artists turn the world into more world, sometimes taking a detour into the world of symbolic representation, but usually manifesting material artifacts or temporal performances" (Penny, 2017, p. 435). Through the further chapters there is an effort to show how robotic art in its core of creation already has this performativity and not even now but starting from past centuries. While in one section of the thesis there is a perspective to observe these robots in the art context, another section tries to see the same essence of performance within the scientific context. In the first case therapeutic robots are conceived as artworks, in the second case they observed in their functional space as therapeutic tools. If in the first case we still stay in an art space, the second case takes us very far to scientific labs and health care facilities. In both cases, however, the fact that these robots perform is what constitutes the whole essence of our observations. In the art context the performativity of these robots is observed within the contextual values of art and its characteristics. In the scientific context the fact that these robots can perform specific actions brings the beneficial impact within the group of their interaction. Therapeutic robots should perform in order to act for their functional purpose. They teach, they repeat, they respond to their names, they answer questions, they move, they look, they hug: even though being very well scripted by humans all these actions create the environment of responsive, collaborative experience between them and the humans they interact with. All these variations are scripted, thus theatrical in their core and no surprise that these robots can be utilized as "actors" and "dancers" on theatrical stages. It is exactly what is both distinguished and discussed in this thesis. There are various examples of theatrical performances, where these therapeutic robots have been used as collaborative partners. In all those cases they are observed within the context of testing and experimentation with their new possibilities of interaction which leads to understanding all their possibilities and capabilities inside and outside of the theatrical stage. When the *NAO* robot dances on the stage, it creates the patterns of understanding all nuances of its movements for the further elaboration of it on educational and health care spaces. When the Geminoid robot performs in a scripted theatrical play, it already generates the idea how therapeutic robot can behave with a real patient. There is a staged and scripted storytelling on the theatrical space which goes further when shifting to heath care sphere.

One of the arguments of this research is in its necessity to visualize the importance of the art context for these robots. Why it is necessary to observe therapeutic robots in the art sphere? Again, the comparison lies between the artistic and scientific approach. Health care researchers in a care facility focus on a patient and a robot is just a tool. For an artist in the art sphere a robot is still a medium for implementing and covering bigger issues but during the process, anyway, the artist is interested in exploring the robot's possibilities more than the health care researcher. Thus bringing robots to the therapeutic scene somehow blocks the opportunity to fully observe their potential and to see how they are progressing or how they can be developed. They remain on the same stage, where limited specific tasks they are required to perform do not allow for other possibilities they may have. What art and artists do is reveal these hidden layers and bring to the surface, try to show how these robots can be put in a completely different environment and still be able to perform by using non primary settings to elucidate new possibilities. In other words in the art context they use non therapeutic configurations but exactly those help to understand their potential further in therapy.

As it is already noted in both cases robots perform but in health care facilities the interaction with robots is one sided, there is no feedback, while in art context there is mutually constitutive of the reciprocal relationship between a human and a robot where a human gets feedback from a robot about any kind of actions performed during the interaction. In this context theater especially plays a crucial role, as it makes explicit this interaction and develops better tools on further explorations of these robots. Art poses questions about these robots functionality more explicitly than the health-care system is capable of. It tries to reflect on what could be done more to increase these implications of how the technology will benefit both people with impairments and researchers alike.

Furthermore, this thesis also tries to fill the literature gap of explorations about therapeutic robots and again suggests art perspective in approaching and investigating these robots' functionality. The crucial part of articles and reports are written by scientists representing health care facilities, and HRI labs or such kinds of disciplines as engineering, computer science, robotics. Very few studies are carried from artists and less perspective can be observed from the artistic point of view, especially in the media art history context. Thus the method implemented here is based on art historical discourse and on the observations carried by art historians and artists.

Accordingly, this thesis is divided into several chapters, each of which has a clear division in discussion of a particular topic. The first chapter presents an overview of robotic art and general introduction to robots in the context of media art history. The second chapter focuses on therapeutic robots in scientific studies and brings few examples of them sketching general characteristics, design and functionality inside health care facilities and educational spaces. Finally, the third chapter observes these robots in the artistic context, particularly in theatrical performances trying to visualize the necessity of researching therapeutic robots out of their initial context and emphasizing the beneficial outcome from experiments they have on the stage prior or during their main use in the scientific context. In the process of showing all these aspects the third chapter also reveals a few methodological approaches towards robots in general, acquiring their agency, embodiment and mimetic representation as important steps of understanding their use and functionality inside the art space.

Literature Review

The purpose of this research is to show the functionality and the role of therapeutic robots in the scope of media art, therefore subsequent literature tries to cover all important issues accordingly. In one case this study relies a lot on the theoretical grounds of HRI, machine embodiment, robotics, uncanniness and agency, written by outstanding theoreticians of the fields. From the other hand there are a lot of studies, reports, surveys and analytical articles realized by the representatives of the health care system, engineers, psychologists, from whom we mainly get vast knowledge about the practical matters of these robots. In the first case there is a more humanistic approach, in the second case - more scientific. As such, with all this literature there is an attempt to combine art and science, along with theory and practice.

Departing from this logic the chapters are constructed based on the literature grouping. One of the leading books included and used in all three chapters is artists Damith Herath, Christian Kroos and Stelarc's edited book on *Robots and Art: Exploring An Unlikely Symbiosis*. Here they combined and edited many important articles from famous researchers, like Simon Penny, Jean-Paul Laumond, Ken Rinaldo, Elizabeth Jochum, Ken Goldberg and many others, where they introduced embodiment, interaction, otherness and explorations of robots in art. These texts widely cover lot of aspects discussed throughout this master thesis.

In the first chapter more general issues around robotic art and theoretical frameworks of their functionality are discussed and the literature introduces main narratives of robotic art. While trying to observe robots as sculptures with intended function, the main focus of this chapter centers on Jack Burnham's observations of the role of sculpture and its influence on robotic art. Michael Chemers' thoughts about the role of performance and theater in the establishment of empathic relationships with robots are also considered. Ghedini and Bergamasco's ideas about the anthropomorphic nature of robots, their space in contemporary art and correlations with conceptual art are important steps towards this thesis's intention to introduce new perspective of the research on therapeutic robots in the art context and critically examine the outcomes of implementing these robots in the media art space more and more. The questions about uncanniness of robots are discussed through Masahiro Mori's famous essay about Uncanny Valley and through Elizabeth Jochum and Ken Goldberg's article about the comparison of Mori's and Zigmund Freud's theories. While uncanniness is not in the center of the discussion for this study, it is important to consider it in the process of understanding the actual existence and functionality of social robots.

A slightly different approach can be seen through Simon Penny's observations about computationalism and embodiment through which he states the gap between immaterial world of a code, where robots act as self-guiding machines and the idea of materiality, where robots are observed as representation of the material world.

The literature used in the second chapter is based on studies and surveys around specific examples of therapeutic robots, about their design, purpose and also their use in research or in health care facilities. Thus, there are more scientific articles included from roboticists, artists, engineers, designers, as well as surveys from representatives of health care facilities. Some PhD researches became useful points to understand current attention towards therapeutic robots in academic circles. For example, Sofia Serholt's PhD on *Child–Robot Interaction in Education* where she discusses *NAO* robot in education or Martijn Jeroen Scheuemie's PhD about *HCI and Virtual Reality Exposure Therapy*, where he brings examples of using *Virtual Reality Exposure Therapy* (VRET) to cure agoraphobia, arachnophobia, fear of heights, claustrophobia, fear of flying and discusses the collaborative process between patient, therapist and technology. For this thesis such researches can be an interesting example to show how human - technology interaction, demonstrated in various dimensions, can be put to beneficial therapeutic use.
Besides, very valuable information and interesting approaches can be seen in Jens Dinesen Strandbech's PhD on *Humanoid Robots for Health and Welfare* defended in Aalborg University in 2018. Strandbech is particularly focused on Hiroshi Ishiguro's *Telenoid* and the whole

dissertation is based on a direct collaboration with the Ishiguro lab and a case study with *Telenoid* realized Denmark.

Further, the list of literature for this chapter includes individual researches and conclusions about such therapeutic robots as *NAO*, *Keepon*, *Telenoid*, *Faro*, *Roball, Kaspar*. For example, Hiroshi Ishiguro, the creator of *Telenoid*, has various essays about *Telenoid* and its use, function and the need among elderly people. In one of such essays, describing the use of *Telenoid* in Japanese care facilities, Ishiguro's main focus, however, is more turned to Denmark, where, as it is already stated, *Telenoid* is used in few health care facilities with elderly people. The text is about the experiences carried in the Danish environment and generally is a good source for approaching and researching *Telenoid* as a therapeutic robot.

The same approach of testing and reporting on some specific robot can be observed in various research articles about case studies with the use of *Paro* and *Keepon*. These articles cover all processes of interaction with elderly people, especially with dementia patients and also with autistic children. There are also few texts which open talks about the emerging role of robots in pediatric therapy. Based on the game-interaction child's participation in the therapy sessions can be much more motivational, which is increasing through the use of interactive robots both for physical therapy and for the children with developmental disabilities. Among few other tele-operated assistive robots author also discusses the function of *Kaspar* and *Roball*.

The literature used for the third chapter is based on the various dimensions of performativity of therapeutic robots and their use in theatrical settings. The focus is on mimesis, imitative interactions, the embodiment and the agency of those robots. Evelyn Fox Keller discusses examples of specific robots which are in the use of research with toddlers. She notes about the imitation and mentions how valuable this process of imitation of their behavior can help humans in the care field. She wants to show how useful it can be if these robots from mere entertainment robots for toddlers can be transformed to health care trainers for children with autism. Elizabeth

Jochum and her colleagues realized and introduced case studies on the use of various robots on theatrical settings, which are a great addition and examples in tackling specific questions.
Further questions about mimesis are discussed not only by Plato's and Aristotle's visions on the concept but also in contemporary views of researchers from various disciplines, like Kara Reilly's views on humans' learning process via imitation, Abigail Susik's notions about mimesis in media art prototypes, also zoologist Konrad Lorenz's comparisons of imitative interactions between animal and human worlds. French psychoanalyst Jacques Lacan's theories on mirror stage are also taken into consideration in this chapter.

Grounding on theoretical studies around the concepts of uncanniness, human-like robotic embodiments, this study tries to rely on the researches of Lucy Suchman in her analytical arguments about the human-machine relationship, about their borders and differences. Drawing from lot of studies from cultural anthropology, sociology, philosophy and feminist theories Suchman shares her thoughts about the relationships between a machine and a human and focuses not only on the machine aspect but on the human side as well. What Suchman tries to formulate is that agency cannot be assigned but can be found in the result, as an effect of ongoing reaction. Basically, through the machines she wants to understand humans and how they are reflected in machines. The same approach can be observed in Christian Kroos and Damian Herath's research around questions of agency. In their studies they widely talk about the ways in which technology adapts to the new environment and how this adaptation evokes new qualities in human-technology interaction and behavior. Like Suchman they also tackle the questions about the conditions of evoking the agency asking if the agency is installed since the beginning or it is discovered based on the context of interaction with a technology.

Chapter 1

Robots in media art

1.1. Cultural imaginary

Before approaching the contemporary understanding of robots, it's crucial to observe the evolution of their "ancestors" - mechanical automatons of previous centuries, like the 16th century *Automaton of a Friar* or *Musical Lady* from the 18th century. From earlier ages we also have examples of writings about automatas by the Greek mathematician and engineer Heron of Alexandria dating approximately from 50-200 CE. Some examples of the human/robot relationship can be provided by Nicolas Schöffer who in 1956 created *CYSP 1*, a kinetic sculpture which responds to light, sound, color and movement. Later examples can be registered by Canadian artist Norman White's *Helpless robot* (1985), Ken Goldberg's *Telegarden* (1995), Louis-Philippe Demers *The Blind Robot* (2012), Stelarc's various performances with a third arm or a virtual ear, etc.

Departing from literature gives exhaustive insight about the notion of robots, their function and dystopian worlds composed around their existence. The brightest and first example from where we also have the word *robot* (which comes from the slavic word *robota*, meaning *hard work*) is from Czech writer Karel Capek in his play called *R.U.R. (Rossum's Universal Robots),* dated and first performed in 1921.

Here the main character Domin describes two Rossums who had created robots. Old Rossum who initiated the idea of robots' creation was spending years in order to make them like humans, trying to copy every part and organ of the human body. Thus his approach was more scrupulously based on the desire to create artificial life, mimicking every anatomic detail humans have and spending years on the research and creation of unique robots. It is somehow reminiscent of the creation of an artist masterpiece. Conversely, the young Rossum's new approach is to create labour machines and in order to manufacture these models he has to adapt them by reducing similarities between humans and robots and excluding many anatomical details. In the end he creates perfect machines designed to perform specific and stable tasks. This can be a great example to show the different approaches in perception, also in the creation of robots. According to general reasoning they are just machines and they should do whatever they are designed to do (like industrial robots) and for other cases they are art pieces (like social robots), unique, crafted objects with maximal potential of being autonomous and self-controlled as initiators of artificial life.

R.U.R. is important not only by bringing the term *robot* into the use but also by explicitly emphasizing the growing dissonance between human classes. It combines and visualizes all events of the early 20th century starting with technological revolutions, industrialization and communist propaganda with growing working class and "rather than the spectacle of mechanical life made by man, as seen on the eighteenth-century stage, R.U.R. reflected the growing fears that man himself had become machine" (Stephens & Heffernan, 2016, p. 34).

Later and crucial examples in the literature are traceable by American writer Isaac Asimov in his science fiction novels about future worlds where robots are humans' protectors by following established universal laws. Interestingly, in his most famous piece *I, Robot*, which is a combination of several short stories, told by robopsychologist Dr. Susan Calvin, this is the first time we encounter the term *Robopsychology* - a study, designed to research behavior of robots but which is not entirely observed, except *Robopsychology* department in *Ars Electronica*, which existed for some period. In the same novel Asimov defines Three Laws of Robotics:

1. Robots cannot hurt human beings
2. Robots should obey orders given by human beings
3. Robots should protect their own existence as long as it is not in conflict with the first law

Asimov's perspective on robots' functions played a crucial role in the creation of robots' general image and had its reflection on understanding the complex play of human-machine. For example, a small excerpt from *I Robot* "Well, since the Machines are giving the wrong answers, then, assuming that they cannot be in error, there is only one possibility. They are being given the wrong data! In other words, the trouble is human, and not robotic" (Asimov, 1950, p. 253). Here, it is clearly observable the problematic relationship between human-machine and the notion that robots are reflections of humans and deeply depend on the quality and the content of data given by them.

Another, very important example in the field of science fiction literature, which again played a crucial role in the further understanding of robotics and also had its reflection in other genres, like movie and theater, can be noted by the work of American writer Philip K. Dick. Particularly, his work *Do Androids Dream of Electric Sheep?* published in 1968 is a post-apocalyptic novel which had its further implementation in Ridley Scot's 1982 famous movie *Blade Runner*.

1.2 Concept of Mimesis and Imitation

Cynthia Breazeal notes that robots and cyborgs are a very favorite topic of science fiction. She thinks that such stories reflect the nature of humanity and society. In all these stories robots are represented as machines supporting humans and having human intelligence (Breazeal, 2002, p xii). As actual mirrors they walk step by step with humans performing tasks which biological entities cannot perform and try to fulfill humans' desire for reproduction. As such robots are a non-biological reproduction of humans with their emotions, feelings, behaviors. Humans' desire to mimic their behavior and intellect in a different way is connected with the need to be reproduced in a different way also, in the embodiment of another kind of "species" and be able to project the same kind of interactive and emphatic notion to these new entities, in this case in robots. Their development calls back to the life phases of Friedrich Nietzsche's concepts described in his famous book *Thus Spoke Zarathustra* (Nietzsche, 2006). While Nietzsche never talked about robots, it is relevant to see some parallels with his main philosophical ideas about humans development from animal to super men. In this scope life is metaphorically perceived as a bridge and a human should carefully pass through it in the process of self-education, growth and raise above its animal instincts. Here Nietzsche asserts that god is dead and a man is a new god. If we reflect this on robotics, will be interesting to define a human as a new god who creates a new species in the embodiment of robots.

Humans like to animate everything around, try to give an essence and purpose of existence of many objects surrendered with, to see their reflection in various entities, be that objective reproduction of human mind in direct or non direct form. This means humans have an urgency and need to “give a birth” to new things. Creation is a part of their existence and everyday life, creation of thoughts, emotions, relationships, interactions, communications, collaborations, objects, art, music, environment. In all these cases humans try to find or inseminate piece of themselves. All these processes are performative. Social robots easily fit in this category where they combine humans’ desire of self-reflection in the appearance, movement, behavior and also intellect. No surprise that researchers Ghedini and Bergamasco perceive robots as “A-Life sculptures” or as “living sculptures”. Here they mean that robots represent such kind of a sculpture which is developed in combination of such various technologies to activate gestures, movement, sensors, behavior (Ghedini and Bergamasco, 2010, p. 735). The authors want to see less boundaries between artificial and organic and they hope that in a future humans can achieve that. For this purpose humans need to put less borders between animate and inanimate objects and to see how robotic art unifies mimetic traditions of anthropomorphic objects and the essence of performativity.

