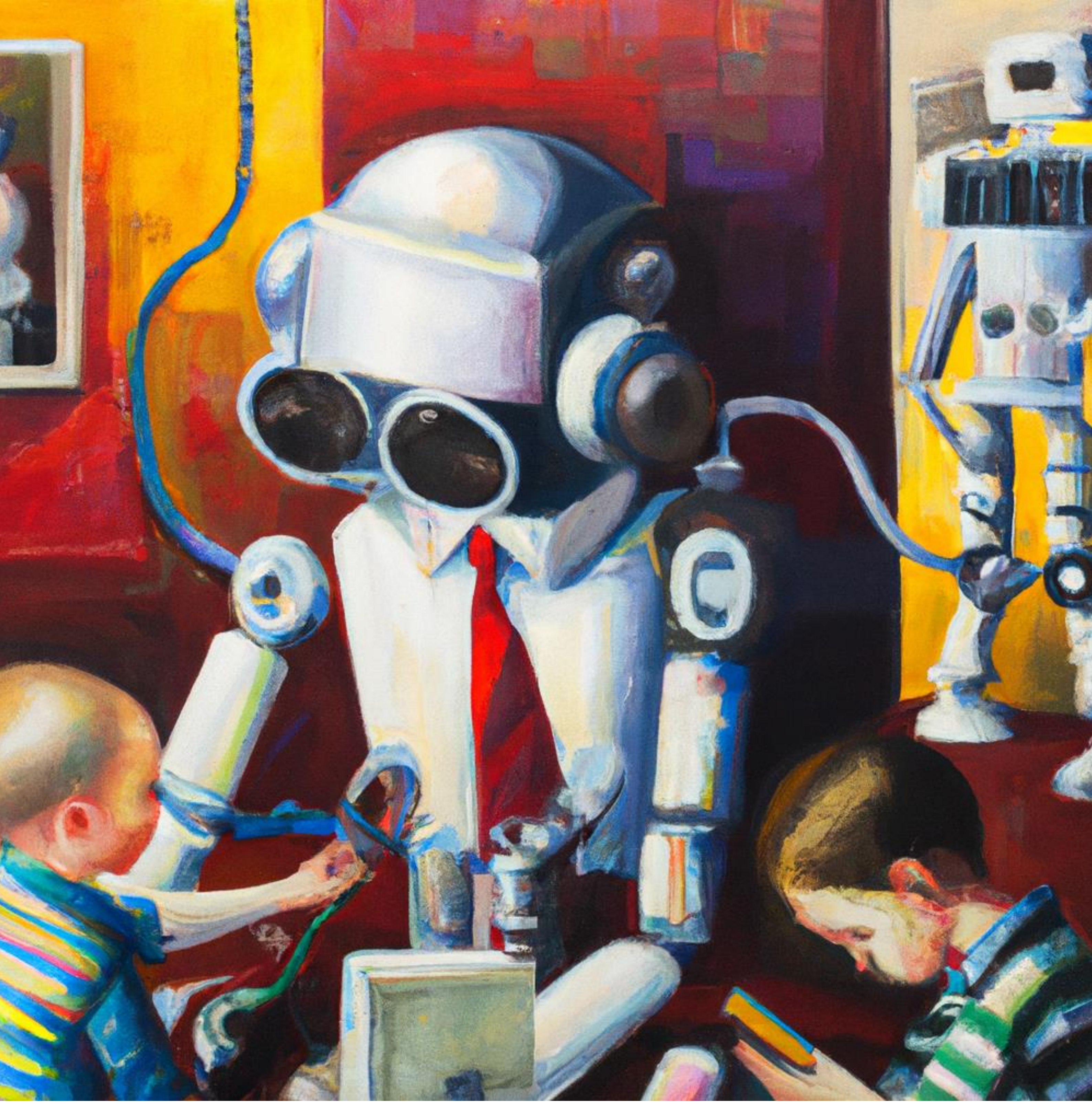

Embodied Empathy Explored

Unravelling Our Perception of Robots

An enactive dramaturgical approach to HRI

Elsbeth Hoefkens

The image on the front page of this thesis is an illustration created with Dall-E by the author with the prompt 'Research about robotics is a hot topic'.

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Abstract

Robots as waiters, self-driving cars and smart home robots, robots are increasingly appearing in our daily lives. Robot research is therefore receiving a lot of attention these days. However, as discussed in this thesis, much research on human-robot interaction has internalised a dualistic perspective on human cognition, separating the body from the mind. This dualistic approach limits the potential of robot design because it does not involve the body in processes of meaning-making.

Following other researchers in this area, I therefore propose to take an embodied cognitive perspective within the field of robotics and human-robot interaction (HRI). This intersection allows me to transcend the mind-body dualism within HRI research and robot design. Complementing this embodied cognitive perspective, I turn to the performing arts as a dramaturgical approach allows me to analyse what meaning is evoked in the human being during interaction with a robot. In doing so, I thus view the interaction with the robot as a performance. Two theories from the field of embodied cognition, Conceptual Metaphor Theory, and the theory of embodied simulation, allow me to further dissect how this meaning is created in our bodies. With this layered perspective on an HRI, I aim to gain insights into the processes of meaning-making within the human body for the design of embodied social robots.

In this research, I analyse two robots: a social robot called Phi and a robot presented within the performance *Simple Machines* (2019) created by choreographer Ugo Dehaes. The analysis of the social robot shows how through its design a contrasting meaning (the robot seen as a machine and as a person) is evoked, thus avoiding the Uncanny Valley. In contrast, the embodiment of the Art robot challenges how we view robots and invites us to broaden our thinking about what a robot might be. Moreover, the medium of theatre and the story the artist tells with the robot raises questions about themes of utility, work, and capitalism in relation to both robotics and society.

Comparing the two robots, a difference can be seen in the way they evoke empathy, an element seen as an important condition for HRI. The social robot does this mainly through its human-like appearance, while the Art robot elicits empathy by evoking the idea of a growing being. Because, besides embodiment, the two robots also differ greatly in context, it is not possible to apply the Art robot's 'empathy method' directly to the situation of the social robot. However, this perspective of robots as growing entities does raise interesting questions within the larger field of robotics. These are questions such as 'What would it do in terms of perception if a robot reached a certain age?', 'What does human responsibility mean in relation to growing robots?' and 'How do we define intelligence within robotics and beyond?'.

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Introduction

A social robot called NAO seems to be staring at me as I try to listen to the group we are collaborating with at VU to work on a human-robot interaction problem.[1] The staring distracts me considerably from listening as I wonder what he is thinking.[2] Later when NAO has been engaged by his designers, he tells me a story. He wanted to go outside earlier but couldn't because it was raining. After a short pause, he continued and told me how he wondered what rain felt like.

That same day, I visited the performance *Simple Machines* (2019) created by artist Ugo Dehaes. An apparently slimy soft-moving pink 'thing' hangs in front of me. As an audience, we are invited to touch the so-called robot if we like. I look around and see a mix of disgust, confusion, and puzzled faces. The robots presented intrigue some and make others wince. I was intrigued.

In both examples, something interesting seems to happen to me. Although I know in the first situation that NAO is mostly made of plastic, metal, sensors, and a lot of wires, I still felt connected to him. I felt sorry for NAO because he couldn't go outside, and a smile appeared on my face when he wondered what the rain felt like. This empathy arose on a subconscious bodily level and thus contradicted what I rationally knew about NAO, leaving me feeling somewhat confused. In the latter situation, I was captivated by the way the robots were embodied in such a way that I perceived the robots as living beings. Indeed, compared to NAO, the robots did not resemble a human being and did not talk. Again, I left the room with more questions than when I entered. The performance made me question the definition of a robot and made me reflect on how these robots had provoked empathy in me like NAO did, despite their abstract form.