For sure in the context of this discussion it is important to discuss the concept of mimesis, and the general nature of imitation. The learning process of humans, from their birth was realized through the patterns of imitation. Basically, mimesis is what constitutes the normal flow and cycle of human communication. Without copying gestures, languages and cultural specifics of our environment humans are not able to become part of a society. Interestingly, the imitative power is found not only in humans but also in the animal world. Austrian zoologist and ethologist Konrad Lorenz asserts that “strictly speaking, the ability to imitate is only found, apart from men, in certain birds, especially song birds and parrots - through here confined to vocal imitation”. (Lorenz, 1978, p. 153). He observes imitative patterns in apes also, especially in chimpanzees but also claims that they are limited and not even compared to birds’ ability to imitate. Apart from the animal world, in his perspective, children can also be considered excellent imitators. (Lorenz, 1978, p. 153). Theatre historian Kara Reilly even thinks that what we learn it is “through the mimetic faculty via socio-cultural conditioning and they are inherently rote or robotic” (Reilly, 2018, p. 193). Thus, usually we learn without questioning what we learned and just mimicking what we are introduced to as a source of the knowledge, and this process by itself is a very mechanical process, very similar to the processes of pre-programming and adaptation through which robots generally pass.

Plato and Aristotle talk about mimesis exhaustively, discussing it in the scope of music, dance, poetry, painting and theatre. Plato defines mimesis as a copy of a copy, as a mode of going far from the original. In his philosophy, mimesis can be interpreted as a provider of “a false impression of knowledge” (Woodruff, 1992, p. 78). While he thinks that mimesis reproduces some of the qualities of the original, he doesn’t define it as a good or bad process. Generally he thinks that mimesis is a medium by which nature realizes unfinished processes (Woodruff, 1992, p. 78). It is a place where everything is possible to reproduce, interpret, shape and finalize. Thus, it is not just a copy, but a possibility of copying something through modifying the original. We can make almost the same observation in Aristotle’s theory of mimesis, where he thinks that “the objects include things as they are, things better than they are, and things worse than they are” (Woodruff, 1992, p. 78).

Researcher Abigail Susik in her article about the mimesis in media art prototypes discusses the notion of mimesis in media art and in its traditional understanding of it asking “how can this impression that the interactive new media artwork has autonomy, animism, agency, or a life of its own, be compared with the traditional and pre-digital aesthetic value of mimesis, or the skillful imitation of given aspects of reality" (Susik, 2015, p. 1). In her comparison between traditional mimesis and mimesis in new media art she states that the first one is based on the visual representation but in case of media art it is realized through "the language of code" where the interaction, and thus the imitation, is adjusted by algorithms. (Susik, 2015. p. 2) Thus mimetic representations in the technological world are highly different notions than they are traditionally. As the author elaborates further "programmed code, as a set of encrypted instructions that communicate and translate messages between human and machine, has nothing to do with resemblance and association based on likeness, to be sure" (Susik, 2015, p. 2). The example, which author brings on is Rafael Lozano-Hemmer's *Tape Recorders, Subsculpture 12-14*, which is an interactive installation realized on 2011. It demonstrates a wall with measuring tapes each of which is connected with a computerized tracking system which detects human presence next to it and activates measuring tape to grow reaching almost 3 meters. Afterwards, it gets back to its normal condition and starts again. What Susik emphasizes here by bringing this example is the functionality of the operating system, which evolves its repetitive actions.

Shifting back to robotics and discussing Plato's and Aristotle's concept of mimesis opens up new horizons of viewing imitation by itself. What interests us here is how the ability to mimic and imitate is located in the machine entities. During the actual use of machines and especially with robots, the imitative behavior helps them to shape their agency and establish a meaningful pattern of purposeful interaction with humans. Robots here act as newborn children for society with the possibility to learn how to behave in the environment of the same society and become part of it. No surprise that in many cases during the performances and various HRI interactions we observe how humans perceive robots as children or pets. Basically, their reaction is that they deal with newly developed and yet to be progressed beings whose first steps and further actions yet should be controlled, shaped, navigated and cared for. When they would be left alone for their autonomous behavior is unknown, as in the case of usual parent-child interactions. K. Reilly also brings the example of children, stating that "the desire to watch robots imitate human actions can be explained by the ways in which we get pleasure from watching child prodigies" (Reilly, 2018, p. 204). Humans want to bring up, educate, shape robots in a way that parents act with their children. Maybe in a similar way when parents learn a lot from children, should humans also learn from robots? Maybe it is the desire to make robots domestic and keep them in a close proximity?

In the same context of discussion of this topic about children and pets, robotic scholar Elizabeth Jochum also describes the same attitude of the performer, where the performer relates to the robot perceiving it as a pet "the performer relates physically to the robot – not always as an equal, and frequently in the manner in which a person might relate to a pet" (Jochum & Derks, 2019, p. 6). No surprise that some of these robots are built to look like and be understood as a pet or baby. The learning behavior is also similar to that. Author Evelyn Fox Keller mentions that "the aim inspiring Leonardo's design have shifted from building a baby that can grow into a toddler to building a robot that can serve as a helpmate to a human in need of care" (Keller, 2007, p. 339). No surprise that this connection between robots and pets can be observed by such instances.

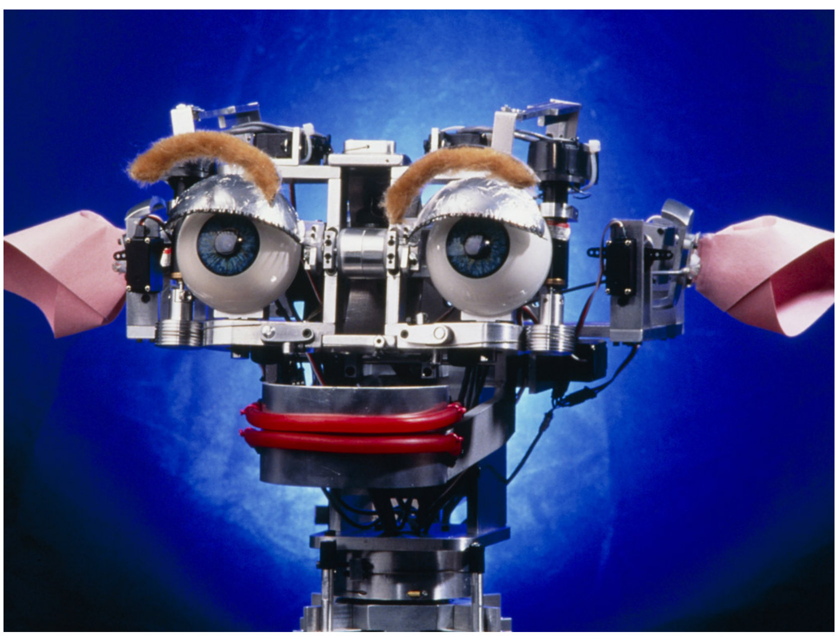

Figure 1: Kismet

Source: https://robots.ieee.org/robots/kismet/

As researcher Treva Pullen talks about this phenomenon in his article about the performative machines aesthetics and affects of robotic art "the lure of animal instinct appears to be an important consideration for the development of intelligent, or simulated intelligent, robotic creatures" (Pullen, 2018, p. 517), which means that robotic artists study behavioral patterns of animals and get their inspiration through mimicking their playfulness into the machine entities.

Figure 2: Leonardo
Source: https://robots.ieee.org/robots/leonardo/

Fox Keller talks about imitating behavior of robots bringing example of *Kismet* robot which was created by Cynthia Breazeal in 1998 and constructed to be humanlike, with a face and eyes which could track a human's gaze and establish direct contact with them (Figure 1). Here Keller discusses the learning patterns of *Kismet* and asserts that it happens through the imitation bringing example of "mirror neurons" in monkeys (Keller, 2007, p. 338). Basically, here researchers carry the same study as with infants or toddlers. Teaching toddlers of any kind of interaction happens through the imitation. They use the same system with robots. In this line of thinking we can place another robot - Leonardo which undergo lot of experiments with researchers for raising interactive pattern of it. Leonardo was also created by Cynthia Breazeal but later in 2002 (Figure 2). It looks like a weird alien animal from sci-fi movies, which somehow confirms Breazeal's affection towards *Star Wars* and sci-fi movies. The purpose of this robot is to experiment with learning behavior and adjust better interaction between a human and a machine through the learning process. Thus, Leonardo learns by the imitation passing through the long process of a teaching-learning game with the researcher. Leonardo is "responsive to environmental cues and can be taught to mimic human reactions, responses and feelings. He is able to reflect human emotions and console through mimicry" (Pullen, 2017, p. 520).

Simulative Emotional Expression Robot which is famous by its short name *SEER* can also mirror the facial expressions of humans (Figure 3). It is a small size head with big eyes and expressive eyebrows created by Japanese roboticist Takayuki Todo. When you look at the robot and mimic, it repeats all your facial actions. For this it only needs to detect your face and establish a contact. The interaction is limited only to mirroring and repeating all actions of participants but even during this short imitative process the communication between a robot and a human is being established. Although SEER does not have any connection with therapeutic robots it represents a great example how humans try to create their mirrored and ongoing imitative versions.

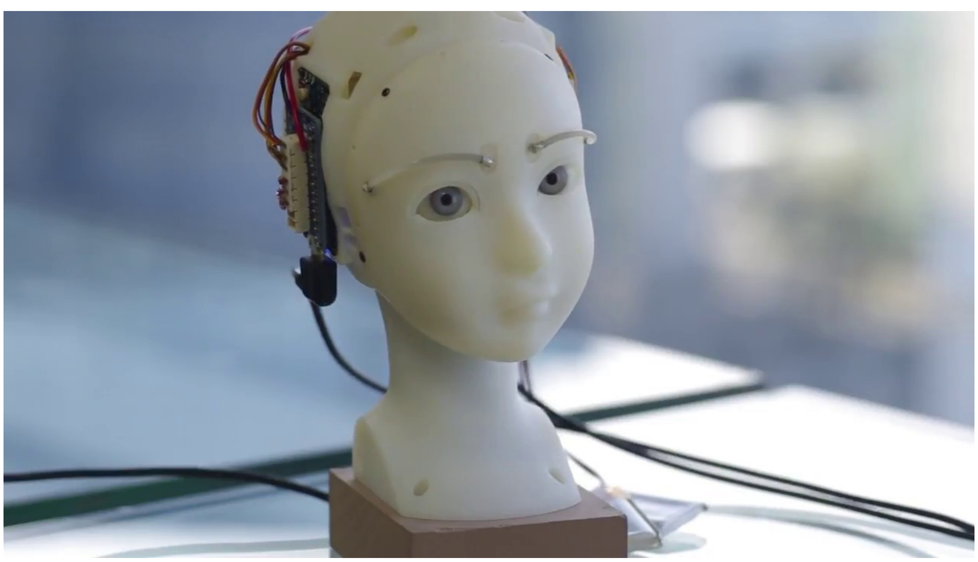

Figure 3: SEER: Simulative Emotional Expression Robot

Source: http://www.takayukitodo.com

As much as mimesis is the normal flow in learning-teaching, in the same way it can be problematic. The nature of mimesis is in its power to fail the perception of the original, which anthropologist Micheal Taussig formulates as “two-layered character of mimesis” (Taussig, 1993. p.24) stating that it encompasses “sentience and copying”. In its sense sometimes mimesis imitates the imitation in the process of imitating the imitators. While we see this applied in description of ancient civilizations and their culture, in reality what we can see in nowadays pattern of imitation is the same attitude of failing to understand who imitates whom - human to robot or robot to human or more, the imitation goes around and gets more complicated in being imitated by the imitator again and again. Mimesis “registers both sameness and difference, of being like, and of being Other” (Taussig, 1993, p. 129). However, while imitating it copies also the power of the original. Taussig calls it “a chameleon-like capacity” when during the copying the entity is introduced as original. (Taussig, 1993, p. 42). Do we also observe this capacity to act originally in robotic performances? Do robots copy human gestures, appearance, behavior and try to act as the original? In fact we can observe that from society’s side in those cases, when the robot is more humanlike and mimetic representation is higher, the way humans approach it is different, more based on trust and confidence. Thus, can we assume that society also demands imitation?

1.3 Robots as artworks

Eduardo Kac mentions that robotics arose within the visual arts in the mid-20th century and artists turned their attention to robotics as a tool to explore society’s obsession by technology (Stephens & Heffernan, 2016, p. 35). Humans interact with robots who can make art, like to draw or to dance, but rarely perceive them as art works by themselves. The functionality is more prioritized than the embodiment. In fact, the same statement can be found in Christian Kroos’s article about the robotic art, in which he tries to observe robots as artworks and not as an artist’s (Kroos, 2016, p. 19). Kroos thinks that the machine by itself, through its existence and its ability for interaction, already refers to agency and aliveness and that “the art is not in the machine, the machine is the art” (Kroos, 2016, p. 21).

For Penny, robotics has two distinctive characteristics: the first is connected with a design of behavior and the second connects codes with materiality (Penny, 2016, p. 49). In this intersection robotic art behaves as a connector between the abstraction of computing and the materiality of art (Penny, 2016, p 53). Moreover, Penny also shows the origins of robotic art in cybernetics, where the concepts of biology, ecology and a control prepare smooth ground for robotic art creation. (Penny, 2016, p. 55).

Unlike many assumptions that robotic art arose in 20th century parallel to the rise of contemporary art, particularly minimalist and conceptualist traditions, there are artists who view the origins of the robotics in a past centuries. Particularly, such kind of a view can be observed in the research of a theater scholar and playwright Michael M. Chemers, who talks about inherently performative role of mechanical devices even starting from the 16th century. He observes few examples from that period and compares it with 21st century innovations in the field. Chemers asserts that dramaturgy and not technology is in the core of any kind of interaction and that the evaluation of machine entities and the initial nudge towards the creation of artificial intelligent can be found in the past (Chemers, 2013). This surely can be helpful in understanding and appreciating current developments in the sphere of robotics and robotic art also, as in the view of Chemers theater is the base and core of human, animal and mechanical interaction. Even in our daily life we perform in specific settings with pre-scripted actions following to already assigned navigations of movements, speech and interaction. If we follow Chemers’ thoughts on no differentiation between animate and non-animate world, we will see that, basically, there is no distinction between humans and machine settings. Following to this logic the patterns of social interaction between these far entities we can find in the theater. The difference between humans and animals, also between humans and machines lays in the fact that only humans demonstrate empathy and only humans have the notion to be part of the group and be able to interact within the group in the meantime having the perspective of another human being (Chemers, 2013, p.

242). While Chemers observes this emphatic relationship in animal world as well, bringing examples of chimpanzees as the closest to humans by their intellect, in the meantime, he asserts that in the human behavior this kind of interaction brings to the space of theater (Chemers, 2013, p. 240). Performance is the core of any kind of interaction. Performance is scripted or non-scripted relational phenomena which creates clear communication, emphatic interaction and strong connection between group of interactors.

Thus the approach is to perceive robots as moving sculptures, as active and dynamic objects, more close to what Eduardo Kac calls “liberated from the static” (Stephens & Heffernan, 2016, p. 37) referring also to the contribution of kinetic art. If we go through the entire art historical discourse, we will see the demand of putting artworks in autonomous process a lot with the effort to resize, move, give them control and the possibility to be recreated by themselves. Moreover, if we observe general human history and especially mythology we will see that the desire to give a breath to unmovable objects has existed always. The best example is the story of Pygmalion who fell in love with the statue he made and asked the gods to make it live.

If we compare robotic art with contemporary art works, we will see that there are a lot of similarities between conceptual representation, aim, function and result. Just, in the first case we encounter autonomy combined with techniques, methods and material freedom and in case of robots we encounter with above mentioned, plus technological experiments about questions of artificial life. Thus, robots can be easily considered as a contemporary art pieces even without creators’ intention and professional affiliation.

In their definition and reference to sculptures Ghedini and Bergamasco extensively cite Jack Burnham according to whom anthropomorphic robots are successors of cultural tradition with all its mimesis based on which the intention of robotic art is to simulate appearance of life by means of behavior, motion and interaction. Thus when Burnham tells that “for our generation much significant anthropomorphic sculpture does not imitate man but imitates robots trying to become human”(Burnham, 1968, p. 325), he clearly refers to this notion that the borders between human and machine are becoming more and more blur. Robot is a successor of sculpture, redeveloped and animated entity of the same interface. Throughout centuries and development of technology sculpture's desire to be active is realized in robots. Burnham even states that "sculpture seeks its own obliteration by moving toward integration with the intelligent life forms it has always imitated". (Burnham, 1968, p. 333).