In this thesis, I aim to dissect how in both cases this bodily affect, and more generally how meaning, is evoked when interacting with a robot and thereby show how this bodily perspective can be fruitful within robot research. Within human-robot interaction (HRI), this focus on the role of the body in meaning-making is an emerging debate, as demonstrated and supported by examples by scholars Mark Paterson, Guy Hoffman, and Caroline Yan Zheng in their text “Designing the Robot Body: Critical Perspectives on Affective Embodied Interaction” (2023).

[1] This collaboration was part of the 'Expanding Performance' course at Utrecht University, where an interdisciplinary collaboration took place between students working from the perspective of performance studies with students in the field of social robotics.
VU stands for "Vrije Universiteit Amsterdam", which can be translated as "Free University of Amsterdam".
[2] I refer to the robot as a "he" because the designers did the same in our conversations.

Research question and methodology

The main aim of this research is to dissect *how* our bodies shape perceptions of the embodiment of robots (anatomy, movement quality and materials). To find out, I analyse two different HRI *as if* they were performances (Schechner 2013, 30). The first is a robot in the context of a performance, which I refer to as 'Art Robot', and the second is a social robot called Phi. A social robot is a robot with a specific purpose designed specifically for social interactions with people. By analysing the robots, I follow an *enactive approach* proposed by philosopher Alva Noë (2006), which proposes an embodied perspective on human perception. To find out *how* our bodies are involved in HRI, I turn to the field of embodied cognitive science which, as will be shown, is in line with the enactive approach. Since I analyse what the robots evoke in our bodies through this approach, my method is a dramaturgical one because I interpret what a robot 'does'. As this thesis is situated at the intersection of performing arts and cognitive science, I use what scholar Lisa Zunshine (2010) calls a *cognitive-cultural approach*. In doing so, I follow the footsteps of theatre scholars Maaike Bleeker and Isis Germano (2014), who in their article "Perceiving and Believing: An Enactive Approach to Spectatorship" analyse two theatre performances using an enactive approach to spectatorship via embodied cognition. Like their article, my analysis draws on two theories within embodied cognitive science: *embodied simulation* and *Conceptual Metaphor Theory*.

This enactive dramaturgical approach to HRI allows me to argue how the sum of elements within the robot embodiment evokes a specific bodily meaning and affect. Ultimately, this enables me to gain insights into the design of social robots.

As becomes clear in Chapter 2, embodied cognition also includes consideration of how sensorimotor skills are embedded and thus influenced by our social and cultural environment (Johnson 1987; Varela, Thompson and Rosch 2017). However, to analyse this in its entirety is beyond the scope of this thesis, as this would require an analysis of a specific spectator's social and cultural environment and all the embodied experiences that this spectator had within this environment. What I do in this thesis to limit that scope is to focus only on the most explicit elements of robot embodiment, as these are likely to touch the most onlookers. This dramaturgical analysis thus reflects on how our cognition is structured through social and cultural elements to perceive these explicit elements. In doing so, I draw on my perspective as a white woman living in the Netherlands. As such, when I write about 'how embodied cognition is encultured', I refer to social and cultural aspects within my position.

Research question

The approach of this research is thus an intersection of multiple fields and perspectives, namely: embodied cognition, enactive approach, performing arts and robotics. Through this intersection, I am able to overcome the separation between body and mind in HRI research and robot design. By doing so I can, from the created enactive dramaturgical perspective on robotics, explore how people shape their perceptions of the embodiment of robots and thus gain insight into the unconscious meaning-making processes within HRI. A specific focus of this process of meaning-making is how our bodies are affected by the robots' embodiment. This thesis addresses the following research question:

> *What insights into processes of meaning-making can an enactive approach to HRI offer for the embodied design of social robots?*

To answer this question, I divide my research into the following sub-questions:

1. How does meaning emerge in the human body through image schemas and conceptual metaphors within the interaction with robots looking at the explicit elements in the embodiment of robots?
2. How is embodied cognition encultured to understand the elements most explicit in the embodiment of the two analysed robots?
3. How does the meaning of the embodiment of robots arising at an unconscious level in our bodies (1) relate to how embodied cognition is encultured to understand the explicit elements of the embodiment of robots (2)?
4. How do the function and story of the robot contribute to the meaning emerging from the robot's body?

Research method and case studies

To approach my research question, I use qualitative research methods, consisting of literature reviews in the fields of robotics, philosophy, cognitive science and performing arts, and an enactive dramaturgical analysis. The analysis includes two case studies, analysing two different robots: the first is a social robot used in various care situations and the second is a robot presented in a performance. I chose these two robots because they are robots very different in anatomy, material, and way of moving, which is what the analysis focuses on. These vast differences in the embodiment are relevant as they allow me to analyse and gain insights into how our bodies respond to different elements of robot embodiment and how they affect our perception.

The social robot Phi (see Figure 1) is a 1.2-metre-long Pepper[3] robot with a human appearance in the sense that it has a face, arms and some kind of legs. It is the world's first social humanoid robot that can recognise faces and human emotions. Unfortunately, I have not seen this robot live, so I use two specific recordings of situations where Pepper acts as a social robot.

The Art robot is one of Ugo Dehaes' robots that was presented in the performance called *Simple Machines,* made in 2019 and it is still touring. I saw this performance live on 23 November 2022 at theatre de Brakke Grond in Amsterdam. The robots featured in this performance are presented as growing creatures that initially look like foetuses and then develop into strange insects (see Figures 2 and 3). As a result, they challenge ideas of what robots look like.

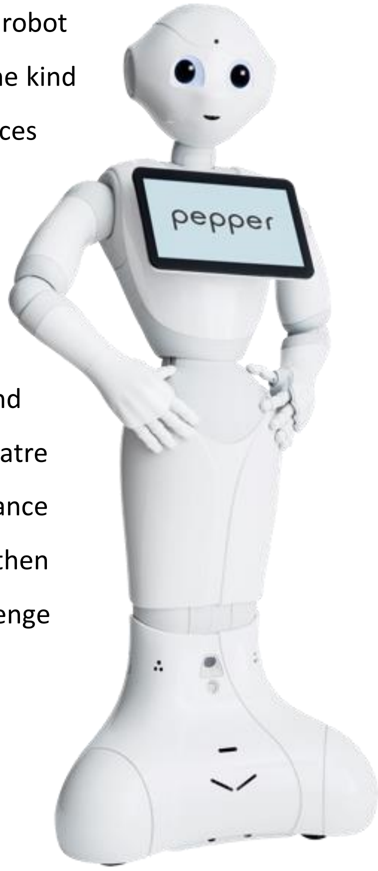
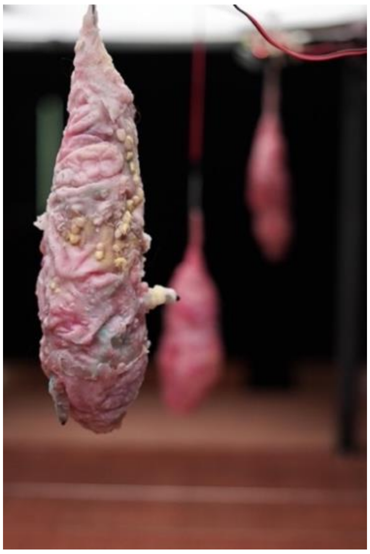


Figure 1. *Robot Pepper, 1.2-metre*, n.d. (Photo: United Robotics Group)



Figures 2 and 3. Robots presented in *Simple Machines*, n.d. (Photos: Arne Lievens)

As robot Phi overlaps with a well-known manifestation of robots, namely the 'humanoid robot', analysing this robot first allows me to contrast the Art robot with the social robot. However, the two completely different contexts of the robots restrict the application of the insights gained from the

[3] Pepper is designed by Aldebaran Robotics. This robot has a touch screen to communicate along with speech, and because of its slightly different shape from a human, it is labelled a semi-humanoid robot.

analysis of the Art robot to the social robot because Phi has specific criteria that its functions require. Therefore, the reason I juxtapose the Art robot with the social robot is not to replace the social robot but an invitation to question and broaden our thinking about robots by asking, ‘What else could a robot look like?’. A second relevant issue, looking at the difference in setting, is its impact on our perception of robots, as the setting of the performance greatly influences how we perceive the robot. In my research, I have found strategies to account for this difference in my comparison of these complex objects of analysis, these I explain further in the analysis.