However, according to Burnham sculpture's problem is in the fact that it is not responsive and the communication with a human was one sided action and only from human side. In order to achieve to communication there should be equal share and distribution of emphatic interaction. Burnham talks about organized entities, which he defines under the term *systems* and thinks that it is not necessary that systems will interact with an environment they exist. If they interact then we can talk about established communication (Burnham, 1968, p. 318). In case of machines and robots the interaction starts from the process of programming. According to Burnham all efforts are always done to make machines to be more responsive than they are. In case of robots specifically, he thinks that these new machines are able to have some kind of autonomy and they can make decisions (Burnham, 1968, p. 320). Based on how Burnham interprets the transition from an art object to systems, the parallel between sculptures, as passive art objects and robots, as organized systems of artificial force, shows the transition from pure physicality to more conceptual levels of art creation. Robots are conceptual in their representation. They have material forms but the core which moves it constitutes in non visual patterns of various responses and artificial thoughts. Coming from this logic that robots achieve to more independence and appreciation throughout the century, for Burnham these technologized sculptures are slowly freeing themselves from humans and seeking to come to the point of reproduction. This reminds the situation described in R.U.R. when besides dominating on humans, another desire of robots was to be reproduced.

1.4 Museum space

Museums are also particular spaces for defining the new role and place of robots. After such a long trip from labs to health care facilities and schools, one of their stops can be in the museum space also. Here robots are introduced not in the framework of their functionality but as art pieces, as sculptures perceived to preview all their capacities and the purpose of creation. The mode of display in museum spaces can be sometimes opposed to what these robots are able to do. In many cases the movements, activities, speech and responses can be seized and limited while the appearance and all questions about design can be put upfront and the visual aspect of the robot is emphasized more than the functionality. One thing to note also is that even in case of demonstration of their functionality the outcome and interaction will not be the same as the communication will be shifted from target group to the general public.

In one article about experiments carried out with robots in public places, the authors discuss HRI and the engagement of human and robot in the museum space. They are concerned with the fact that in museums robots sometimes are situated behind the glass or in enclosures, thus “such “off-limits” exhibits further the perception of robots as functional devices to be avoided, not as social actors meant for interaction” (Herath, Jochum & Vlachos, 2018, p. 1) and already prevent any interaction between humans and robots. In this context those robots’ autonomy is limited and human-robot interaction is not smooth. Further, the authors claim that it is important to observe social robots in real-world environments and that “galleries and museums provide rich sites for open experimentation with untrained interactors” (Herath,Jochum & Vlachos, 2018, p. 3).

Chapter 2

Therapeutic robots, general view

2.1 Therapeutic robots

Reflection upon the general description of therapeutic robots is necessary at this point as it will draw a whole outline of the patterns of creation, use, function and outcome. From humanoid to animal like, from autonomous to tele-operated on Wizard of Oz (WoZ) mode, they all fit into the category of Therapeutic Robots as a subclass within the field of social robotics. WoZ is a technique by which a person from distance controls the robot's movements, voice and gestures. In one of studies about WoZ in HRI it is stated that "Researchers who employ WoZ argue that because robots are not sufficiently advanced to interact autonomously with people in socially appropriate or physically safe ways, this kind of puppeteering allows participants to envision what future interaction could be like" (Riek, 2012, p. 119).

Therapeutic robots are widely used in health care facilities and actively investigated in ongoing research studies and experiments. The explorations are usually focused on such issues such as how and at what degree the interaction with these robots can help to establish communication with children who have autism, or help alleviate symptoms of dementia in elderly people, or how they are used in educational spaces as a trainer in child-robot interaction.

Turkle et al. has a term "relational artifact" while talking about computational objects. According to them these are objects "that present themselves as having "state of mind" that are affected by their interactions with human beings, objects designed to impress not so much through their "smarts", but through their sociability" (Turkle et al., 2006, p. 313). Humanoid robots and therapeutic robots are closer to this notion of being sociable, as in interaction with patience the most important aspect of their communication lays not in the part of acting intellectual in their responses but acting sociable enough for establishing engagement between a human and a robot, in many cases also between a human and a human. The term "artifact" tells a lot about itself as it calls to attention that these robots and robotic applications have deeper cultural significance as evidences of human creation. We already have a broader field of media archeology, a field which tries to understand the emergence of new technology based on the old one. Perhaps, in the future robots will be considered as an old technology ready to be explored in the scope of archeological importance.

Technological impact on the health care system and new applications of using this progress for therapeutic purposes are already in a wide use. It can be observed not only through robots and in HRI generally but also in other digital systems. Sometimes existing technologies are being reshaped and reused in different purposes to investigate new ways of their implication in to the health care system. For example, Virtual Reality, with its immersive environment, is being used to cure many phobias in patients. Considering that VR is not a new technological platform, redesigning its interface to fit into the scopes of cognitive therapy is an interesting turn of development. Virtual Reality Exposure Therapy (VRET) by Head-Mounted Display transfers patients to virtual space and helps them to face their worst fears. Specific scenarios of immersion provide immediate interaction with their fearful objects or situations and patients have virtual experience of confronting them and overcoming their phobias. (Schumie, 2003, p. 4). In such a way there is already registered therapy for agoraphobia, arachnophobia, fear of heights, fear of flying or talking in public, claustrophobia, etc.

The same idea carry therapeutic and assistive robots by being used in different applications which brings to the changes of their functionality and to the establishment of the new patterns of interaction with them. Medical robotic applications, such as daVinci system, endoscopy bots, antibacterial nanorobots, telepresence robotic surrogates, micro-robots, disinfectant bots are already in a wide use in health care system. They perform various tasks: surgeries, medical transportation, sanitation, etc. As this research is mainly focused on therapeutic part of their functionality, these medical robots are not taken into consideration. Also, some of these robots are still in the development process and being tested in clinical trials in order to become real therapeutic tools.

As noted already virtual reality provides full immersion and opportunity for people to confront their problems. This means the ability to create appropriate interfaces for particular scenarios mentioned above. They can vary according to phobias and the possibility to create appropriate environments for each of them. This means covering a beneficial interaction for a range of problems. Thus the target group is expanded and not limited within two specific groups as in the case of robots' interaction. Here robots are mainly used in assistive purposes for autistic children and elderly people suffering from Alzheimer's, dementia or other impairments. Thus, in future / subsequent introductions of these robots all discussions will be centered around their interaction with these two groups.

Generally, these robots are created purposefully to help children to enhance the socialization and help them to acquire simple mechanisms of communication. There are robots, whose features are intentionally simplified to make them easy approachable for autistic children. For example, *Keepon* and *Kaspar* can be classified under that category. With elderly people and especially with dementia patients there are robots which were not created specifically for them but already put under use and experimentation and have produced positive results. We can observe this by *Telenoid* and *Paro*.

Turkle thinks that technology uses human vulnerability and already became inseparable part of our life, kind of extension of our bodies helping us not to feel alone. When she talks about sociable robots she asserts that they "may offer the illusion of companionship without the demands of friendship" (Turkle, 2011, p. 1). That illusion empowers us to hide behind the screens, pretend that we have social life, not to be responsible for any relationship and communication and pretend that we are not alone. Technology accomplishes us on a physiological and sometimes even on physical level, like in case of prosthetics. No surprise that some artists even try to incorporate them in their bodies, as, for example, Stelark with a third ear on his arm.

Overall, there is a growing body of evidence that therapeutic robots have a big potential in health care. In one of the articles Duquette et al., for example, talk about *AuRoRA project* (Autonomous Robotic platform as a Remedial tool for children with Autism), the initiative which investigates "how a robot can become a "toy" that could possibly serve an educational or therapeutic role for children with autism" (Duquette, et al, 2007, p. 148). It is considered to be "the first systematic study on robot therapy in autism" (Pioggia et al., 2007, p. 606) in which scope various mobile and humanoid robots been created and put into the research.

Autism or autism spectrum disorder (ASD) refers to conditions characterized by the limitation of social skills, behavior, facial expression, speech. Early signs can be seen since in 2-3 years old children and although it is an untreatable disorder, early interventions can somehow decrease the symptoms and make the children to become more adjustable to social environment.[1] As studies claim "people with autism demonstrate abnormal patterns of social visual pursuit consistent with reduced salience of eyes and increased salience of mouth, bodies and objects" (Pioggia et al., 2007, p. 605). As autistic children should acquire many mechanisms to cope with their condition in social interactions, there are numerous therapies designed to support them in getting such social tools. One of these therapies is focused on the use of robots or robotic applications. The first example of such therapy is dated by 1976 with the use of a turtle-like robot called *LOGO* (Pioggia et al., 2007, p. 606). Later examples include such robotic applications as *Robota*, *Kismet*, *Infanoid*, *Keepon*, *FACE* (Facial Automaton for Conveying Emotions). The latter is an interesting project based on the theories of mirror neurons and imitation. As humans' brain neurons respond to any action they observed, researchers of this application decided to use this biological system. According to them "imitation paves the way to the comprehension of the intentions of others establishing a reciprocal non verbal communication process in which the roles of imitator and model are continuously exchanged" (Pioggia et al., 2007, p. 607). They also assert that one of the characteristics of existence of autism is the dysfunction of these mirror neurons (Pioggia et al., 2007, p. 607). Thus FACE is a body with face which can express few

[1] For more information see https://www.autismspeaks.org

emotions, analyze emotional reactions of participants and generally acts as interface to enhance the social interactions with autistic children.

Researchers of such studies think that there are some beneficial aspects of using robots in therapy. They are more focused and attentive with robot mediator than with human one, because of simplicity of robots' interface and easy use of their applications. Besides, they can be easy redesigned according to needs of autistic children (Duquette, et al, 2007, p. 149). Duquette et al. carried the study with four autistic children two of which were paired with human mediator and other two with robot. With this research they were trying to explore and understand the difference of interaction of autistic children with human or robot. The results showed that children paired with a robot had more visual contact and increased reaction to voice and lights of the robot, however, in terms of a body imitation those paired with human showed higher interaction (Duquette, et al, 2007, p. 161). In all such studies and experiments researchers do not try to exclude human mediator and replace it by a robot but rather they focus on including robots in the therapy as assistants who can increase the valuable outcome of any interaction with human mediators (Duquette, et al, 2007, p. 163).

As one of the research papers states "There is anecdotal evidence that autistic children exhibit less severe autistic behavior when interacting with robot compared to during interacting with their peers" (Hamzah, et. al, 2014, p. 215). Interestingly, the same article talks about the preference of autistic children to interact with robots that do not resemble human beings (Hamzah, et. al, 2014, p. 215). Basically, the process of helping these children is not only to "detect and understand emotions and social behavior" (Shamsuddin. et. al, 2014, p. 10) but also to "provoke interactive and social responses that are not naturally occurring in children with autism" (Shamsuddin. et. al, 2014, p. 10).

Diehl et al. wrote a critical review on robots use in autism spectrum and noted that it is very inconclusive to understand the impact of robots on autistic children as the studies more focus on technology than on the application of the technology. Besides, various studies focus on various data and mostly provide not enough information about details of their research, like more specific characteristics of groups included in the research (Diehl et al, 2012). They also mentioned that in recent studies there is a more attention to effective type of robot rather than to their involvement in therapies (Diehl et al, 2012, p. 250). Overall, their approach and summary of findings asserts that lack of consistent data does not allow to clearly state if robots have more beneficial impact on autistic children than humans. It is worth to state whether social robots and also these therapeutic robots mainly scientifically researched only after being created as an artistic investigation about questions of AL and AI.

The desire to put robots into the research with autistic children is very much linked with the previous examples of therapy with these children. The same clinical image can be observed in the studies with elderly people suffering from dementia or Alzheimer's disease. Dementia is a term which describes lot of symptoms associated with the low memory or its complete loss. It can also impact on the ability to stay focused, communicate and verbalize thoughts.[2] To take care of dementia patients is a very hard task, as they need constant and careful supervision. That is one of the reasons why new technologies are being designed to provide appropriate help and support to dementia patients. One of such designs concern also to robotic applications. Lot of studies try to carry months-long research studies with patients and their caregivers to understand how to design the robots that would fit in to individual needs of patients and be helpful "colleagues" for caregivers. Moharana et al. bring the example of their research when they try to collaborate with dementia caregivers to build robots for patients (Moharana et al., 2019). As a result they designed few robots - for joy, for exercising, for answering, regulating nutrition, etc. They considered all design elements which can fulfill the participants' needs. For example, one of the robots was designed with mechanical arms to perform exercises and another one - with humanlike hands to be closer to human touch, etc. Overall, their goal is to show how robots can be integrated into the supporting activities with dementia patients and which kind of details should be considered in building such robotic interfaces. Although, it is very close to experience

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[2] For more information see https://www.alz.org

design, it also can be the point to depart in building up the content and functionality of such robots.

2.2 Functionality of therapeutic robots

Some of the valuable changes observed in the functionality of therapeutic robots can be registered by exploring the notions of agency and the change of the space. In the scope of discussion about surrounding agency it is better to consider that these robots are not created for being perceived as only machines but also as specific tools by which it would be easier to realize human to human interaction. *Telenoid* is remote controlled, perceived as an embodiment of an object by which one can talk with relatives over long distances. *Kaspar* is also remote controlled, through the technique known as Wizard of Oz (WoZ) and is specifically designed for autistic children for whom differentiation of the borders between machine and human are not so defined. *Keepon* looks like a toy and again had been created for autistic children and because of this it has a simple appearance and minimalistic design. *Roball* had been created as a toy and then started to be used in therapy for autistic children. This list can be long but all these examples show how such robots are used in a research and which kind of outcome can be expected from them. We see how these robots shape our understanding about the existence of therapeutic robots and which place and role they have in the scope of robotics in general.

Discussions about the change of space leads us to another territory. These robots have been relocated from labs to clinics or schools and they can be exhibited in museums as well. What matters is that they have been put in a completely new environment - health care facilities, child care centers, schools, etc. All these spaces change the perception of their belonging, which in turn influences on the interaction and function of agency and autonomy.

In one case they still function in the framework of their initial context, meaning that the change of the space from labs to health care facilities does not necessarily change the initial context of their functionality. If they are created as robots used in therapy then the discussion goes around the change of the space only while the purpose of their creation is the same. However, observing them as entertainers or performers on the change, or even sometimes static objects in museum spaces visualizes the change of their context and the new setting of adaptive environment. Adaptation to the new environment and to new conditions of those spaces repurposes their functionality and assigns new specifications. It becomes a new context for them to be shaped and to be developed.

In this scope of understanding the change of the setting only, the health care facilities are very appropriate places to study human-robot interaction and to observe the beneficial aspect of robots on humans and technological and cognitive progress of robots. By carrying out detailed analysis of interactions it is possible to identify a pattern of research about their functionality, possible ways to avoid anxiousness and overexcitement, to alleviate fear of non-human presence and general fear for humanity in the face of gloomy predictions of robots rule over humanity in the future. As opposite, it is interesting to observe the change of their functionality in the scope of physical and functional transformation to the entertainment and performance contexts. This clearly impacts on the interaction scenarios, as from human side non-expected responses from robot can change the perception and further approach towards robots. Which means that if the robot is acquired as therapeutic medium, people cannot know how to interact with it seeing it on the stage or meeting in the museum spaces as entertainers. This clearly talks about the expectations which humans have from robots and maybe somehow the fear towards their unpredictable behavior. If they are designed as machines with specific coordinated functions then interacting with them outside their initial context can raise unawareness to approach them.

In the following pages these robots will be introduced in a more detailed way. As some of them are autonomous robots and some are tele-operated in WoZ mode, they will be grouped accordingly. For this research only few of them are outlined and presented: *Telenoid*, *Paro*, *Keepon*, *KASPAR*, *NAO* and *Roball*.

2.4 Tele-operated robots:

Kaspar

KASPAR (Kinesics and Synchronization in Personal Assistant Robotics) is designed for autistic children to help them to address their problems of socialization and interaction with each other. (Figure 4 and 5). *KASPAR* was created in 2005 by Dr. Ben Robins and his team in the University of Hertfordshire in England (Webster, 2018). Being designed as a humanoid robot and having the appearance of a simple doll, *KASPAR* performed very productively in enhancing social interactions with autistic children. Many researches around this have already proved its beneficial outcome. It is interesting that regardless of the fact that *KASPAR* is a humanoid robot, its features are very simplified. This is intentional as seems autistic children are more relaxed with those robots who have less features and a more simplified appearance (Webster, 2018). Before creating *KASPAR* Dr. Robins even led an experiment with autistic children trying to identify if they will be more social with humans or robots with simplified or more human like features and found that a minimalistic appearance and less facial expressions made the children more relaxed and social (Webster, 2018). No surprise that its small size also adjusted to be more attractive to children than adults. It looks like a doll and is perceived as such by children.