Procedure

As I give a detailed description of the analysis method in Chapter 3, I now give a brief overview of the different steps. In line with my sub-questions, I begin by analysing how meaning emerges within our bodies from the bodily experience of my case studies. I do this by arguing which image schemas and conceptual metaphors are evoked by the robot's anatomy, movement quality and materials. To analyse the robots' movements, I use the concept of embodied simulation, which in short is an unconscious cognitive process where people mentally recreate experiences in their heads to understand the actions of others (Gallese 2010).[4] Second, I map through literature research how embodied cognition have been encultured to look at the most explicit elements within the embodiment of the analysed robots. Third, I compare the outcomes of sub-questions 1 and 2 and analyse what meaning is created by combining the two. In the case of the Art robot, I then analyse whether the narrative in the performance told by Dehaes changes or reinforces the meaning embodied by the robot. In the conclusion, I compare both analyses of the robots and analyse what insights can be drawn from them for HRI. Here, it becomes clear that empathy plays an important factor in how the robots evoke a bodily affect in people and thereby create meaningful interactions.

Analysing the difference in acted perception of the two robots shows the effect of unconscious meaning processes. Moreover, by uncovering (part of) the unconscious meaning processes, insights can be gained for the research field of HRI, as, on the one hand, it can be investigated whether the created meaning of the social robot is consistent with the desired outcome and, on the other hand, the Art robot raises the questions ‘What could a robot also look like?’ and ‘What advantages would that bring within HRI?’.

[4] To give a simplified example, I argue, for instance, that the anatomy of the robot and the way the robot moves (and people simulate this in their bodies) evokes the image schema 'SELF-OTHER', which in short reflects the idea that robots are seen as separate entities. Next, I argue that this refers to a CM as 'Robots seen as Companions'.

Chapter 1. Where we come from…

Exploring the intersection of robotics, performing arts and cognitive science

As described in the introduction, this research delves into the fields of robotics, performing arts and cognition. The aim of this chapter is therefore to understand the relevance of this intersection to my research. To achieve this goal, it is important to examine how these different fields have crossed and influenced each other in the past and how this manifests itself in the present. This first chapter, therefore, covers some relevant topics in robotics (1.1), the intersection of robotics and art (1.2) and a specific approach within cognitive science known as the dualist perspective that has significantly influenced the field of robotics (1.3).

1.1 Venturing into Robotic Realms: Navigating Relevant Topics

Robots are increasingly present in our daily lives. Examples include automatic hoovers like the Roomba, robots as waiters or assistants, and the rise of self-driving cars and smart homes. As a result, the field of robotics is receiving a lot of attention. However, the ambition to create a moving and autonomous entity seems to be of all times. Attempts to create lifelike machines can be seen as early as ancient Egyptian culture (Wilson 2002, 369). To explore what topics are relevant in the field of robotics today, and thus for my research, I go back to the origins of the word 'robot' and look at what performance *R.U.R.* still means today. From there, I move on by looking at what a robot is and how this question is still relevant. I continue to explain how robot design is always a result of its time and is therefore never 'neutral'. To illustrate this interaction between robots and society, I then give two examples of so-called robots. Finally, I briefly discuss how and when HRI emerged from robotics.

What the play* R.U.R. *tells us

For the origin of the word 'robot', we turn to author Karel Capek who in 1921 used the word 'robot' in his play called *R.U.R.* which stands for Rossum's Universal Robots (Hockstein et al. 2007, 113).[5] Since the word 'robot' comes from the Czech 'robota', meaning compulsory work, the performance defined a robot accordingly as "an artificial humanoid machine created in great numbers for a source of cheap labour" (370). The play shows a factory where robots work under the supervision of humans. Being oppressed by their creators, the robots begin to rebel, take over the factory and eventually destroy

[5] Back in 1917, Karel Capek's brother Josef Capek described automata in his short story *Opilec*. Within the Czech literary world, it is therefore still a point of debate which of the two brothers coined the term 'robot'.

humanity (see Figure 4). Because the performance presents the robots first as oppressed and then as oppressors, Capek seems to give a layered translation of the issues surrounding the rise of robots at that time. Looking at the way the robots are staged in the play, they are products of mass production in the nineteenth century, making it seem like a critique of rapidly growing modern technology. The performance also addresses people's fear of robots on the one hand and how people should interact with robots on the other.

By asking questions about how people should relate to robots, what a robot should be like, and by raising ethical issues within this search for how to design robots, this play is very relevant in the field of HRI and for this research. Moreover, this performance shows how the representation of robots reflects the period in which they were created. I proceed with a more detailed examination of these subjects and their significance within the context of my research.

Figure 4. *R.U.R.* by Karel Capek, 1921 (Photo: Alamy)

What are we talking about?

As can be seen in Figure 4, the robots in *R.U.R.* are performed by people in metallic costumes. Although at the time, since technology was not then able to create 'real' robots, the use of actors was necessary, this design does indicate an ideology within how the creator envisioned a robot. This idea of robots resembling people is still strong within robotics (Rhee 2018). Besides the focus on the appearance of robots, a second focus within the way some define a robot these days is the emphasis on behaviour (Wilson 2002, 371). One perspective is for example that a robot must be autonomous, able to move and adapt to its environment. The question 'what a robot is and could be' is therefore still relevant within robotics. This fact is interesting for my research since the Art robot I analyse stimulates the viewer to use their imagination when thinking about this question and therefore broadens the thinking about what a robot is.

In this research, I follow the definition of scholar and artist Simon Penny, who is an expert in the intersection of robotics and art. Penny defines a robot as a "self-guiding machine tool" (2016, 50), meaning the robot must be self-directed and have a body.[6]

A robot: a reflection of its time

Another relevant element in the play *R.U.R.* is that it reflects the fear people have that robots are taking over the world. This shows that the way robots are designed and presented is strongly influenced by the period in which they are made, as fears, prejudices, and expectations influence robot design. For example, the idea that 'robots should look like people' may underlie the design of robots. In addition, the perception of robots as a physical threat influences robot design, as designers want to prevent this fear from becoming a reality. The recognition of these ideas underlying robot design is relevant because they show that a robot design is never 'neutral' and that these ideas limit the possibilities of thinking about what a robot is and can be. Both elements form the basis of this research as I acknowledge and challenge a norm within robot design, namely mind-body dualism, and like others, propose a different perspective, namely an embodied approach, to broaden the scope of the research within HRI. However, before getting ahead of myself, I give two examples of so-called robots to demonstrate the influence of a particular period on robot design, namely: a Japanese tea serving doll called Chahakobi Ningyō[7] (see Figure 5), and the Digesting Duck[8] (see Figure 6) by Jacques de Vaucanson (1709-1782) (Wilson 2002, 369; Dixon 2007, 281-283).

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[6] Robots used for remote tasks, such as robotic surgery, or robots that perform industrial pre-programmed tasks should not be called robots, according to Penny, because they are not self-directed.

[7] The doll performed a tea serving ceremony. As soon as a teacup is placed on the saucer, the doll bows its head and starts moving towards the customer. When the cup is taken away, the doll stops 'walking'. This action repeats itself when the cup is put back.

[8] The Digesting Duck became famous. The duck was life-size and stood on a large pedestal that contained most of the technical elements. However, despite the name suggests, the duck could not digest food but collected food in a built-in container and had another compartment with pre-stored faeces.