Figure 4: KASPAR

Source: https-//robots.ieee.org/robots/kaspar/

The flexibility of working with *KASPAR* is not constituted only with the possibility to teach autistic children how, through this robot, to try and interact in social environments but also how to program the robot to fit the individual needs of those children. For example, there can be demonstrated some kind of a general behavior, when the robot is preprogrammed to react accordingly to various sets of children's actions. It teaches children to recognize their body by playing an imitation game by touching and repeating names of body parts (Damiano & Dumouchel, 2018).

Figure 5: KASPAR interacts with a child
Source: https-//robots.ieee.org/robots/kaspar/

KASPAR was created not to encourage the relationship with the machine but the relationship between humans. If in this scope we observe some aims of creation of these therapeutic robots, we will see that *KASPAR* is perceived as a medium to aid and to increase the interaction between humans, while, for example, *Roball* robot is perceived as a machine which possibilities of independent movement worth to explore more. On the other hand *KASPAR* and *Telenoid* are like puppets, approached and used as a medium of interaction between two people. As much as the functionality and purpose of *KASPAR* is very beneficial and encouraging, its appearance gives creepy impression to the general public. In the chart of ratings of the creepiest robots *KASPAR* is in the 4th place among few hundreds.[3]

Figure 6: Telenoid
Source: https-//spectrum.ieee.org/automaton/robotics/humanoids/telenoid-r1-hiroshi-ishiguro-newest-and-strangest-android.j

[3] The creepiest robots rank list can be found in https://robots.ieee.org/robots/?t=rankings-creepiest-robots#4

Telenoid

Telenoid was created by Japanese roboticist Hiroshi Ishiguro, a professor at Osaka University and introduced to public in 2010 (Figure 6). *Telenoid* is a tele-operated robot, which, by its appearance, blurs the borders of gender and age specification. It is just a head and torso without legs, arms and hands, with bold head and featureless face. Overall, it has very simple and minimalistic appearance, which gives a bit weird look to it and increases the feeling of uncanniness when you interact with it. In fact it is considered as the weirdest robot in a list of most creepy robots.[4]

As this robot is tele-operated and the purpose is to interact with other human through the robot, the simplicity of facial features helps to imagine the face of a person with whom the actual interaction goes. Perhaps this is the reason the author didn't specify and deepen face features? While being on the tele-operated mode, this robot moves its head according to operator's head movements and speaks by transmitting the operator's voice. *Telenoid* can also give a hug, it is very light and in a perfect size to hold it. Ishiguro states that "if a friend speaks from the *Telenoid*, we can imagine the friend's face on the *Telenoid*'s face and if we embrace it, we have the feeling that we embrace the friend" (Hornyak, 2010). Thus it can sustain the presence of another person over great distances. In fact, Ishiguro himself talks about the imagination agreeing that "Telenoid's minimal design generates room for interpretation, and then the user's imagination fills in details and creates a good communication experience" (Ogawa and Ishiguro, 2016, p. 331). According to him people can project on *Telenoid* anyone they would like to see.

The simplicity of control and communication through it are made very simple and productive for use in health care facilities with elderly people. As it is mainly used with people suffering from dementia, studies show that it gives a productive result. It is stated in one of the articles about Japanese facilities for elderly "residents with a depressive tendency who did not respond when

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[4] For the list of ratings see https://robots.ieee.org/robots/?t=rankings-creepiest-robots

addressed directly by care staff were much more willing to talk to a Telenoid" (Nishio, Minato, Ishiguro, 2015, p. 15). They had a lot of progress while interacting with *Telenoid*, because it made them calmer and more responsive. Also, it gives the possibility for elderly people to interact with their relatives via remote control and not to feel alone and abandoned. It enhances human to human interactions and plays a crucial role in establishing smooth communication between two participants of interaction (Figure 7).

Figure 7: Telenoid gets a hug
Source: https://robots.ieee.org/robots/telenoid/?gallery=photo3

Telenoid is widely used not only in Japan, but in Denmark and Germany as well, where specialists carry researches to understand at what degree can *Telenoid* be useful in the treatment of patients. One of the case studies carried out in Denmark can be observed in dissertation *Humanoid Robots for Health and Welfare* written by Jens Dinesen Strandbech from Aalborg University. He describes few Socially Assistive Robots (SAR) but his main focus is on *Telenoid* and its application in Danish health care system. Apart introducing and analyzing *Telenoid* from the first source, as a result of collaboration with Ishiguro laboratories, Strandbech also carried and presented a short study of testing *Telenoid* in Denmark. For this he collaborated with SOSU Nord staff and with few elderly people with dementia. His approach is the same as in other studies: to understand how *Telenoid* can impact on welfare of dementia patient and his conclusion also the same that *Telenoid* can be a useful tool between dementia patients. He mentions that “the immediate first-time reaction from many Participants was disgust” (Strandbech, 2018, p. 84) which actually would be overcome by time and after several sessions.

2.5 Autonomous robots

NAO

NAO is one of the interesting robots in the industry, created by SoftBank Robotics (previously Aldebaran Robotics) and the first commercially available version was introduced in 2008 (Figure 8). It is considered to be not only a therapeutic robot but also acts as a research platform and teaching tool. Plus it is used also in entertainment. *NAO* is a humanoid robot and can have multi-responses during the interaction. It is a small robot, which can be programmed to interact autonomously and display various reactions like a speech and a movement.

In educational and entertainment context, *NAO* has an ability to be preprogrammed for specific actions. It can be shaped and adapted to various contexts and based on that change its form and function. This is what makes *NAO* to be one of the flexible and adaptive robots. As an entertainer it has the capability to dance and all dance movements can be choreographed easily and adjusted to body flexibility of the robot. As an educator, again, it can be preprogrammed to follow specific steps of teaching something particular or leading some kind of educational activity.

Being a humanoid robot, *NAO* has a combination of hardware and software, touch sensors, cameras, microphones. It has an ability to speak in many languages and very much useful in teaching Science, Technology, Engineering and Math (STEM) in primary and secondary education.[5]

Figure 8: NAO
Source: https://robots.ieee.org/robots/nao/

Among many activities *NAO* is constantly being incorporated into research and practice in health care facilities. With all the equipment which *NAO* has and with the appropriate size and flexibility this robot is easy to use and put into Human-Robot Interaction research. As one of the research articles states "It can be programmed autonomously and could perform verbal and non-verbal interaction during the Robot-based Intervention Program (RBIP)" (Ismail, et. al, 2012, p. 1442).

There are numerous studies carried out in the field of HRI where *NAO* is used for research, especially in cases of children with autism. Here, *NAO* is mainly used in interaction with autistic children acting as mediator in the interaction and to improve their attention. Swedish researcher

[5] More information about NAO in https://www.brainaryinteractive.com/nao-robot

Sofia Serholt, specialized in Child-Robot Interaction, in her PhD writes about the possible change of space for these robots designed as tutors and educators “while robotic tutors mainly feature in research currently, it is likely that they will eventually move out of the research laboratories and into actual classrooms” (Serholt, 2017, p. 6). As such, *NAO* and other robots show promising results in interaction with children, especially on the primary level of teaching the STEM.

There are numerous researches already carried out with *NAO*. Those, which are done in entertainment, will be discussed in the next chapter. However, it is also worth mentioning its wide use in education and experiments around it. In the same dissertation about child-robot interaction, mentioned above, the author introduces a case study of experiments done in one of the schools in Sweden, when *NAO* was put into research in interaction with children as a robotic tutor and had been programmed in few scenarios to find out the best ways to approach both teaching and learning. The author brings the example of the EMOTE project[6] which she took part in and based on which her dissertation is constructed. The project carries out many activities with a *NAO* robot in various educational settings and workshops. Similarly, the author mentions other such kind of projects in Europe, as well as in South Korea (Serholt, 2017, p. 6).

Another interesting aspect of *NAO* is that it can be used in various researches and every time it should be specifically tuned and programmed in accordance with the experiment of project. Basically, by itself the process of preparing this robot for interaction is also specific and thorough research should be done to understand the all possibilities of *NAO* and future scenarios of such interactions.

[6] For more information see http://www.emote-project.eu

Keepon

Keepon is another type of therapeutic robot with idiomorphic[7] forms created by Hideki Kozima in the National Institute of Information and Communications Technology (NICT) in Kyoto, Japan and then put into the research in the USA by Marek Michalowski (Zax, 2011). *Keepon* is a small robot equipped with cameras, a microphone and motors (Figure 9). Interestingly, the equipment plays the double role of being useful by replacing eyes and nose with two cameras and a microphone. It has a rubber skin, can tilt, bounce, rock side-to-side, node and dance.[8]

Figure 8: Keepon

Source: https://robots.ieee.org/robots/keepon/

Unlike *NAO* and *Paro, Keepon* can also be tele-operated as it has two versions: *Keepon Pro* and *My Keepon.* Keepon Pro has tele-operated mode and used in the social interaction with children who have autism. The commercial version - *My Keepon* went to the commercial market with a

[7] Which means having the proper form or shape. See in https://www.merriam-webster.com/dictionary/idiomorphic

[8] For more information see https://beatbots.net/keepon-pro

cheaper price in 2011 and costs only 40 dollars as opposed to the 30.000 dollars of *Keepon Pro*. *My Keepon* is more simplified, toy version of *Keepon Pro.* The intention to create such a low budget version is connected with its popularity among people. This robot is so cute that everyone wants to have it and no matter that it was created for the therapeutic purpose of children with social developmental disorders, it gains success among healthy people as well. Its commercial use is comparable with another example of a toy - *Tamagotchi*, a digital pet famous in 1990s. *Tamagotchi* was commercially affordable small interface with buttons by which users could control the life of their pet, feed, entertain, etc. Again, as *Keepon,* it had limited functions, simplistic design and appealing interaction among users. Easy use of its application made it possible to become one of the most famous digital toys of the period. The same way *My Keepon* basically is acquired as a toy. However, this toy can perform a lot of actions - from tilting, bouncing to dancing in a rhythm while catching the beats of music (Hornyak, 2011). It has two modes - Dance and Touch. As already mentioned, Dance mode reacts to music and dances to the rhythm and Touch mode reacts to touching, squeezing, tickling with subsequent emotions of curiosity, happiness, sleepiness, etc. This consumer version is developed by BeatBots and its statement is that all budget from the sales of *My Keepon* will go to developing further research into therapeutic robots.[9]

Paro

Another successfully realized project of building a therapeutic robot ended up with the creation of *Paro* - baby seal robot with the cute interface, multi functionality and imitated voice of real baby seal (Figures 9 and 10). This robot is mainly used in therapy with elderly people suffering from dementia and widely used not only in Japan where it was created but also in countries such as the USA, Germany, Denmark and Sweden. *Paro* was publicly introduced in 2001 and immediately gained a huge popularity, it also won a few competitions in the sphere of robotics. It

[9] More information about Keepon can be found here https://www.menkind.co.uk/my-keepon-interactive-dancing-robot

was developed by Japan's National Institute of Advanced Industrial Science and Technology by the engineer Takanori Shibata.[10]

As such, *Paro* replaces ordinary pets and somehow acts as a different version of pet therapy. The difference is that this pet does not need the actual care, thus it is very useful and beneficial in therapy, especially with dementia patients. *Paro* has tactile sensors and responds to touch and stroking, sound, light, heat. It can open and close its eyes, move its head and recognize its name. With light sensors it differentiates light from dark, it remembers if someone beats it and tries to avoid to repeat the action for which it was beaten, also it responds to voice direction.[11] Basically, *Paro* has multiple responses and sensors which provide a productive outcome of interaction with it.

Figure 9: Paro
Source: https://robots.ieee.org/robots/paro/

In fact, it can be used in various health care facilitates along with actual animals used in therapy, like dogs and birds and because of its excellent interface, the borders of real and non-real in this mix of animals becomes more obscure. It is mentioned that because of this realistic interface many patients don't even know that, in fact, they are interacting with the machine (Johnston,

[10] More information can be found here http://edition.cnn.com/2003/TECH/ptech/11/20/comdex.bestof/index.html

[11] For more information see the official website http://www.parorobots.com

2015). In some cases specialists of those facilities prefer not to tell them about it, maybe because it can be unnecessary knowledge for them and anyway they might forget about it soon. Also, a therapist in one of the articles about *Paro* states “it works better with people with dementia because if the residents are aware that it’s not real, we find that sometimes they don’t engage with it as much” (Johnston, 2015). However, this prompts to think about the ethical aspect of using such robots in therapy. If the patient is unaware about interacting with a robot, but the result is satisfying, does that mean that it is justified to keep the truth from patients? It seems that there is an upfront question of prioritizing the result to the process. In this way of thinking seems there is no sense to tell people about the real embodiment of the animal they take care of as a pet or even tell autistic children that they interact with a robot, if none of them will understand anyway what is the talk about? Should these health care facilities and researchers consider ethical aspects of conducting their research more than trying to reach to positive results? Also, from another standpoint, would these robots could be successfully tested if they would not be out in the research with two most vulnerable groups: children and elderly? Why only these groups need to have therapeutic help? Why not to test them in another appropriate settings, as well with people with another psychological or clinical impairments? Sherry Turkle questions this in her last book asking if people started to think about elderly people as those who do not need a care from people anymore. While there are lot of assumptions about not enough human resources for such kind of difficult tasks, as taking care of dementia patients, Turkle still thinks that as contrary to this, dementia patients specifically need more care from humans (Turkle, 2011, p. 108). According to her these patients need to be surrounded with human care more in order to keep the interaction alive and feel empathy which in case of robots is a great limitation. She thinks that this will help them more than any kind of unresponsive mechanical device.

The difference between real animals and *Paro* in therapy is huge. The same article mentioned above discusses all the problems facing real animals, like transmitting diseases, acting unpredictably and just simply was not being able to stay with patients all the time. It should be mentioned how easily *Paro* solves all these issues by just being easy and simple to use (Johnston, 2015).

Why is this robot designed as a baby seal? The answer is very ambiguous but as it is stated in one of the articles, it can fulfill the fantasy of interacting with an animal with whom in reality such kind of interaction would not be clearly possible. “Interactions between *Paro* and humans are clearly intended to mimic not actual interactions with a seal, but rather a common human fantasy about what interacting with a baby seal would be like” (Calo, et. al, 2012, p. 21). Another reason why *Paro* is actually not the exact imitation of a baby seal is that if it would be very well imitated then patients would notice the difference of behavior from the real seal and it could detach them from the robot. Thus, being in between the familiar animal but also not quite imitating it, gives patients the possibility to project their imagination of how interacting with them could be (Calo, et. al, 2012, p. 21). *Paro* is like a combination of baby seal and teddy bear. It is very cute, fluffy and light but unlike the fluffy toys it can also respond and interact. *Paro* calms down patients, takes stress and increases social interaction between them. As it is stated in one of the sources “building on initiatives with animals, the use of e.g. the robotic seal *Paro* has been applied with interesting results in the fields 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” (Strandbech, 2018, p. 16). However, one of the studies responds critically to this ability of not being able to interact with dementia patients verbally (Jung et al., 2017).

Figure 10: Paro

Source: https://robots.ieee.org/robots/paro/

The same study highlights also the importance of a touch and tactile interaction with *Paro*. For dementia patients touch is a necessary factor, especially considering that *Paro* is a pet robot. This could be especially relevant to *Paro* also because of its fur, which attracts to touch and a hug (Jung et al., 2017, p. 3). However, *Paro* can react to touch in a limited way. It can differentiate positive and negative touch only and is not able to understand variations of positive touch. This, in authors opinion, limits the interactiveness of Paro with dementia patients (Jung et al., 2017). Fro more successful result and to make *Paro* more intelligent, authors suggest to implement other tactile responses, like breathing or heartbeat. They think if *Paro* can react using those sensors then the interaction would be more engaging. They also think that "the robot's response modalities and its appearance should match the needs of to the target group" (Jung et al., 2017, p. 1). Interestingly, this research states that the focus is not on *Paro* and the need to understand its effectiveness but to observe how dementia patients can positively interact with animal like robots in general. (Jung et al., 2017, p. 3)

Another research carried by Šabanović et al. shows the results of *Paro*'s clinical trial in the context of Multi-Sensory Behavioral Therapy (MSBT), which is a method to control visual, auditory, olfactory, tactile sensory systems. (Šabanović et al., 2013, p. 1). The study tries to analyze how strongly participants will be engaged with *Paro* and which effect it will have on them. For this reason, seven participants with physical and cognitive impairments from a senior living community in Bloomington, IN were put in seven week study with *Paro*. After the trial Šabanović et al. concluded that *Paro* has effective impact on elderly people by increasing their attention and engagement, especially with other people. Thus *Paro*'s usefulness is seen in acting as mediator in connecting dementia patients with other people around. Šabanović et al. suggests that not only *Paro* but generally Socially Assistive Robots can help to increase the activity level of elderly people with dementia.