 

Figure 5. The Chahakobi Ningyō (tea-serving doll). n.d. (Photo: Toshiba Science Museum)

Figure 6. A modern reconstruction of Vaucanson's Digesting Duck, n.d. (Photo: Alpha History)

The tea- serving doll, made in the Edo Period[9], reflects its time because this period in Japan was marked by the flowering of arts and crafts, including the creation of intricate mechanical dolls and automata. Moreover, the doll embodied the sophisticated tea ceremony culture popular at the time.

The Digesting Duck, which could eat, drink, and move its wings, reflects the zeitgeist as the design was handmade and contained many technical elements. It reflects the period of Enlightenment that characterised the eighteenth century because it represented a belief in logic and the potential of science to control the laws of nature to create new forms of life (Stephens and Heffernan 2016, 31). Both examples thus show how their purpose and design reflect the ideology of the time in different ways.

From robots to HRI research

Since this research delves into the field of HRI, I now briefly explain how and when HRI came about. Whereas Capek made the relationship between people and robots central to the play *R.U.R.* as early as 1921, HRI did not emerge until the mid-1990s and early 2000s (Goodrich and Schultz 2007, 211).

The main reason why HRI did not emerge until long after the first robots were created is the lack of technology to allow robots to 'interact' with people (206-210). Early robot designs were mostly robots that could only perform tasks remotely. Around 1980, advances within robot mechanics enabled researchers to create the first autonomous robots (208). From then on, the interdisciplinary research area of HRI also began to emerge (211). The first scientific meeting on HRI was the IEEE

[9] The Edo Period is the period between 1603 and 1867 when Japan was isolated from the rest of the world, the 'sakoku'. This period of a military dictatorship featured relative peace and stability, leading to the development of a unique culture and society.

International Symposium on Robot & Human Interactive Communication (RoMan) in 1992. This congress was followed by many other meetings, workshops, and research programmes. Besides the rise of these meetings, there was also the emergence of HRI competitions that had a major impact on the development of this field (213).[10] Because of the challenges presented by the competitions, research became specific and focused on the assignments given.[11]

1.2 A fruitful marriage: Robotics and the performing arts

Since the word 'robot' originates from a theatre performance, the first link between robots and the performing arts was thus established right at the beginning of robotics. This chapter shows further how the performing arts and robotics are connected in different ways. First, I briefly discuss how the performing arts have used robots and what impact this has had on society, robotics, and art itself. Secondly, I discuss how performing arts provide a relevant perspective and a testing ground for the field of robotics.

The influence of robot art on robotics

Robot art[12] has influenced robotics in several ways. It emerged strongly after World War II, mainly due to the increasing accessibility of technologies as a result of technological developments (Penny 2016, 53).[13] In this post-war period, artist Edward Ihnatowicz's work *Senster*[14] (1970) is considered one of the most influential works of robot art (see Figure 7). Although the robot looks like a clumsy giraffe, this artwork was a pioneer of its time because the robot could see and hear its surroundings and react through movement if it heard or saw something. As a result, it has inspired robotics and artificial intelligence (Zivanovic 2005, 107-108).

[10] The greatest influence on HRI research is attributed to the AAAI Robotics Competition and Exhibition and the Robocup Search and Rescue competition (Goodrich and Schultz 2007, 2013).
[11] An example of one such challenge is that during the sixth AAAI Robot Competition in 1997, where the robots had to serve snacks to guests during the conference reception (Goodrich and Schultz 2007, 213).
[12] In this chapter, I use the terms 'robot art' and 'robot performing art' interchangeably. I do this since the characteristic of performing art is that it is a live event, performed by performers, and these elements are also always present in robot artwork, as there is always a performer (the robot) performing a live action.
[13] Examples of technological developments include a radar system and self-steering machines.
[14] The *Senster* in operation: https://www.youtube.com/watch?v=wY85GrYGnyw.
This work was commissioned by electronics giant Philips.

Figure 7. The *Senster* by Edward Ihnatowicz, 2020 (Photo: Eric Frenks)

Another remarkable but very different robot artwork made around the same time is *Homage to New York* (1960) by artist Jean Tinguely (see Figure 8). Although this artwork is strictly speaking not a robot as it cannot respond to anything but is pre-programmed, it still had a great influence on the way people could look at robots, namely: with humour (Dixon 2007, 285). The work consisted of eighty bicycle wheels, tubes, a bathtub, bottles, motors, a piano, metal drums and many more elements that were all connected like a collage. The whole structure was built to self-destruct, and when the motors attached to the different parts of the sculpture turned on, that was exactly what happened.[15] By destroying itself, the performance criticised the destructive core of modern society. Besides humour, the performance challenged the boundaries of art and influenced future art forms, as it is seen as an important milestone in the development of conceptual art and performance art.

At the end of the 20th century, when robot art received renewed interest[16], robots also became (co)performers on stage (Dixon 2007, 271). Performance art that widely applied the use of robotics emerged in the mid-1990s. Artists staged robots to interact with human performers and audiences, exploring themes such as the relationship between human beings and robots, the impact of technology on society and the blurring of boundaries between human beings and machines. Works

[15] The performance in the garden of the Museum of Modern Art: https://vimeo.com/218619751.

[16] As Penny describes, the field of robot art received another surge of interest in the 1970s due to "the maturing of basic technologies, their miniaturization and mass production" (2016, 48). The visibility of new developments such as driverless cars and self-driving drones and for example, Google's investments in robotics also contributed to this renewed interest (Markoff 2013).

such as the installation *Robotic Church*[17] (see Figures 9 and 10) by artist Chico MacMurtrie, in which robotic bodies are used as instruments, and Stelarc's *Reclining StickMan*[18] (2020) (see Figure 11) in which the human body is expanded, show how the use of robotics within the performing arts influences robotics. They do so by exploring the robot body and the boundaries between people and robots. Both provide an interesting perspective for this research because my case study, the Art robot, also focuses on the robot body.

These artworks all have thus proven to be highly relevant in the field of robotics, AI, and within art itself. Hence, these examples illustrate the impact robotic art can have and show the potential relevance of my Art robot as one of my case studies.