Turkle mentions about *Paro* in her book referring to roboticists who tend to find *Paro* and other companion robots useful for elderly because of the lack of human resources (Turkle, 2011, p. 24). It seems that these robots are created in order to help the staff and fulfill vacant positions in health care industry. Turtle is suspicious of *Paro*'s positive result and her claims is that *Paro* and other kind of pet robots, designed for elderly people, raise some kind of an addiction from them (Turkle, 2011, p. 104). She even compares children and elderly people stating that unlike children elderly people fall in love with these pet robots. The reasons are different: partly, because the robot pets never die, partly elderly people reimagine and recreate their life as parents (Turkle, 2011, p. 105). In any case Turkle thinks that the nursing homes should be careful in implementing pet robots in such an increasing way. She also thinks that dementia patients would prefer human companions more than robots if they would have enough visitors in their life (Turkle, 2010, p. 219). This argument raises contradicting responses. While from one side Turkle's approach is understandable, because she is worried about the huge and overpassing technological impact we are facing now and which makes us co-dependent from this technology in such an increased way that it is difficult already to imagine our life without our phones and screens. From another point of view, especially in this cases of having conversations with care robots, seems too much exaggerated argument to refer only to the lack of human companions. In my view, people always find interesting ways to express their thoughts and feelings, also interesting places to implement them. We can write our thoughts, we can talk with ourselves, we can talk with our pets, with plants. Sometimes, we can talk with complete strangers telling them our life stories because it is easier to interact with people whom you don't know than with familiar ones. In this scope talking with non-human objects is not an exclusion either. Maybe non-familiarity of the object can bring more trustful interaction than familiar one? Also, in many cases we don't need any response, we just need to get rid of our thoughts and emotions without an expectation of any response. Thus Turkle's arguments that robots in care industry can't really care and respond in terms of expressing any feelings or having empathy, does not entirely assuring. The other question can be why then choose robots over any other object? If the need is only to talk with something, then it can be easily replaced with ordinary objects in our life. Turkle responses to this with an argument that because of not understanding the human robot can’t respond and thus will keep the interaction in the present, which I guess in case of many patients is a good place to be focused on (Turkle, 2011, p. 202).

The same approach of testing and reporting on some specific robots can be observed in a research article from five authors of various universities and aged care services in Australia and Singapore (Birks et al., 2016). The article is a small experiment and report about the use of *Paro* seal robot in one of the aged care facilities in Australia. The goal is to understand how beneficial can be to work with *Paro* robot and what are the actual outcomes, limitations and problems of using therapeutic robot in age care facility. Thus after interaction of *Paro* with residents they carried interviews with therapists in order to find out responses, reactions and emotions of residents, also to observe the benefit of interaction with the robot. Their conclusion is that, in general, the therapeutic robot is not for everyone, although every interaction can be powerful and that the carers also should be adequately trained to make a productive interaction between a robot and a resident. Overall, all text is constructed on highlighted examples of reactions of residents after interaction with robot and analyzing these cases for concluding better outcome for residents.

Roball

Roball is a ball-shaped rolling robot, which is again designed for entertainment and for interaction with autistic children. The first prototype was built in 1998. Again, we should consider that this robot belongs to the toy robot category, as the actual similarity to a ball and easy movements help to take children’s attention easily. However, it is also easy to destroy, as children used to play with a ball by dropping it and *Roball* is not excluded from this desire. Thus it is built to be more resilient, carefully designed to resist such “violent” actions. The spherical shape helps it to pass all kinds of surfaces and to resist contamination. It is a robust mobile toy and can be interacted with through vocal messages (Michaud & Caron, 2000). Authors of this robot state that by creating it “the objective is to see how autonomous navigation by a toy may create interesting new interactions with children” *(*Michaud & Caron, 2000, p. 212). The authors objective to put it in interaction with autistic children specifically is connected with the idea that “a robot toy may help autistic children open up their surroundings, improve their imagination and try to break repetitive patterns” (Michaud & Caron, 2000, p. 219). Overall, *Roball* had been used in small experiments of interaction with children and put under the future work of prototyping better versions of it.

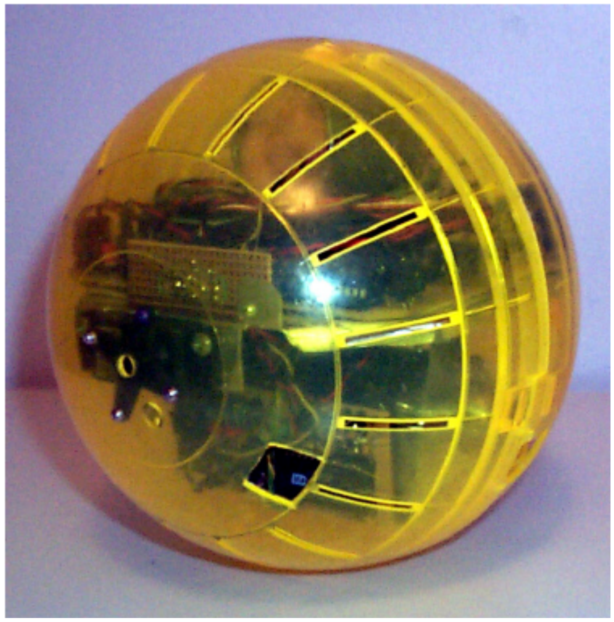

Figure 11: Roball
Source: https://www.researchgate.net/publication/225469697_Going_into_the_Wild_in_Child-Robot_Interaction_Studies_--_Issues_in_Social_Robotic_Development/figures?lo=1

Overall, the short introduction of these specific therapeutic robots and the appropriate examples of case studies and researches carried with them is just an effort to accumulate all necessary information in one space which will help to observe the positive or negative outcome of their performance in therapy. In all mentioned examples the authors mainly mention the positive impact of these robots. However, their research experiments with these robots are not sufficient yet in terms of participants numbers, duration of the experiment and the registered outcome. Also, in all these cases it is noticeable that these robots are mainly perceived as replacements for health care staff rather than interesting pieces to examine further. In sum, in scientific experiments the robots’ role is defined more passively as just therapeutic tools which will help to enhance the communication between humans and will replace human caregivers. In such a view there is no expectation of any kind of feedback and autonomous interaction with those robots. They are perceived as devices with specific, pre-scripted and regulated tasks.

Chapter 3

Agency and imitative patterns of therapeutic robots

3.1 Ability to perform

Therapeutic social robots are considered to be a small group in the framework of assistive robots. Some of these robots are used in therapy with elderly people suffering from dementia, some are used in treatment of children with autism. Some of these robots are tele-operated and others are autonomous. They can have human-like features (NAO), or zoomorphic (Paro), or non-anthropomorphic (Keepon). What unifies all of them is the notion of performativity in a wider sense of the term. They all perform in various settings and in various scenarios and this performativity concludes the result and outcome of their purpose. As Treva Pullen mentions, “robotic art is characterized by an inherent performativity that is important to consider when addressing its affective import through triggering sympathy and empathy in human spectators” (Pullen, 2017, p. 516). The same point of view about the performativity of robots can be found in Jean-Paul Laumond’s article about robotics, where he asserts that “robotics explores the relationship that a machine which moves, and whose motions are controlled by a computer, can have with the real world” (Laumond, 2016, p. 67).

While therapeutic robots are not necessarily created to be a part of robotic art, anyway, they constitute some of the characteristics of becoming an art piece and being used in various case studies. We perceive them in specific spaces they designed to be in, like health care facilities or schools, but they also perform in completely opposite settings close to the art context and reveal all the specifics of art work development. That is the intention of this research, to observe these robots’ functionality in robotic art environment and reveal aspects of interacting with them out of the initial context of their creation. As Eduardo Kac states “with its emphasis on behavior, it was only a matter of time for robotic art to expand its realm of possibilities into theatrical and performative events." (Kac, 1997) which this chapter will attempt to observe and analyze. Thus theater becomes the space of departure in a big journey of exploration of these robots' possibilities. Ghedini and Bergamasco propose that "robots, being surrogates of individuals, are inherently theatrical" referring also to the fact that the term *robot* derived from Karel Capek was first time used in theatrical setting (Ghedini and Bergamasco, 2010, p. 733).

Algorithms govern a given robot's behavior and are set to perform specific actions in the process of interaction with humans; it can be expressed in immediate verbal response or a body movement. One of the performative moments interesting for us in this thesis is the ability to dance. While dance is the point of departure here, it is also used as a method to study imitative patterns of these robots and the learning-teaching experience of humans. It is one of the performative paradigms which some therapeutic robots have and practice in entertainment, like *Keepon* or *NAO*. However, the main focus will be on *NAO* robot as it has already demonstrated and proved in many instances its successful implementation of dance practices.

Are these strategies to imitate human entities rooted in the agency of these robots or evoked through the process of interaction? This brings us to the main question of this study. Do humans learn through the interaction with robots? Do they get insight about their own capacities of behavior and actions? If yes, then what exactly they learn and how? This study aims to bring examples and theories to highlight how humans, who create machines that mimic human behaviors and skills, have a lot to learn from machines and through this learning process might develop self-awareness that leads to deeper insight or personal transformation. My argument is that robots are mirrors of humanity, mirrors through which humans have much to learn yet.

All these questions are discussed through the theories of Lucy Suchman, Evelyn Fox, case studies of dance performances with robots and academic scholarship on concepts of mimesis and imitation. Although dance is a vehicle and method here through which this study explores movements and gestures of robots, it is not the central point of discussion. Dance is one of the performative paradigms which some therapeutic robots have and practice in entertainment, like *Keepon* or *NAO* robots. However, the main focus is on *NAO* robot as it already demonstrated and proved in many instances its successful implementation of dance practices (Figure 12). With this example, this thesis tries to focus primarily on imitative motions of these robots while also addressing questions concerning the topics of agency and interaction space.

Figure 12: NAO robots dance Gangnam style
Source:https://www.pouted.com/are-you-stressed-watch-these-robots-dancing-gangnam-style/

Particular focus is given to one case study which combines all topics of performativity, imitation and the learning-teaching interaction paradigm between human and robot. As previously mentioned, the robot which is in the center of this example is *NAO* robot, created by Softbank robotics (previously Aldebaran Robotics) in 2008. *NAO* had been created for assistive purposes in therapy, education and also as an entertainer. It has an ability to dance and can be used in theatrical settings. There are several examples of such performances but discussion will go around one recent show which will visualize previously mentioned arguments.

In May 2018, in Stockholm, Swedish choreographer Robin Johnson premiered the show *The Most Human* with a *NAO* robot named Alex (Figure 13). *NAO* had been created for assistive purposes in therapy, education and also as an entertainer. It has an ability to dance and can be used in theatrical settings. There are several examples of such performances but *The Most Human* is more relevant in highlighting all important aspects of *NAO*'s interactive and imitative patterns. The show is a performance between a human and a robot during which they dance, recite poems and interact with the audience. The show tries to question how humans interact with robots and the change of attitude towards their existence as they are more and more integrated in our social life, in art and in research facilities. The show is still touring through Sweden, Germany and the Netherlands. Among the many aspects this performance raises, the interesting part for this study is connected with imitation and learning possibilities through the interaction of human and robot, when robots act as agents who do not mimic humans directly but are being mimicked by them. When the interaction takes the opposite direction and the robot becomes a teacher, from whom the choreographer learns how to move and adapt to the robot's movements.

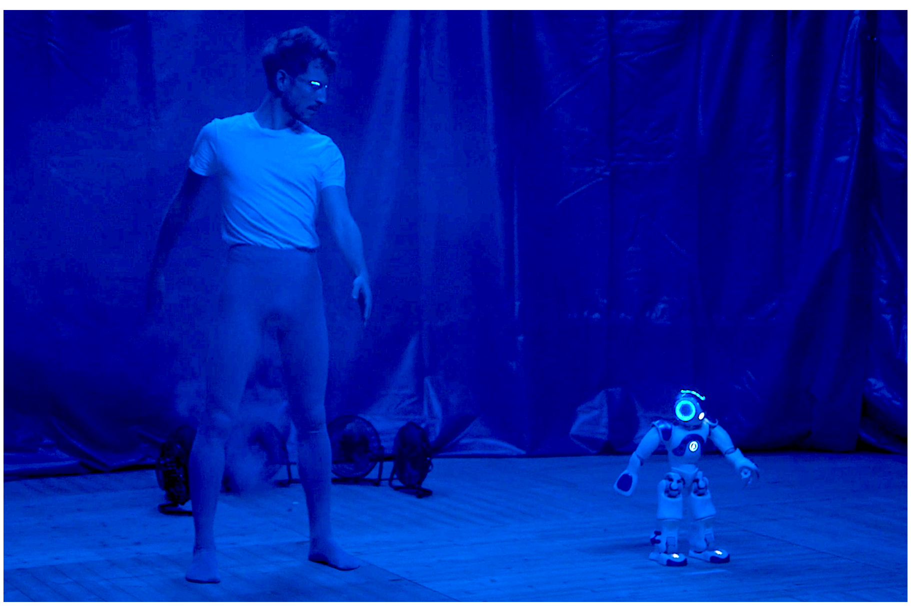

Figure 13: The Most Human show

Source: Screenshot from the video of show trailer at https://vimeo.com/276726094

When speaking of the dancing ability of therapeutic robots, it is also worth mentioning another robot, *Keepon*, which is used in the treatment of autistic children. *Keepon* can catch the beats of music and dance in rhythm. However, compared to *NAO*, *Keepon*'s movements are limited as this small, stationary robot can't actually move from its place, it is static and attached to a base, so that all movements are limited to tilting and bouncing, rotating around the base and leaning from side to side. As much as the dancing ability of *Keepon* plays a crucial role in the interaction with autistic children and registered productive results, in any case, in the scope of the discussion of the surrounding performativity and imitation, *Keepon* can't be the best example of tackling such questions. Another robot in this category is the *Blossom* robot - handcrafted soft social robot which is build with wool and wood in a traditional craft fashion[12] (Figure 14). It is also used in research with autistic children and its movements recall static dance movements like in the case of *Keepon*. As creators note it "allows lay-users to create gestures using a smartphone as a puppeteering interface" (Suguitan & Hoffman, 2019, p. 5). Thus this robot basically creates a unique environment, where the interactions can build it from scratch by designing its appearance and then script and control its movements. *Blossom* was already demonstrated its abilities in few case studies run in exhibitions, workshops with students and interaction with children in Children's Science Day (Suguitan & Hoffman, 2019, p. 13).

Figure 14: Blossom
Source: https://robot.cfp.co.ir/en/newsdetail/515

[12] For more information about the robot see http://guyhoffman.com/blossom-handcrafted-soft-social-robot/

However, in both cases we don’t observe the change of the space and transfer to theatrical stage as in case of *NAO*. Specifically, *The Most Human* performance is not the first one with the participation of a *NAO* robot. Earlier in 2013, choreographer Blanca Li in London’s Barbican premiered a show called ROBOT - a ballet where *NAO* robots and humans dance together (Figure 15). The show raises similar questions discussed above - the borders between humans and robots and how machines replicate humans. Also, in 2016 researchers adapted a two-character play called *Cornell*, which was depicting communication between a patient and healthcare robot (Figure 16). For the role of robot, the organizers again chose to work with a *NAO* robot (Jochum et al., 2016). The purpose of the performance and further study was to understand interactions between human and health care robots while the theatrical space could give the possibility to observe human-robot interaction. There are more examples where *NAO* robots were used in theatrical settings, shows, dance performances, but, mentioning all of them will not be so relevant for this research.

Figure 15: Dancer Gael Rougegrez of Blanca Li Dance Company performs with a NAO robot at Barbican Centre in London, on Feb 22, 2017
Image credit: Ian Gavan via Getty Images
Source: http://www.chinadaily.com.cn/business/2017-03/01/content_28391824.htm

The uniqueness of *NAO* is that it is used in multiple settings, from scientific research laboratories to educational settings, health care facilities until the theatrical stage. This adaptivity to so many different spaces is defined by its initial capabilities common to Adaptive Social Robots in HRI. Authors of a paper about adaptivity in HRI bring the list of adaptive capabilities of such robots. These are to "understand and show emotions, communication with high-level dialogue, learn/adapt according to user responses, establishing a social relationship, react according to different social situations and have varying social characteristics and role" (Ahmad, Mubin & Orlando, 2017, p. 1). Basically, *NAO* is designed to adapt to human input easily and demonstrates all these characteristics in research settings. While developing adaptability in social robots is not an easy task and not every robot can be successful example of this, in the case of *NAO* there are several case studies already done, which confirm its adaptivity and flexibility as a social robot.