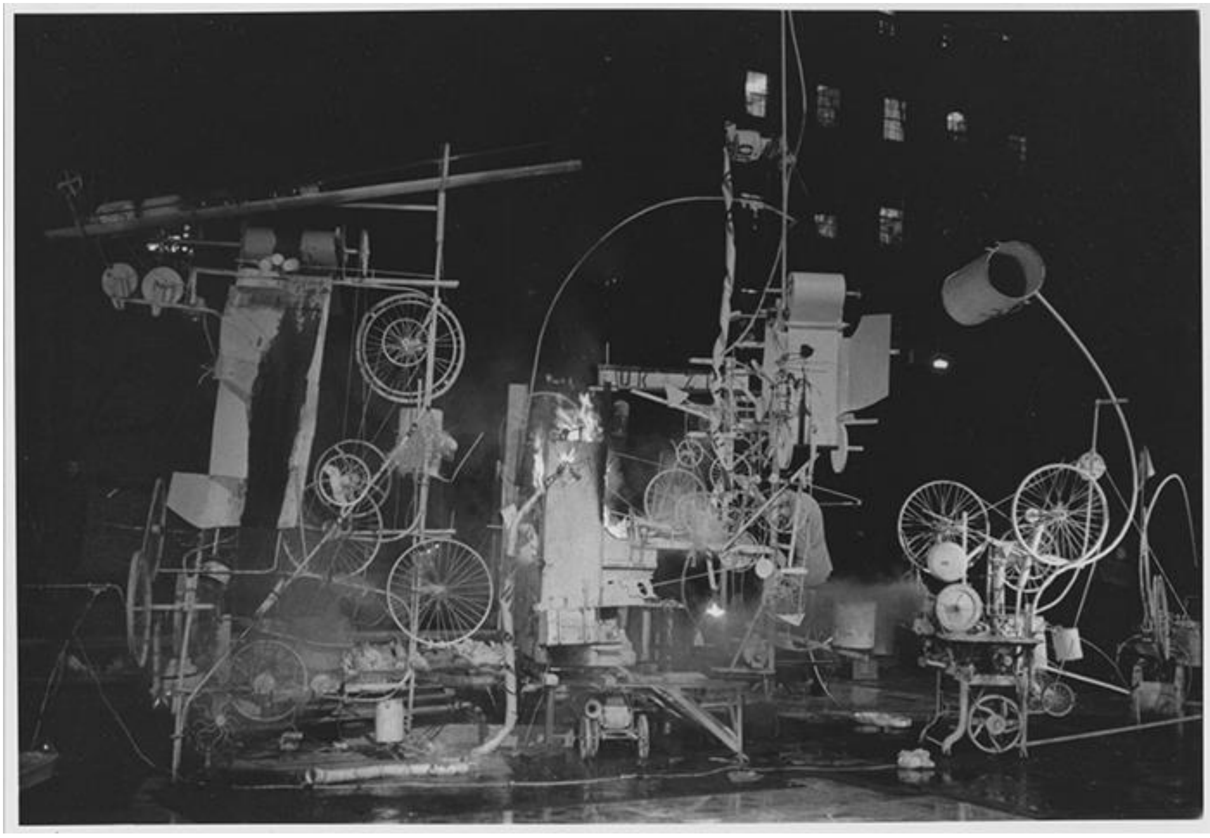

Figure 8. *Homage to New York* by Jean Tinguely, 1960 (Photo: MoMa)

[17] The installation in a former Norwegian Seamen's Church in, Brooklyn, New York: http://amorphicrobotworks.org/the-robotic-church.
This installation, which is simultaneously a collection of the work of MacMurtrie created between 1987 and 2006, consists of fifty computer-controlled sculptures scattered around a church, forming an orchestra. However, the percussive machines do not play an instrument but are programmed "to beat, strum, vibrate, spin, and otherwise play their own bodies to communicate in their own unique voice" (MacMurtrie n.d.).
[18] The work presented as part of the 2020 Adelaide Biennial of Australian Art, Monster Theatres: http://stelarc.org/reclining-stickman.php.
Reclining StickMan is a nine-metre-long robot powered by antagonistically bunched pneumatic rubber muscles.

Figures 9 and 10. Some robots from the installation *Robotic Church* by Chico MacMurtrie, n.d. (Photos: Eve Sussman, Andrew Boyle, Mathew Galindo, and Douglas Adesko)

Figure 11. *Reclining StickMan* by Stelarc, 2020. (Photo: Saul Steed)

Five reasons for robotics to take a look at the performing arts

Research in robotics requires an interdisciplinary approach, as designing robots requires both technological knowledge and knowledge about human interaction. However, this insight is quite recent, as scientist Lucy Suchman (2007), specialised in human-computer interaction, shows in her book *Human-Machine Reconfigurations: Plans and Situated Actions*. This book, published in 1987 and revised in 2007, was indeed one of the first texts emphasising that human interaction with machines depends not only on technological aspects but also on social and cultural context. Suchman argues that human-robot interactions are more complex than the one-sided technical approach that was often used within research and therefore calls for an interdisciplinary approach to address the complexity of HRI. In doing so, Suchman's work has had a major impact on the current interdisciplinary approach to robot research as it has significantly broadened the scope of research.

Opinions on the relevance of the field of performing arts in this interdisciplinary research vary within robotics. The view that HRI research is "inherently interdisciplinary in nature" (2007, 216) is nowadays underlined by Michael A. Goodrich and Alan C. Schultz, among others, in their much-cited article "Human-Robot Interaction: A Survey". They, however, as well as Bartneck et al. (2020) do not mention in their book *Human-Robot Interaction - An Introduction*, the performing arts as a relevant discipline as a component within HRI research. However, they do mention the importance of the fields of "engineering, computer science, robotics, psychology, sociology, and design" (1) and "cognitive science, linguistics, […] mathematics, and computer science" (Goodrich and Schultz 2008, 216). Nevertheless, there are authors in the academic field who stress the importance of knowledge within performing arts, because the performing arts have a lot of knowledge that is substantially different from the other aforementioned fields. To argue why the intersection of robotics and performing arts, as has already been demonstrated by much research, is relevant, I refer among others mostly to the aforementioned scientist and artist Penny and robot designer and media scholar Guy Hoffman specialising in HRI.

The first and most frequently mentioned argument why performing arts are relevant to research on robots and HRI is because of the material basis of performance. As Penny describes, the technology underlying robots is inherently abstract and disembodied because their computational technologies constitute "a platonic world outside matter and time" (2016, 53). Therefore, robotics must bridge "the immaterial world of computing and code" (49) and the real material world. Because the core characteristic of theatre is that it is embodied, it entails a different way of thinking because it practices the art of making things sensory and tangible. Penny states, "The way that art 'means' is in the normal way that (physical) things come to have meaning to people—through embodied experience." (2016, 52). The performing arts are thus relevant to robotics as they take place *in* the world *in* time and space.

Another important element within the field of performing arts is the focus on the spectator, as a performance exists because of its audience. This focus creates a holistic approach because a performance is seen as a whole rather than as isolated separate elements. This approach is highly relevant to research on HRI because meaning is created by the convergence of the various elements of an interaction within its environment. Among others, Bleeker (2019) mentions this concentration on *spectatorship* as what she describes as a term to analyse how a performance puts the audience in a specific state (33). To do this, a performance is analysed within its context and all the elements performed are considered, including how they are connected and what relationship they establish with the audience.

The third argument, mentioned by Hoffman in his text "On Stage: Robots as Performers", focuses on performances as testbeds for the development of robots (2016, 1). Since a performance is usually a framed medium with a script or score setting the boundaries, researchers can "isolate elements of human- robot interaction, while fixing other aspects as necessary" (1). Performances can thus provide a framework to evaluate HRI while getting feedback from an audience. An example is the research by Jochum et al. (2016), in which they describe how they used theatre to investigate relevant factors within the study of care robots such as "social dynamics, inter- personal communication and conversation, and issues such as timing and improvisation" (457). In the Netherlands, such research is done for example within the research project "Acting Like a Robot" in which experts from theatre and robotics use theatre as a testing ground to investigate the intersection of performing arts (theory and practice) and robotics (Utrecht University 2023).

Fourth, instead of the theatre as a testing ground, Hoffman (2016) also argues how the performing arts contain much knowledge useful for robotic research. This argument is widely recognised, as there are already many examples of research using this knowledge. Some of the many examples include research on movement (Hoffman and Ju 2014; Alcubilla Troughton 2022), creating believable robot characters (Simmons et al. 2011), improvisation (Jochum and Derks 2019; Rond et al. 2019; Alcubilla Troughton et al. 2022) and acting (Knight and Gray 2012; Hoffman 2016).

Finally, because art is a self-reflexive medium, it is always more than it is because it reflects directly on what it performs. As Wilson (2002) aptly puts it, "Questioning what is taken for granted in other disciplines is often the heart of the artistic enterprise." (387). Therefore, the performing arts can reflect on issues around HRI and raise ethical questions, as we have seen in Karel Capek's play *R.U.R.*. Moreover, performances using robots can open thinking about robots by rethinking what robots could be and do. By abandoning the limitations assumed within robotics, such as ‘a robot must be useful’, a performance can influence society's attitude towards robots, as Jean Tinguely's performance *Homage to New York* did.

What is my perspective?

In the first part of this section, I gave a few examples of robot art. These examples give a brief idea of the impact robot art can have on robotics and society. This shows the relevance of analysing robot art as I do in this research. Indeed, by analysing a robot performance, I analyse how the use of robotics within art provides insights within robotics and society.

In the second part of this paragraph, I offered several reasons why the performing arts are useful within robotics. Within my research, I focus within these qualities of performing arts on the materiality of robots and what it evokes in the spectator. Finally, I look at what the self-reflexive quality of theatre provides within the analysis of the Art robot.