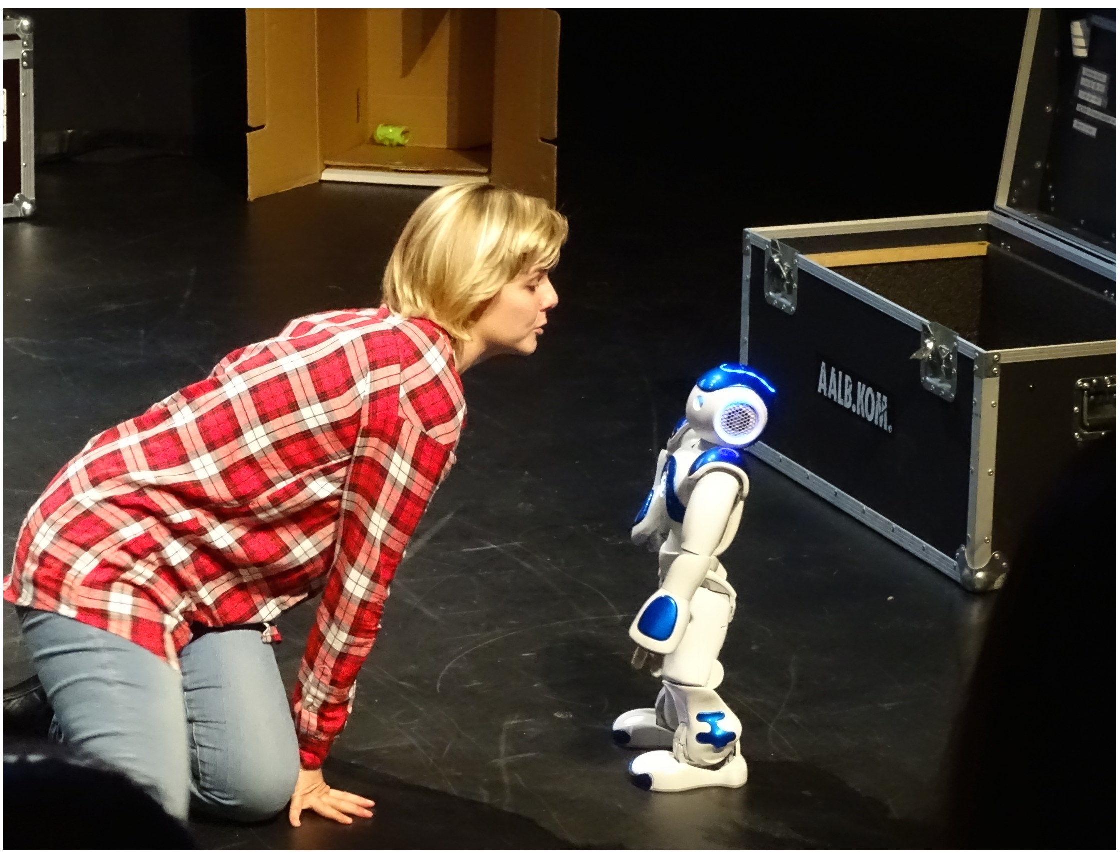

Figure 16: Cornell - two-character theatre play, 2016
Source: Screenshot from https://www.youtube.com/watch?v=KORmeKa4m1k&feature=youtu.be

3.2 Imitative patterns of robots

As in many cases, humanoid robots are designed with mimetic representation of humans, respectively their actions are also programmed to imitate the real actions of humans. Generally *NAO* robot's actions in education and entertainment are carefully scripted through the *Choregraphe* programming software.[13] The script defines all the possible movements, talks, questions-answers and other reactions. During the process of interaction and rehearsal with the robot the performer learns how to imitate possible limited or advanced movements of robot. In many cases *NAO* can't directly mimic the same gestures of performer but rather must create another version of these motions trying to follow also within the constraints of its material body. Here, without being able to get the actual imitated move from the robot, the performer tries to imitate back to the already modified movement of the robot. As a result we see that initial idea of having a machine following a human, we have a human following back to machine and redeveloping its choreography. Not only does the robot learns from the performer, but also the performer learns how to interact with the robot; and how to shape its movement in order to find the best synchronization. The way the robot moves is not similar to the way a human body can move. Because of these limitations of body flexibility, the movements of the dancer can also be changed. The robot automatically becomes co-choreographer of the performance. Moreover, here *NAO* is not only the co-choreographer, but also a "teacher" as instead of learning from human performer it teaches them how to move.

Similarly, in the video of the performance, a performer recounts that while they were rehearsing, he felt that the interaction with the robot is similar to unscripted interaction with a human partner (Figure 17). He adds that "sometimes it (the robot) feels programmed and sometimes it feels like it makes choices".[14] So it is not only predetermined instructions to the robot stating what it

[13] It is a special software designed and developed by Aldebaran Robotics which allows to script NAO robot's movements and interactive behavior

[14] For the documentation of rehearsals look here https://vimeo.com/293518652

should do and how it should follow the movements, but also, a very interesting collaboration between them when the dancer also learns how to behave, move and follow as they would with a human partner. The unpredictability of incidents with it somehow doubles this sensation: robot can get heated, stop working, break down and here as robotic art scholar Elizabeth Jochum mentions in her article "the improvisational skills of the human actor play a vital role in these instances" (Jochum et al, 2016, p. 261). Thus the robot gives the illusion of improvisation but the actual improvisation comes from the human counterpart who always tries to keep the natural flow of play under control.

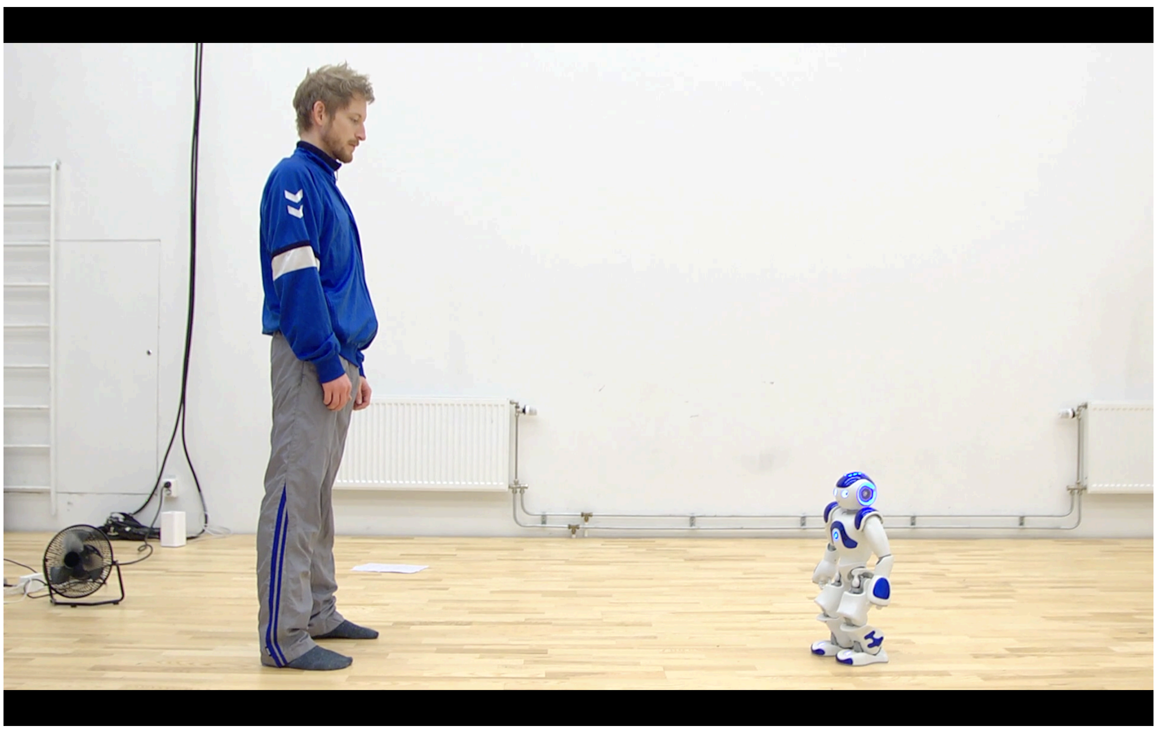

Figure 17: Rehearsal with NAO
Source: Screenshot from the video https://vimeo.com/293518652

This show is entitled *The Most Human* in reference to Brian Christian's book *The Most Human Human*, where the author discusses his experience as a part an experiment that replicated Turing Test in 2009. The Turing Test was developed by Alan Turing in the 1950s but was first time implemented in 1991 by Dr. Hugh Loebner who announced a $100,000 prize for those who could pass the test. The goal of the test is, through five-minute conversations with unidentified participants, to find out if they are machines or humans. If machine successfully imitates human and fools judges then it gets a prize. Initially Turing created this test as an imitation game between genders. Instead of machine in the 1950s it was a woman who would have imitate a man and trick the judge to accept her as a male.[15] Basically, the philosophy of the test, and thus the book as well, is to discuss what it means to be human and in which way, in this technologized world full of highly intelligent machines, is it actually possible to prove anyone's humanity. Johnson's desire to make such a show and name the show with a referential title is because he wants to move this discussion to the stage and show the productive collaboration between humans and machines.

Interestingly, the dancer thinks that he is the only human on the stage. However, it gets attached to its non-human counterpart and during the performance the borders of human and non-human for the dancer are also blurred. As Johnson states in the interview, in a few cases the dancer could just turn and ask Alex if he/she/it is all right without even realizing that he is basically talking to the machine.[16] In general, Johnson states that "this piece is more about Alex becoming a dancer rather than Ludvig (the dancer) imitating Alex".[17]

This ambiguity between real and non-real, machine and human, is visible during the show. In therapy, there are robots like *Paro*, who are considered by patients as a real baby seal. They don't think that it's a machine, they see it as a real living thing (Johnston, 2015). We can say the same of the *NAO* robot but discussing in the context of improvisation. It is obvious in the video, but Johnson in his interview also confirmed that the audience is completely unaware of to what degree *NAO*'s movements and responses are scripted.[18] Even though the audience doesn't know

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[15] For more information about Turing Test look here http://www.psych.utoronto.ca/users/reingold/courses/ai/turing.html

[16] From Skype interview with Robin Johnson on April 8, 2019.

[17] ibid

[18] ibid

how scripted *NAO*'s movements and responses are, in the meantime, it improvises as well following sensors towards bright lights and sounds. Johnson mentions that *NAO* can't see in the dark so it reacts to light. The it is light Alex can see more faces and can look around.[19] These actions are not scripted by the *Choreographe* program and surely reveal themselves during the performance. So the robot can focus its gaze on someone from the audience for a longer time making eye contact, which can give the impression of an intimate interaction. It can also move toward the direction where the majority of the audience is (Figure 18). Johnson mentions in the interview, "It seems like it stuck on some people, so some persons get a lot of eye contact while it is doing the monologue so it is kind of more powerful".[20] In such circumstances it is absolutely difficult to define which part can be deduced as pre-programmed and which is not. In fact, even if it could be understood as pre-programmed interaction, *NAO* leaves the audience with a strong sense of its improvisation and spontaneous interactivity. Suspension of disbelief plays a crucial role here, as the audience is ready to accept the actions of the robot as real and believable.

Authors of one article about puppets and engineering discuss the "binocular vision" of the audience. In this process of creating the illusion of being alive while also moving, robots "transfer" public to another dimension of accepting fiction as reality and prompting them to feel the same emotions towards robots as to humans. They state that "while a human actor never has to prove their "liveness" to a spectator, puppets and robots hover in a liminal space between the animate and the inanimate and must therefore work differently than human actors to provoke binocular vision" (Jochum and Murphey, 2014, p. 309). Certainly, this is somehow different in puppets, marionettes and robots, as in the case of robots there is no human actor behind to control them and the audience follows the independent actions of the robot which doubles the impression of binocular vision. Jochum and Murphey argue that "in both puppetry and robotics, expressive movement is an integral aspect of mimesis, influencing how deftly the illusion of life is created and sustained" (Jochum and Muphey, 2014, p. 311) and that binocular vision is sustained more based on that movement rather than on the visual design of robots.

[19] From Skype interview with Robin Johnson on April 8, 2019.

[20] ibid

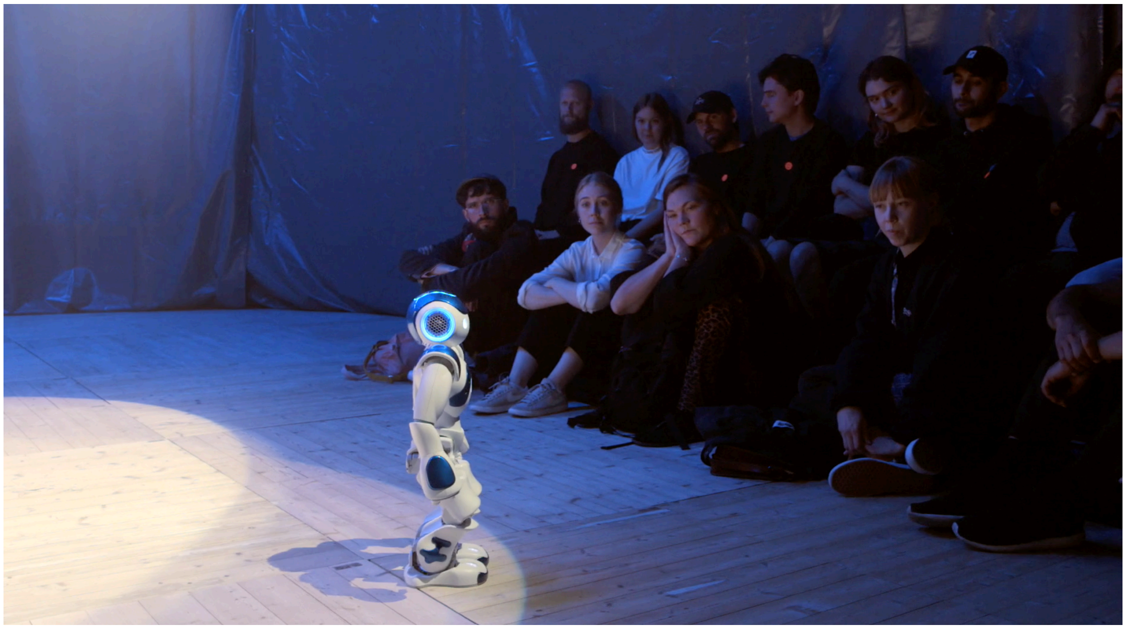

Figure18: NAO interacts with the audience during The Most Human show
Source: Screenshot from the video of show trailer at https://vimeo.com/276726094

While interviewing Johnson the discussion was focused on the gender specification of *NAO* and also the choice of the name - *Alex*. It's very usual not to be able to define the exact gender of robot and he also confirmed that the audience always have this issue of not being able to specify to which gender they should refer - he, she or it?. Thus the choice of such neutral name - *Alex* is partly connected with that. The intention of the show is not to discuss to which gender humans can classify robots but how "human" they can perceive robots to be. This comparison with humans is actually also present in the interface of *NAO*. It gets tired like humans. It gets heated in some parts of the joints and it can be damaged. In case of theatrical performances it can't be around theatrical lights but preferably only next to LED lights as it can get overheated very easily. It also needs some rest to cool down like humans. That is the reason that on the stage of this show there are many fans around so it can be cooled all the time. It also gets old and worn out like humans and It warns that it will go out of order and whether some part of the body overheated. As Johnson mentions "*Alex* is similar to us, it gives us some clues how do we work.

How *Alex* lays down or stands up is so strange, so weird and funny but we could also do that. It is another way of doing things. It kind of fills light how easy things are for us and how hard they are for robots".[21]

While in this show Johnson tries to understand what part the robot plays in this interaction, Lucy Suchman would try to understand what role the human is occupying here. Johnson likes that it is physical body and it can dictate its movements. It gives the feeling that you work with a human and because this robot also is not a program which should run, it can change its flow of interaction at any point.

While Johnson poses the question of human side of the robot, another performance realized in 2017 in Dance Lab at the University of Illinois, Urbana-Champaign by New York based choreographer Catie Cuan and assistant professor of mechanical engineering Amy LaViers opened up a new question about humans becoming more robot-like (Cuan, Pakrasi & LaViers, 2018, p. 20). To answer this question, participants were put in performative interaction with robots, including the *NAO* robot and were forced to play a mirror game with them. By mimicking and repeating the robot's actions the authors of the show try to understand how people perceive new technologies (Cuan, Pakrasi & LaViers, 2018, p. 21). Here we see the intended purpose to mimic the robot's actions and by this to take out the invisible wall between human and technology. The performance is called *Time to Compile* and was compared to *The Most Human* performance. The performance is not pre-scripted choreography between two participants, but pre-scripted actions of the robot whom human participant will follow through the whole performance. While the robot will surely act as a teacher and trainer in this interaction, the part of improvisation will be out of discussion as the robot's actions were carefully scripted before. So, this will be another level of collaboration between robot and human, a space where the robot will act as a leader of interaction.

[21] From Skype interview with Robin Johnson on April 8, 2019.

3.3 Script and improvisation

In this scope, it is interesting to compare two robots *NAO* and *Leonardo*. In the process we will see that the latter has learning paths and mechanisms. Researchers conduct thorough actions, training Leonardo to recognize objects and differentiate their negative or positive aspects. This process of "writing" the script is a little bit different from what we observe in the case of *NAO*, as *Leonardo*'s learning process continues through the interaction; also and not entirely pre-scripted as in the case of *NAO*. After first interaction with a human *Paro* already learns how to react the second time and what to expect from the person. It memorizes how the person approaches *Paro*. This artificial memory integrated in robots plays a crucial role not only in casual interaction with them but also in therapy as the person might simply forget his/her actions and robots memorize all possible scenarios of interaction with them. This is again the case and situation to discuss the adaptability of social robots and emphasize the patterns of productive interaction between a human and a robot. It may seem in this specific case it's appropriate to talk about memory based adaptation "We believe that researchers need to find more sophisticated means to implement robots that modify their actions based on past interactions of the user" (Ahmad, Mubin & Orlando, 2017, p. 19) and that *Paro* at some point achieved that goal of creating social engagement with humans.

Besides just memorizing and helping elderly people to cope with dementia other therapeutic robots like *Kaspar,* for example, help to improve social interactions between autistic children simply by the reaction to specific actions of humans. For example, in the case of children behaving violently with it *Kaspar* can react in a specific way like saying "ouch" and simply teaching the child that the action can have a negative impact on another person and it is better to avoid doing that (Webster, 2018). Again, we see how by regulating particular actions and imitating human gestures and speech can help to develop the social skills of autistic children. As *Kaspar* works on WoZ mode in these cases it really acts as a mirror for these children helping them to clearly see all the consequences of their behavior in a social environment.

In the process of achieving mimetic representation and liveliness of robotic bodies one of the modes of imitation can be seen not only in the fact of how human-like a robot is but more whether it has eyes or not. Locating eyes even on non human like robots can force the human to find points of interaction with the robot. In everyday communication the need to look into each others' eyes is projected here in the need to look to the robot's eyes and make eye contact. The exchange of gaze and finding the point of connection constitutes one of the first stages of successful human-robot interaction. Pullen mentions a few robotic artists who accentuate this a lot in their works and consider it an important aspect in building their robots. For example, she mentions Steve Daniel's work Whimsy, where the artist "mounts eyes atop the machine because "(they) are strong triggers of emotional response for humans" (Pullen, 2017, p. 515). This aesthetic feature is one of the ways in which the artist can humanize the machine. This helps the audience to be more engaged with the robot and sustain the imagination that the robot will follow and return the gaze. The same question was discussed with Robin Johnson during "The most human" performance where he was talking about the gaze of *NAO* robot which could find and focus on one of the audience's faces during the show thus giving the idea of close engagement between them. Johnson mentioned that after the show people were sharing their emotional state during the gaze exchange being absolutely sure that the robot was actually talking and communicating specifically with them[22].

Robot-human interaction based more on improvisation can be observed by another example. *The Dynamic Still* was an improvisational dance with a robot realized in 2017 in Aalborg Theater in Denmark. The invited dancers generated 7-10 minute improvisational dance performances with a mobile robot. The goal of the performance was to understand how to conduct interesting interaction between robot and human and "using dance improvisation as a frame, we could study how dancers with different backgrounds and training approach moving with a robot, and observe what kind of interaction patterns these elicited" (Jochum & Derks, 2019, p. 2). Connected with the risks of being in close proximity to humans, Jochum and Derks state that "when robots do

[22] From Skype interview with Robin Johnson on April 8, 2019.

perform autonomously, they rarely appear in close proximity with live performers, as the risks to the human performer are too great" (Jochum & Derks, 2019, p. 2). But in case of *NAO* this risk is less as this robot was initially designed and created as an assistive robot in therapy, education and entertainment. Thus risk factors with it are fewer and maybe this is also one of the reasons that we see it in such a close proximity of interaction with the dancer in Johnson's show.

In the same article Jochum and Derks continue to observe "for the robot and human performer, the process was reciprocal only insofar as the performer generates new sequences based on the robot's behavior, but the robot could not generate any behavior without some input" (Jochum & Derks, 2019, p. 4). Which means that humans can follow and adapt to the robot but the robot can't generate any performance on its own, thus maybe the improvisational part doesn't work as it should? Basically it is not the robot who improvises but the human: during the process of following the robot the human dancer sometimes changes his movements, which brings to another kind of improvisation. Jochum also talks about this, she also mentioned that "stillness also because an important action—alternating moments of stillness created poetic moments where even the performer became momentarily uncertain about who was following and leading" (Jochum & Derks, 2019, p. 7). It is a good example to show that for the performer sometimes it is confusing who is leading whom and from the improvisational perspective it is also obvious that the human performer is not necessarily always a leader.

3.4 Agency of therapeutic robots

While there are so many discussions around agency of robots in the scope of the human-machine relationship, Lucy Suchman states that agency is not initially implemented but arises more as a result of the interactions, and the adjustments of human perception of machine agency and shows how human agency shapes machine agency. She asserts that "agency on this view is rather an effect or outcome, generated through specific configurations of human and nonhuman entities" (Suchman, 2007, p. 261). In this scope, what interests Suchman more is to understand not only machine agency but that of humans as well. Thus she talks about the necessity to perceive the difference between machine-human relationships differently and she emphasizes how these agencies become incorporated during the process of their implementation (Suchman, 2007, p. 267). Here it is important to remember that the learning mechanisms of robots can not only be programmed but are also integrated during the process. Does this mean that if we use robots in theater then we can find ways if raising emphatic behavior in them? So we can teach them to be responsible to their environment and interact with others based on the notions of collaboration?

For Simon Penny “agency is a key word in any conversation about behaving systems and performative technologies” (Penny, 2017, p. 355). He thinks that it’s not important with which kind of agency we deal: biological or technological, the most important thing is that it has the capacity to take actions and make decisions. Here he refers to computer system but we can also easily refer to robotics, also with its complex way of interaction with human agents.

In the scope of this research agency is an important place to depart in order to understand the configurations of robots, their function, the need of implementing mimetic representation and the desire to bring machines and humans closer together through those imitative practices. By creating human-like or animal like robots, researchers try to make them more adaptable for humans. It’s easier to interact with a machine who acts like a mirror to human than with one without any familiar features. It is not only a purely mimetic representation of the appearance but also imitation of human movements and actions. This is more relevant to social robotics and also relevant to robots used in therapy - be that with elderly people who have dementia or with children with autism.

Here the question of imitation has various notations. For example, Suchman even questions machines’ mimicking ability asking if “one day they might successfully mimic the capacity of autonomous human subject” (Suchman, 2007, p. 285). However, we can even ask if in reality we want or need that complete, absolute imitation to us? Why do we want to create machines who will replicate us without, in the meantime, being organic? Is it not better instead of forcing any kind of imitation, to give autonomous privilege, where the possibility of mutual share of knowledge and fulfillment would be much more productive? Don't we need also to learn? What, if anything, could machines teach us? We created these machines to use their possibilities to avoid limitations of humans (like death, physical and emotional exhaustion, etc) but in the meantime we want that they replicate humans. Suchman thinks that through machines humans try to understand themselves. They are tools for reproducing human's behaviors and they do not have the capacity to mimic. In this context can we state that humans just really need to see themselves from the exterior and robots are very good example for that? Through their mimicking ability, they convey the ways of perceiving human nature; and humans can learn a lot about themselves just by interacting with robots.

Alan Blackwell, who wrote a review on Suchman's research states about her findings "Her overall concern remains the question of how humans are described and imagined, in the light of machines that imitate humans and in the work of researchers who design such machines" (Blackwell, 2006, p.138). So by giving machines the ability to mimic human behavior, designers also impart their understanding of what it means to be human. Thus, the result is a projection of the human perspective onto machines and a desire to know how humans are using machines' mimicking action. Do we need mirrors always to see us from the outside? French psychoanalyst Jacques Lacan's research on mirror's stage centers around the discussion of how biological species need to be in close proximity of their own while passing through maturation or transformation as well as when and how humans learn about their existence through the process of mirror stage as an identification phase of looking themselves from externally. While monkeys can go through the identification and realization process earlier, human infants recognize themselves only starting from the age of six months. Lacan calls it a "transformation of the subject" (Lacan, 1949, p. 503) and observes mirror stage as a relation between organism and reality (Lacan, 1949, p. 505).

Treva Pullen in her article mentions about another case, the case when robots look themselves in the mirror. He talks about Grey Walter's experiment with robotic tortoises when he watched how robots observed themselves in the mirror "the robots flickered, jiggled and twitched like a "clumsy Narcissus", according to Walter, as he argued that the tortoises had displayed some evidence of being self-aware". (Pullen, 2017, p. 517). If we agree that humanoid robots are human replicas with imitative capacities designed with the very intention of mimicking human appearance and action, then we understand them as reflections and give them the power to be people's mirror copies. Humans' desire to find themselves is always reflected in their environment finds its expression in the desire to see that reflection in robots also. Moreover, empowering robots with artificial intelligence, again, humans transfer and replicate human abilities thus mirroring themselves in the actual machines. There is even a term in psychology called Pygmalionism. It is when the person is involved with the object of its creation and originally refers to Greek mythology and the story of king Pygmalion who fell in love with Galatea - the statue he created.

3.5 Embodiment of therapeutic robots

Christian Kroos mentions that "From different embodiments follow different behaviors and different ways of interaction with humans: An anthropomorphic robot is expected to act human-like and any deviation is quickly noticed" (Kroos, 2016, p. 23). Thus therapeutic robots which embody the notion of being created for assistive purposes and should have carry only those embodied functions are perceived as completely different embodiments when it comes to look at them on a theatrical stage. The behavior change also changes their embodied entities.

Kroos also states that the complexity of embodiments does not necessarily mean that the interaction with it should also be the same, be that simple or complex embodiment (Kroos, 2016, p. 23) and this can be observable, for example, with therapeutic robots. They can have simple and minimal appearance but what their performance is more complex. For example, Keepon or

Kaspar robots that have very simplified minimalistic appearance and generally researched in interaction with autistic children. What they perform with them is quite difficult in terms of the move to establish some kind of a contact, communication and interaction between children themselves or a children with an adult. In the meantime, Keepon has the simplest and most minimalistic appearance among all, which surprisingly works as opposite considering what it performs with them. Kroos also brings the same argument stating that "plain robotic structures can have a strong emotional impact on the audience, elicit empathy and force us to re-evaluate our relations to machines" (Kroos, 2016, p. 24).

Louis-Philippe Demers uses the word *machine* instead of *robot* to describe the issues of embodiment. He defines "the machine performer as embodied and intentional (whether or not is apparent, whether or not real) and set to perform in a specific spatio-temporal situation (e.g. a play, a social or cultural context) (Demers, 2016, p. 274). That's the reason he broadens the term and tries to implement a wider perspective. He wants to find an equal ground between embodiment of human and machine performer and thinks that in this process "the machine performer needs the co-presence of the audience to be fully realized" (Demers, 2016, p. 276).

3.6 Learning mechanisms of robots

As the study poses the question about learning from machines or teaching them, it is important to consider all instances of such argument. For example, how machines are being redeveloped through the experimental processes of interaction for transforming to more intelligent entities. In this scope it is worth mentioning a quite recent article about machine behavior written by a group of professionals in this field including Iyad Rahwan, Manuel Cebrian, Nick Obradovich, Cynthia Breazeal, where they discuss all layers of understanding the machine behavior. Interestingly, they observe machine behavior parallel in discussion of animal and human behavior. They authors insist that machine behavior similar to animal or human behavior should be explored in the context of its action "machine behavior similarly cannot be fully understood without the integrated study of algorithms and the social environments in which algorithms operate" (Rahwan, et. al, 2019, p. 477). All the comparisons between these various worlds give them the insight to conclude that machines can behave, learn and adapt to multiple environments in a way animals and humans do. Moreover, in their arguments they insist that "similar to animals, machines may exhibit "social learning". Such social learning does not need be limited to machines learning from machines, but we may expect machines to learn from humans, and vice versa for humans to learn from the behavior of machines" (Rahwan, et. al, 2019, p. 482).

In this scope as a comparison point it is interesting to observe also the learning mechanisms of humans also. They teach children to play with toys giving them dolls and all kinds of anthropomorphic toys since their birth to educate them about the appearance and behavior of humans. By playing with their dolls and puppets children do their first steps into communication with others and it helps to establish social interaction with another humans. Children give names to their dolls, they animate them in their imaginary plays writing various scenarios of life like, interactive and performative interactions with them. However, dolls teach children how to be able to take care of another creatures. Empathy is not only biological but also educational. It can be in the core of our consciousness but it needs to be stimulated, nurtured and developed. Robots, as a smooth transformation from puppets and dolls, basically realize the next step of this interaction shifting from mere passive objects to responsive "subjects". While the responses are not necessarily connected with the conscious levels of understanding the core concept of their verbal articulations or behaviors, anyway, on a basic level they demonstrate some kind of a collaboration and here we encounter with the performance.

In all these discussions about robots in art context, their learning mechanisms and imitative patterns the most important aspect is that they augment humans thoughts and understandings about themselves projecting their imaginary understandings about human existence in a mirror-like anthropomorphic or non-anthropomorphic forms.

3.7 Theater as a new space

In the case of therapeutic robots acting as entertainers, it is very important to also consider the shift of the space. What happens when they move from a studio or lab to the stage? There can be lot of unpredictable movements as the space is also unfamiliar to the robot as it is not programmed to know how to move in specific conditions, for example change of light, the surface of the flooring as in case of *NAO* who always struggles to move fast and often gets overheated. All these conditions impact the performance in meaningful ways but they can't be fully anticipated before testing in new spaces. Thus the space is important for such shows. Johnson talks about the slow movements of *NAO* robot. It walks very slow thus it is beneficial that the stages for this show were always very small, and the borders between performers and audience are not so visible. In terms of the space, it is important to also consider the quality of the floors. As *NAO* always struggles to move fast and often gets over-heated. In Alex's case, he also had some problem with his right leg; the best surface for these movements and dance is the wooden floor.[23]

It will be interesting to find out if researchers and creators of such robots as *NAO* had done thorough research to find out how their behavior, interface and functionality changes in the process of shifting these spaces, especially from labs to theatrical settings. As *NAO*'s main function is to serve in therapy and education, it seems that being engaged in such active movements as dance and sport can wear out the robot faster and it can be broken in crucial moments like during the performance. Such factors should be considered while creating the robots which have an ability to function as dancers.

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[23] From Skype interview with Robin Johnson on April 8, 2019.

The need to observe therapeutic robots on theatrical setting has its reasons. As authors of the article *Using Theatre to Study Interaction with Care Robots* argue, there is the importance of having initial research with these robots in a pre-scripted environment before putting them into real interaction with patients. They state that "co-creation of theatre between dramatists and robot researchers can assist the acceptance of social robots by addressing user concerns in specific application scenarios" (Jochum et al., 2016, p. 467). While choosing specifically theatrical stage for realizing HRI research with care robots, the authors show that their results "suggest that theatre audiences could be influenced positively towards accepting socially assistive robots during hospitalization, rehabilitation periods, or potentially as companions". (Jochum et al., 2016, p. 467). Thus, theatre as a space of play and actual interaction can be an experimental stage in understanding the behavior patterns of therapeutic robots. It is not only useful in integration with one or two human partners but also putting under the observation from the bigger audience. What Jochum and her colleagues realized in this research constitutes the multiple possibilities of testing the robot's ability to behave in another setting, completely different from the labs where it is created and not yet arrived to the space of health care facilities where it is intended to be. Theater becomes an intermediate preparatory space, where the possibility of movement and integration of these robots might be realized in a smoother fashion. The scripts can be changed and adapted and choreography can be explored. Also, the narration and scripted behavior gives the possibility to carry the research without interrupting and disturbing patients in health care facilities.