1.3 The Dualistic approach

As mentioned in section 1.1, there are always (unconscious) ideologies and assumptions underlying the design of robots. And as shown in paragraph 1.2, the relevance of the intersection between performing arts and robotics is recognised by many (Penny 2013; Varela, Thompson and Rosch 2017, 147-157). Within this intersection, however, there is an ideology that limits the possibilities of this intersection, namely the separation of body and mind. Instead of looking at a body as a whole, both researchers within robot design and HRI do not consider the role of the human body in cognitive processes. Penny argues that this dualistic approach is due to the way cognition is approached within robotics namely, from a classical cognitivist point of view (2013, 148). To understand what this dualistic perspective means, where it comes from and how it has impacted our way of thinking, I now look at the classical cognitivist approach. This will also help understand the approach I take in this research, namely embodied cognition, which I cover in Chapter 2.

The Cartesian dualism

Within the history of cognitive science, in the late 1980s and early 1990s, there has been a shift between two paradigms commonly referred to as 'classic cognitivism'[19] and 'second- generation cognitive science'. Today, both approaches still exist and are sometimes even blended. The difference between the two paradigms is that within the classical approach, the brain is seen as a computer that translates inputs through algorithmic processes to create an output (Lakoff and Johnson 1999, 75-76; Johnson 2017, 69-70). In contrast, the second-generation perspective sees the brain as part of a body that is influenced by its environment and conversely shapes its environment.

[19] Also referred to as 'first-generation cognitive science'.

The separation of body and mind within robot design and research on HRI is in line with the classical approach, which was heavily influenced by the dualistic approach of philosopher René Descartes, who argued that body and mind were two different entities. This approach, commonly referred to as Cartesian dualism, emerged as a philosophical concept in the 17th century and became influential during the Enlightenment. Nowadays, it is still influential because the theory of functionalism is still present.[20]

The theory of functionalism

Functionalism emphasises the functional relations between mental states and the physical body and therefore argues that mental states cannot be reduced to the body, thus joining Cartesian dualism. Furthermore, functionalism is based on the concept of representationalism (Lakoff and Johnson 1999, 75-76). This concept implies that there is an outside world and to understand this world we need to create a representation of this world in our brain. As such, this cognitive approach disconnects thinking from the body and the world. Because the theory of functionalism is still present today, the body-mind dualism underlying this approach still influences the way we think about cognition today.

The body-mind dualism also leaves its mark within robot design, as Penny (2013) describes, as there is still a strong emphasis on the concept of representationalism. A similar tendency we see in research on HRI. As researcher Irene Alcubilla Troughton (2022) mentions there seems to be a logic within the research on HRI that robots "must look like humans in order to connect with us" (2). This is, as Alcubilla Troughton describes, based on the "internal paradigm" (2) that movement is an expression, and thus a medium, of an inner fixed state, which is consistent with the idea that the mind (inner state) and the body (movement) are separate.

Cartesian dualism has thus still a major impact on how cognition is viewed as the theory of functionalism is still influential today. Combined with the concept of representationalism on which functionalism is based, there is a tendency within cognition to disconnect thinking from the body and the world. As this tendency influences robotic research and therefore limits its potential, I, like other researchers, challenge this perspective by proposing a new embodied perspective to cognition.

[20] The theory of functionalism is still important today because of the popularity and success of the computational model of the mind, within which functionalism is often implicated because it is closely related to it, as both view the mind as an information-processing system that processes inputs and generates outputs.

1.4 Conclusion

In section 1.1, the relevance of the question, which my research addresses, of what a robot is or could be, became clear. In addition, the reflection of ideologies in a period within robotics and HRI was discussed, which is important for this research because it forms the starting point and relevance of my research. Indeed, in this thesis, I replace a dominant ideology within robotics, the dualism between body and mind (1.3), and adopt another ideology in my research, that of embodied cognition, which I explain in Chapter 2. In section 1.2, I demonstrated the potential of my Art robot as a case study by illustrating how the use of robots in the performing arts has influenced robotics, AI, and society. Moreover, I showed the relevance of using performing arts within robotics, as I do in this thesis, by providing five benefits. In this research, I mainly focus on two of these benefits, namely 1.) the material basis of performance when I analyse how the embodiment of the robots creates meaning within human beings, and 2.) the focus on spectatorship when I analyse how the spectator is invited by the robots to create meaning. In addition, I also briefly analyse the effect of the self-reflexive quality of theatre on the meaning of the Art robot.

Chapter 2. The Embodied perspective

Unveiling the Embedded and Embodied Approach

This chapter is dedicated to the embodied perspective from which I base this research. As seen in Chapter 1, the intersection of robotics and art is and has been fruitful for several reasons. Besides combining these fields, in this study I also add the field of embodied cognition and the enactive approach described by Noë (2006), which are discussed in sections 2.1 and 2.2. In combining these, I thus follow an embodied approach to the intersection of robotics and art. This allows me to analyse robots from the point of view of what they evoke in the human participant, since an embodied perspective approaches perception as a process within the human body rather than just solely within the brain. The analyses are informed by two theoretical perspectives from the field of embodied cognition: *Conceptual Metaphor Theory* (2.3) and *embodied simulation* (2.4). Both theories are discussed in this chapter.

2.1 Embodied cognition

As mentioned in Chapter 1, both Penny and Alcubilla Troughton signal the body-mind dualism within cognitive science in robot design and HRI research. In their texts, they both propose replacing this approach with an embodied perspective to recognise the role of the human body in meaning processes and include it in robotic research. As such, my research aims to contribute to this. In doing so, I use the lens of embodied cognition described by many academics (Johnson 1987; Varela, Thompson and Rosch 2017; Shapiro 2019). In a key text in this field, *Embodied Cognition* (2019), scholar Lawrence Shapiro, who specialises in the philosophy of psychology, describes how embodied cognition is usually seen as the "next step in the evolution of standard cognitive science" (1) and is now widely known. Briefly, this perspective implies that the mind is embodied and embedded in its environment. In this section, I dive into what this embodied and embedded perspective entails, commonly referred to as 'embodied cognition'. Finally, I look at the intersection of embodied cognition and the fields of art and robotics.

The embodied and embedded perspective

Embodied cognition broke with the convention of the isolated mind and sees the mind as embodied and embedded in the world and in our bodies.[21] Scholars Francisco Varela, Evan Thompson and Eleanor

[21] Around 1980, while embodied cognition emerged as a field of research, the rise of *connectionism* was also visible within the field of cognition. Because it was radically different from the representationalism perspective

Rosch describe how they define this embodied approach in their book *The Embodied Mind* (2017) which is leading within the field of embodied cognition:

> By using the term *embodied* we mean to highlight two points: first, that cognition depends upon the kinds of experience that come from having a body with various sensorimotor capacities, and second, that these individual sensorimotor capacities are themselves embedded in a more encompassing biological, psychological, and cultural context. (173, italics in the original)

The first element they mention is the body with its sensorimotor capabilities. To illustrate how important our body is within our perception, consider an animal with a different anatomy and perceptual system: a giraffe. Evidently, human beings' anatomy differs from that of a giraffe, and they have a different perception system because the eyes are not on the front but on the side of their heads. Shapiro argues, "As a result of these differences in bodies and perceptual systems, the sensorimotor capacities of the two organisms will differ." (60). The giraffe will see things that a human being will not see when walking the same path and vice versa. Which can then lead to different actions because of what they perceive, which in turn can lead to a different perception. For this interaction, Varela, Thompson and Rosch use the term 'action' in relation to embodied cognition because they want to emphasise that "sensory and motor processes, perception and action, are fundamentally inseparable in lived cognition" (2017, 173). In other words, perception and action determine each other. This means that, instead of a pre-given world, the way people are embodied determines how we can act and how subsequently we perceive the world (2017, 173).