To answer the question if these robots are scripted or improvised, one can conclude that they are scripted to give an impression of improvisation. Usually, the audience is not going deep enough to understand how the algorithms and pre-choreography of the robot has been set up before the performance. Thus, during the performance the smooth and synchronized movements of the robots give a good overall impression and illusion that it's just an improvisation or very productive imitation of the human's movements. For therapeutic purposes health care professionals sometimes deliberately don't tell patients that they are dealing with robots. This is a case of *Paro*, for example. Patients suffering from severe cases of dementia are absolutely unaware that the baby seal is not real. Professionals of this sphere find it unnecessary and unproductive to burden patients with questions of real and non-real, when in the meantime after a few hours, anyway, they might forget. Also, the illusion that they are dealing with living pets gives a better result than if they would learn about its artificiality. This notion somehow borders the case of *NAO* performing on the stage and spreading the illusion of its synchronized and improvised nature of performance. In many cases, only choreographers and dancers know in reality how scripted is each and every step, movement and gesture. In the case of deviating from the script, the audience will not notice it, as they are not familiar with the play. Thus, audiences do not perceive any difference between scripted and improvised performances. So we can conclude that the overall impression can be very inconclusive - what seems improvised can be scripted in detail, what seems scripted can be improvised and only professionally of the show and the performance can blur the borders of understanding the line between script and improvisation.

3.8 Uncanny Valley

The story of Pygmalion and this line of recreation, imitation and prototyping of new movable objects has been visualized and realized in the director of robotics at Osaka University Hiroshigo Ishiguro's *Geminoid HI-1* (*gemini* from the Greek word meaning *twin*) created in 2006. The robot is a mimetic representation of the author, a kind of a self-portrait, the sculpture which can be moved, controlled and be communicated with. It even has the author's biological components, like hair. Ishiguro thinks that *Geminoids* are useful for exploring individuals and for understanding the very nature of their individuality. He claims that "Geminoids allow us to examine personal aspects, such as presence or personality traits, tracing their origins and implementing them into robots" (Ogawa and Ishiguro, 2016, p. 328)

However, the *Geminoid HI-1 is* tele-operated and controlled on WoZ mode, which means that while being a copy of the author and being active sometimes, the actual movable scenario is entirely dependent on the authors will. Without Ishiguro's "command" and control the sculpture remains as just a sculpture, no matter of its internal initial capacity to move or to produce sounds (Figure 19). So, how can we understand this need to move unmovable objects but also make them to behave semi-autonomously and be dependent on our desire and will? What is the role of creator, in this case of an artist who gives a new life to the sculpted object or tries to move an artificial entity with a force of creativity and control? Maybe for those cases Penny refers to Ezra Pound's words calling artists as "an antennae of the race" and brings example of Stelarc as one of them who was a creator/carrier/controller of such robots in many of his performances? (Penny, 2016, p. 50).

Ishiguro's another robot known as *Geminoid F.* is a first robot actress to play in android-human theater piece *Sayonara* (which means *good-bye* in Japanese). This was a collaboration between Ishiguro and Japan's leading playwrights and directors Oriza Hirata which started in 2008. Hirata follows the *Contemporary Colloquial Theatre Theory (CCTT)* which is designed for human actors but applicable for humanoid robots (Figure 20). It "advocates precise, rather than ambiguous, instructions for actors" and creates the stage as a suitable space for developing such kind of android robots. (Ogawa and Ishiguro, 2016, p. 334).

Figure 19: Hiroshi Ishiguro and Geminoid HI-1

Source: https://www.vice.com/en_us/article/jp5n73/the-man-building-robots-to-better-understand-humans

During the duration of the performance of *Sayonara,* the uncanniness of the scene is that a human being and a robot look similarly alive. The plot of the play is about the caretaker robot which helps the young girl to fight her illness and recites poems for her. While the discussion here centers on the urgency of recreation and activation of those robots, it should be noted that even here in this play we encounter a therapeutic robot, a robot which can help and support a human. This kind of interaction between a robot and a human explicitly visualizes the questions raised in this thesis, the need to consider therapeutic robots as a separate category within robotics while also considering their relation to the scope of art. Ishiguro adds that the idea to create a human-robot theater project is not to shock people but "to show the presence of robots and how they interact with humans on stage, to provoke the audience to reflect about what it means to be human" (Ogawa and Ishiguro, 2016, p. 335).

Figure 20: Geminoid F in Sayonara play

Source:https://www.theverge.com/2013/2/8/3968130/the-actors-are-robots-but-the-emotion-is-human

The uncanniness of the *Geminoid* robots raises issues concerning representation and the uncanny. Japanese roboticist Masahiro Mori's *Uncanny Valley* essay, written and published in 1970 made crucial changes in uncovering the psychological patterns of interaction with robots (Mori, 1970). According to Mori, industrial robots do not attract humans and do not raise the sensation of uncanniness simply by avoiding resemblance to humans, while human looking robots capture our attention and affection until the point of understanding their artificiality and eeriness. When visuality attracts but direct interaction points out its artificiality people get shocked from the ambiguous sensation towards the object and from the realization of the fact that it is not alive. That is the path of the uncanny valley, the psychological state when affection and eeriness exploit in mixed and contradicting emotions towards robots or any artificial device resembling humans or their body, like prosthetic hands discussed in Mori's essay.

While Mori's concept of uncanniness applies only to human-like robots, Elizabeth Jochum and Ken Goldberg in their article discuss the uncanniness which can be experienced through non-anthropomorphic robots as well. They state "in our discussion we discern two types of uncanny: the representational uncanny is triggered by objects that look lifelike while the experiential uncanny occurs when objects behave in responsive or ways that signal awareness" (Jochum & Goldberg, 2016, p. 148). Bringing examples of Ken Goldberg's *Telegarden* (1995-2004), Patrick Tresset's *Six Robots named Paul* (2012) and Louis-Philippe Demers's *The Blind Robot* (2012), the authors show how representational uncanniness can be shifted to experiential and how this shift can influence people, changing their position from pure spectators to active participants. Moreover, the article demonstrates how uncanniness now centered in-between real and virtual and how "the contemporary uncanny can be said to hinge on heightened experiences that provoke ambiguity about the authenticity of experience and the "aliveness" of an artifact" (Jochum & Goldberg, 2016, p. 151).

The feeling of uncanniness I experienced witnessing director Stefan Kaegi's (Rimini Protokoll) *The Uncanny Valley* performance in May, 2019 in Utrecht, Netherlands. (Figure 21 and 22). The performance was part of a *Performing Robots Conference* (May 23-25, 2019) organized by

Transmission in Motion (Utrecht University) and SPRING Performing Arts Festival.[24] This 3-days conference was not only designed for panel presentations and keynote speeches but also had been coordinated with amazing robot-performances of internationally recognized theatre directors.

The Uncanny Valley performance was an hour-long play with a humanoid robot, a direct and a complete copy of German writer Thomas Melle. [25] Here again the robot belongs to the *Geminoid* type - direct copy of the person which reflects not only appearance but also all emotions, gestures and acts as an original. As Ishiguro states in his case of prototyping himself in such circumstances "a robot appears not to resemble a living person, but also to be a copy of the original person" (Ogawa and Ishiguro, 2016, p. 329). This is the case when imagination and design does not have any role or power and the skillfulness of molding becomes more important factor. During the performance, the robot acts as an original human being diminishing the borders of understanding if it is the writer by himself or a simulacrum, as all movements, gestures, gaze and mimicry were very well scripted. Plus the semi-dark space was blurring the visibility of details so from the first 2-3 minutes of play it was hard to discern whether the protagonist was a robot or a human. Even though everyone knew that they are attending in a performance with a robot, anyway, without knowing when to expect the entrance of robot the first impression and reaction towards it was that increased uncanniness. The show was designed exactly for that purpose to raise the effect of it. Ishiguro states that in case of humanlike androids "76% of subjects cannot distinguish an android from a human after watching for less than two seconds" (Ogawa & Ishiguro, 2016, p. 334).

Here Jochum and Goldberg's argument about authenticity and aliveness fully applies, also considering how this robot was acting and moving, its authenticity was not so important and was not prioritized. The more striking prospect was my struggle to stay focused on its ability to differentiate a machine from a human. The reality of representation, effective direction and

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[24] Full information about the conference and the festival can be fund here https://transmissioninmotion.sites.uu.nl/programme-2/

[25] For more information about the performance look here https://www.rimini-protokoll.de/website/en/project/unheimliches-tal-uncanny-valley

excellent composition of the stage between light and dark elements was increasing the audience's focus and acceptance of the double as a double and not an original.

Figure 21: Uncanny Valley performance
Source:https://www.rimini-protokoll.de/website/en/project/unheimliches-tal-uncanny-valley

While this example surely relates to the second type of uncanny discussed in the above mentioned article, Jochum and Goldberg think that in both cases uncanny objects "create the awareness of awareness" (Jochum & Goldberg, 2016, p. 151). And this is the point where robots literally fascinate the general public by their existence, be that connected with the design or with the functional possibilities. Here, artists act as mediators of this fascination in order to establish some kind of a bridge and a connection between robots and humans. As Eduardo Kac states "the artist creates not only form but the actions and reactions of the robot in response to external or internal stimuli" (Kac, 1997) and based on this the artist uses the space and narrates scenarios of realization of mentioned communication between a robot and a viewer. However, in discussion of *Geminoids* and also what I witnessed during the performance, it should be noted that the performativity and moving ability of such robots is quite limited. The robots are mainly in seated position, as in the case of Thomas Melle's double robot, which was constructed initially by being merged with a chair. Thus it couldn't be separated or moved to another chair or surface.

The copied subject and supportive object became the same in the process of realization of the robot's presence. The actual merged image was not seen from the front position and could be observed only from the back. The robot which was perceived by the audience as a human being at first glance and then understood as a robot after sometime, at the end reveals itself as a "chair" after approaching it from the back. How does dimensional change alter the perception of the subject as real or non-real and which kinds of feelings can it raise in such interactions? It was interesting to observe, also, changes in my own feelings before and after the performance and how much I was impressed by the experience of near and far proximity interaction with such a robot. After the performance the active and dynamic figure appeared as just a static human-chair combination which was surely very strange to observe in that setting. As the robot was tele-operated, after the performance it was already static but some parts of interface were still shaking making more weird impression than with the previous full movement of body parts. The uncanniness of the whole performance surely had passed, though various transformations, as the same uncanniness, had been replaced by the surprise, amazement, shock and admiration. All these emotions were combined with the inseparable and deep feeling of not being able to leave the place. I think the one hour-long performance was smoothly followed by a one hour interaction with the robot on the stage when the audience allowed to approach to it to some limited distance and observe or take photos. The actual performance continued with the "second part" where it was the turn of the audience to start acting by taking numerous photos, videos and initiating discussions and conversations around it.

There is an interesting correlation between this performance and Sayonara. In both cases, the robots are in a seated position and instead of active movements and gestures, they mainly talk with recorded human voice. They both raise philosophical discussions and thoughts about the existence of life and they both have that uncanny look that blurs the borders between a machine and a human. I think that this a point where general expectations from robots as movable and active objects or the concept of movable sculptures shifts to more static entities but bit more advanced human-like intellect, talks and discussions.

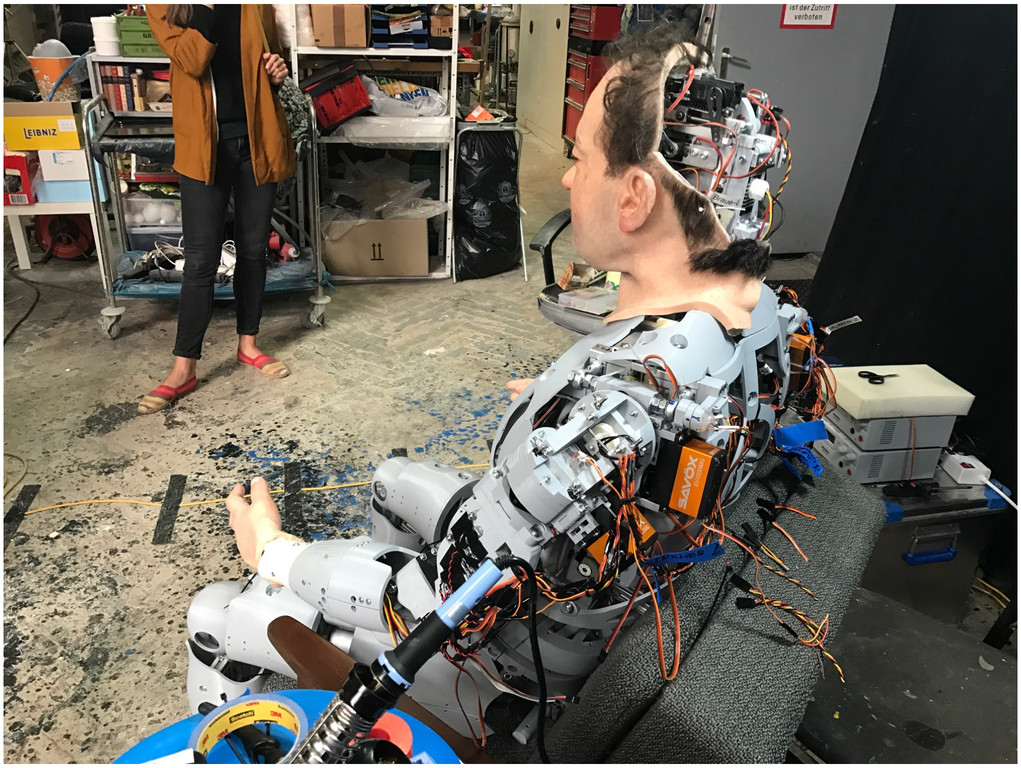

Figure 22: Robot of Uncanny Valley performance

Source:https://www.rimini-protokoll.de/website/en/project/unheimliches-tal-uncanny-valley

Ishiguro poses a question of it in the teleoperation system a “human’s “mind is separable from his or her “body”” (Ogawa and Ishiguro, 2016, p. 330). I think this question is quite important in all discussions of mimetic representation and imitative behavior of robots. While we discuss only the imitation of G*eminoids*’ appearance, these robots explicitly show that the mimesis switches from pure representation to another level of imitation - to the imitation of thoughts, ideas, mind and behavior. In fact, Ishiguro mentions about adjusting a behavior in a way that will give it a natural look. He asserts that because humans never stop to breathe or eye blink the robot also should be configured accordingly, if the intention is to provide maximal behavioral similarity with the human (Ogawa and Ishiguro, 2016, p. 331).

In case of *The Uncanny Valley* performance the above mentioned characteristics of a robot becoming identical to a human in terms of the appearance and animation, revealed itself in the performance. The robot started to control another technological device - the huge theatrical light located on the stage. The commands were verbal and synchronized with the robot's narrative about the interrelation between humanity and technology. While the robot was manipulating the light to become bigger, wider, brighter, switching it on and off, the uncanniness of the whole situation became more and more explicit. The copy was replacing the original so overtly that beside to another technology it was merely acting as a human being. To observe the interaction between the two technologies, where human intervention was minimal in the process, besides pre-scripted, excellent choreography, was an amazing emotional encounter. It visualized how technology can act without human and be put on autonomous process of reshaping and developing itself when it's needed. The whole play was very powerful and that part was the highlight of the whole concept of the original's elimination and the replacement by the copy.

Conclusion

The goal of this thesis was to show how therapeutic robots can be discussed in an art context, specifically in the media art context and what benefits can be gained from it. While being a creation of scientific thought, the design and functionality leads us to the art space. Art becomes an alternative virtual world, where these robots are tested and experimented before being used in their main purpose with vulnerable target groups. Basically, here we talk about the power of art, the power to make explicit and further implementation of new settings for these robots, the power of creating another space and another dimension where everything can be scripted and designed in order to have a lifelike experience without harming those who can be harmed by experimentations in therapy. Art filters the effects of interaction with robots and shows the possibilities of further collaboration. The necessity to change their context of implementation also changes the human perception of the notion of their creation and the actual functionality.

In this discussion theater especially becomes a new space to carry these investigations deeper. Being on the experimental stage allows robots to change their pre-scripted tasks which, in turn, blurs the perception of robots as just mechanical devices created to perform repetitive actions. Also, the expectations from robots towards a more autonomous flow of collaboration differs because robots' feedback becomes equally important to their performed tasks. In all cases of theatrical performances the bond is visible between robots and human performers and the process of collaboration opens up new discussions about equal distribution of interaction and communication.

In scientific settings therapeutic robots are only tools to enhance the well being of humans. They replace the actual staff and help to grow interaction between humans. This kind of perception does not open any discussion about the expectations of the robots themselves and does not open any conversation about the technological advancements in general. In the art context these robots' role widens to include them as carriers of new technological innovations where their functionality is not investigated enough beyond their initial settings. Thus art reveals unpredicted interaction between robots and humans and visualizes it for society at large. Robots show humans ways to learn more about themselves. They help to navigate humans towards perceiving the full capacity of the human body, the flexibility of motions and movements. By not being able to move in a fluid way as the human body does, robots at least perform humans' ideas about themselves. After all, robots are human creations, direct imitation of human intelligence, body and movements.

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