The second element the authors address is that sensorimotor abilities are embedded in biological, psychological, and cultural contexts. As they describe, cognitive structures are made up of recurrent sensorimotor patterns and as philosopher Mark Johnson (1987), to whom the authors refer earlier, states, "These embodied patterns do not remain private or peculiar to the person who experiences them." (14). On the contrary, the society in which our bodies live codifies a lot of our felt patterns (14). Which makes our perception strongly influenced by the world.

Having defined the embodied and embedded perspectives I use in this thesis, I now explain how embodied cognition has influenced and is influenced by the performing arts. This to gain insight into the benefits of combining embodied cognition with robotics and performing arts.

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on the mind connectionism is seen as the beginning of what has been called the 'second generation of cognitive science' (Dooremalen, de Regt and Schouten 2010, 61-77). A central characteristic of connectionism is that the mind is seen as a neural network of interconnected nodes. Knowledge is thus not seen as neural representations but is represented by the patterns of activation within these nodes.

2.1.1 Embodied cognition in relation to robotics and art

The cognitive turn and the invention of mobots

The development of embodied cognition caused a turn towards cognitive science within the humanities. Theatre scholars Bruce McConachie and Elizabeth Hart (2006) describe in their book *Performance and Cognition: Theatre studies and the cognitive turn* that eventually performing arts also joined this 'cognitive turn'.

Whereas the field of embodied cognition thus influenced the arts, a development within robotics had a crucial effect within the development of embodied cognition namely: the development of mobots. Robot maker Rodney Brooks began making robots that functioned via sensorimotor feebackloops called 'mobots' (mobile robots) (Dooremalen, de Regt and Schouten 2010, 105). In doing so, he abandoned the idea that there should be a command centre inside the robot that gave instructions based on a detailed map of the outside world. Instead, he created a robot that could 'sense' in the world and act accordingly. These (more) embodied robots had a major impact on the way people thought about cognition. In addition, it was also a revolution in the field of robotics, as these mobots acted much faster because they did not have to perform new calculations each time to adjust their map of the outside world, which was also initially why people started looking for other types of robots.

An example of the intersection of embodied cognition, robotics, and art

Thus, as shown in the previous sections and Chapter 1, the fields of robotics, embodied cognition and art have inspired each other. Penny and Alcubilla Troughton build on this fruitful interaction by combining the three fields in turning to art to arrive at insights about robots using an embodied approach to cognition. In doing so, they take the same approach as I do in this study, however, none of them use specific theories from the field of embodied cognition as I do. To demonstrate this perspective, I use Penny's research as an example because it builds on an important movement called cybernetics.

Cybernetics

Penny uses the embodied perspective by looking at the sensibilities of art that can be seen in robot art because these sensibilities, as he calls them, bridge the gap between body and mind. What he seems to mean by these sensibilities is the quality of art to look at something within its context and the interrelationship between them, which could lead, for example, to robots that learn from their environment. Penny writes: "As such, these systems mirror the ongoing sensorimotor engagement of humans (…) in the world.” (2013, 1). By adopting this perspective, the artists Penny investigates, are building on the movement called *cybernetics*, which emerged in the mid-20th century and had a major impact in the arts but also on many other sciences.

Mathematician and philosopher Norbert Wiener coined this term in 1948. Wiener's goal was to study the general principles of control and communication in complex systems, drawing upon various disciplines such as engineering, biology, psychology, and mathematics. In his book Wiener describes how cybernetics was based on the idea that “machines and living beings are essentially similar in the way they relate to the world” (Penny 2017, 42). The concept of ‘feedback’ was a key element in this regard, as Wiener (1948) argues how feedback can create inputs from which a robot can learn. By focusing on feedback methods Wiener strived for “self-organizing systems” (181) that can maintain a dynamic equilibrium by constantly adjusting their behaviour based on feedback from their environment. Like, for example, a thermostat that controls the temperature in a room. Since the philosophy of cybernetics focused highly on the interaction of a robot with its environment the renew interest in this approach offers robot design a better understanding of “embodiment, gesture, materiality, physical and social space” (2).[22]

What is my perspective?

This example shows how the embodied approach to robot art broadens the spectrum of robot design. My thesis takes the same approach by analysing a robot within a performance and, in addition, analysing a social robot *as* a performance. In doing so, I focus on the viewer's embodied perception of a robot and analyse the robots from the point of view of what they evoke in the observer. Both the elements embodied and embedded play a role here in analysing what people experience when encountering a robot.

In doing so, I take an *enactive approach* to perception as proposed by Noë (2006). Although I follow Noë's enactive approach, I stress that Noë does not use cognitive science in his research, as I do in this thesis, because it allows me to analyse not only what meaning the robot’s embodiment evokes, but also how that meaning is evoked.

2.2 The enactive approach

Noë's enactive approach is an embodied approach to perception and, as shown in his book *Action in Perception* (2006), consistent with the findings of embodied cognitive science. However, it is useful to

[22] This approach is contrary to what Penny calls *symbolic AI*, which was a dominant paradigm between roughly 1960-1990 and followed the ideology of representationalism.

take a closer look at this approach because 1) Noë draws on the discipline of philosophy that enriches the approach to embodied cognition and 2) Noë emphasises the role of autonomy within embodiment. The latter therefore adds to the notion of 'action' raised by Varela, Thompson and Rosch (2017) that this action involves an active agent moving from within itself.

The main idea of the enactive approach, which rejects the idea of representationalism and hence the body-mind binary, as described by Noë (2006, 1), is that "perceiving is a way of acting". Perception is something we do and "not something that happens to us" (1). The claim Noë makes, implies that our perception is shaped by our possession of sensorimotor knowledge (2).[23] The sensory input we receive from our environment is constantly linked to spontaneous movements, such as an eye movement, a head turn or a reflex to catch a ball. This makes that "we modulate our sensations with movement in a way that is responsive to thought and situation" (6). This requires, as Noë writes, practical knowledge of how our movements alter stimulation (8). A very simple example of this is how we move our bodies closer to something when we cannot see something in enough detail.

An experiment and follow-up research by scholars Richard Held and Alan Hein (1963) add to this need for body knowledge the concept of "self-actuated movement" (Noë 2006, 13). In the experiment, two kittens were attached to a carousel; one in such a way that it could walk and the other that it did not touch the ground and thus could not walk. The result was that although both kittens moved in a circle and received the same visual stimulation, (sadly) only the kitten that walked developed normal depth perception and paw-eye coordination. Noë concludes from this, "Only through self-movement can one test and so learn the relevant patterns of sensorimotor dependence." (13). Here, autonomy becomes visible as an essential factor in the enactment of perception, as the research shows that being moved is not sufficient to acquire sensorimotor knowledge necessary for the creation of perception.

Instead of perception being a process in the brain by creating a representation of the outside world, perception is thus an ongoing interaction between a self-acting person and their environment. The practical sensorimotor knowledge used in this process is, as we saw when discussing the embedded element within embodied cognition, acquired within a social and cultural environment, and thus, it is strongly influenced by it (2014, 366). How we enact perception is therefore inextricably linked to our system of beliefs. Since I look at spectatorship as something we enact, the role of our social and cultural environment must be addressed.

[23] One of the examples Noë gives to highlight the use of sensorimotor knowledge is about people who have undergone surgery to restore their visual sensation; after completing the surgery, these patients experience *experiential blindness*, as he calls it (4). This means that these people receive visual sensations but cannot integrate them with their bodily skills because they did not learn them while growing up.

The approach I use in this research is thus embedded, embodied and 'active' because we acquire perceptual knowledge by doing. This is relevant to this research because it highlights the notion that our *moving* bodies create perception. Perception is thus a lived experience rather than a given blueprint or something others can teach us. From now on, when I use the 'embodied' perspective in this thesis, I refer to an enactive approach that is embodied and embedded.

Our sensory body is heavily involved in how we make meaning of the world, but an important note here is that this happens at an unconscious level. This points to the potential of an enactive approach to uncover the unconscious meaning-making process in our bodies that strongly influences our perception of robots. To do so, I use two theories from embodied cognition science, conceptual metaphors and embodied simulation, which I explain in the next two paragraphs.

2.3 Conceptual metaphors

One of the components I use to analyse how meaning is evoked through our bodies while encountering a robot is the Conceptual Metaphor Theory (CMT) developed by cognitive linguist and philosopher George Lakoff and Johnson. In the book *Metaphors We Live By* (1980), Lakoff and Johnson describe the theory coming from cognitive linguistics which, however, does not mean that the theory is only reflected in our language. In the book, they explain how metaphors play a role not only in our language, but also in our thinking and actions. The term 'metaphor' here does not refer to the literal definition of the word but is used to convey how abstract concepts are embodied. What Lakoff and Johnson argue is that the way we think about concepts is "fundamentally metaphorical in nature" (1980, 3).

To explain this, I use their examples of conceptual metaphors: 'Happy is Up' and correspondingly 'Sad is Down' (14-15). First, the spatial orientations 'up' and 'down' come from the fact that people have a body that can move up and down. These spatial orientations are then linked to the feelings happy and sad because of our bodily experiences with these emotions. As Lakoff and Johnson describe: "Drooping posture typically goes along with sadness and depression, erect posture with a positive emotional state." (15). The conceptual metaphors 'Happy is Up' and 'Sad is Down' that come from this bodily experience shape not only how we talk about our feelings, but also how we experience them. For example, we feel 'up' or 'down', something 'boosted' the spirit, or the mind 'sank', and someone 'fell' into depression or feels 'lifted'. And on the other hand, when we feel down, it can help to straighten your back and lift your head to feel better. The metaphors we connect with concepts therefore structure "the actions we perform" (4).[24]

[24] The 'we' I mention here refers to people living in the context of Western culture. Indeed, as Lakoff and Johnson argue, conceptual metaphors are linked to a specific culture. Within another example: the concept of

Conceptual metaphors are thus highly embodied, and to explain this further, it is important to look at how, according to Lakoff and Johnson, a conceptual metaphor (from now on indicated with the abbreviation 'CM') is structured, namely by *image schemas*. In his book *The Meaning of the Body, Aesthetics of Human Understanding* (2007), Johnson describes image as "structures of experience" created by our bodily experiences in and with the world around us (146). This means that image schemas are grounded in our sensory perceptions and that "we understand every single abstract concept we think with in terms of a specific experience of moving our body or sensing with it" (Germano 2013, 34). The anatomy of the human body is therefore fundamental to the image schemas we have. Examples of image schemas are 'GRASPING', 'BALANCE' and 'FRONT-BACK' which stem from the fact that human beings can grasp something, stand on two legs, and have a front and back.[25] As obvious as this may seem, these image schemas enable people to act and make sense of the world. For example, among other things, the image schema 'FRONT-BACK' makes people project front and back onto objects and makes people turn their bodies towards the front of something or someone they are looking at.

Image schemas can be seen as the basic bodily structure from which conceptual metaphors emerge. Within the context of cognitive science, Lakoff and Johnson describe in their book *Philosophy in the Flesh* (1999), how people reason about abstract subjective experiences through other mostly sensorimotor experiences (45). An example of this is how we think about understanding something (subjective experience) in terms of grasping something (sensorimotor experience[26]). This cognitive mechanism that allows people to think of 'understanding' in relation to 'grasping' is called conceptual metaphor. The conceptual metaphor 'Grasping is Understanding' develops through repetitive experiences of a correlation between a sensorimotor operation (grasping) and a subjective experience (understanding) (Lakoff and Johnson 1999, 55). This in turn can lead to more complex metaphors like 'I get what you mean'.

Since conceptual metaphors emerge in our brains from an early age, "they typically operate beneath the level of our conscious awareness" (Lakoff and Johnson 1999, 41; Johnson 2007, 136). Because of the unconscious influence of image schemas and CM on our lives, the aim of this dissertation is therefore to uncover some of the CM that structure our perception of the embodiment of robots by making them explicit.

'argument', they describe how the conceptual metaphor 'argument is war' shapes not only how we talk about an argument, but also how we experience it (1980, 4-5). For example, we can win or lose an argument to our opponent. In this example, they invite the reader, whom they assume is Western, to imagine what it would be like if an argument was seen as a dance instead of a war.

[25] Some other examples of image schemas are "PATH", "CONTAINER", "SCALE" and "OBJECT" (Johnson 1987, 126). Since Lakoff and Johnson notate image schemas in capital letters, I follow this notation method.

[26] Image schemas are the patterns that emerge from our sensorimotor experiences.

2.4 Embodied simulation

The term *embodied simulation*, used within the field of social cognition, as neuroscientist Vittorio Gallese (2010) explains, describes the presence of unconscious bodily processes that people perform in response to what they perceive. Among these processes is the *mirror-neuron system* (MNS). Mirror neurons are a class of motor neurons that become active in the brain when another person seen by the observer performs an action.[27] The neurons 'mirror' someone else's action allowing us to interpret perceived movement (Giacomo Rizzolatti et al. 2002, 249).[28]

As I analyse robots' movements, our MNS plays a role in how we perceive robots, because it has been proven that our MNS is involved in perception when our body recognises a movement, regardless of the embodiment (Valeria Gazzola et al. 2007, 1674-1675).[29] People thus relate movements to their own actions through the MNS and will therefore give meaning to robot movements from their own movement vocabulary. In interpreting robots' movements, mirror neurons thus play a role in meaning-making, which is why I briefly mention its operation here and refer to it in the analysis. However, mirror neurons are not explored in depth in the analysis, so a comprehensive discussion of the MNS is beyond the scope of this study.

2.5 Conclusion

In this chapter, I began by explaining the embedded and embodied cognitive approach I use in this research. This perspective emphasises that our perception depends on the sensorimotor capacities of our bodies that we acquire within biological, psychological, and cultural contexts. Second, I looked at the interaction of robotics and performing arts with the field of embodied cognition. And I gave an example of a study using an embodied perspective on robot art. In section 2.2, I considered the

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[27] Neuroscientists Giacomo Rizzolatti et al. (2002) discovered these mirror neurons and described them in their text “From Mirror Neurons To Imitation: Facts and Speculations”.

[28] Amy Cook (2007) gives a clear example of this in her article “Interplay: The Method and Potential of a Cognitive Scientific Approach to Theatre” (588). In it, she describes how when an actor on stage picks up a phone, the spectator simulates this action via mirror neurons and therefore understands whether the actor is picking up the phone or randomly playing with it.

[29] Valeria Gazzola et al. (2007) argue that when mirror neurons are activated, the purpose of the action is more important than the way the action is performed. Building on the fact that the MNS implies that people understand actions of others by "translating them into the vocabulary of our own actions" (1674), the authors argue that people can bridge differences in embodiment if the goals of the actions are familiar to them (1675). As part of this argument, they describe their research results showing that the MNS was both activated, without significant differences, when seeing human and robotic actions. Within this line of argument, they refer to the recent study by Valeria Gazzola, H. van der Worp, T. Mulder, Bruno Wicker, Giacomo Rizzolatti, Christian Keysers (submitted for publication). It therefore follows that the unconscious influence of the MNS plays a role in human perception of robots. This means that seeing a robot in motion can induce an embodied simulation in the observer, provided the action or movement has something familiar that we can relate to.

enactive approach, described by Noë, as complementary to the embodied perspective within cognition, because this perspective emphasises that perception requires autonomous action. Both sections 2.3 and 2.4 were devoted to two theories from the field of embodied cognition that I use in my research to dissect how people make meaning of robots with their bodies. Conceptual Metaphor Theory explains how our perception is highly metaphorically structured and how image schemas are the bodily components by which these metaphors are constructed. The theory of embodied simulation shows, focusing on mirror neurons, how people understand movements by performing them in their own bodies.

Chapter 3. Analysis case studies

An enactive dramaturgical analysis

I now turn to my two case studies. First, I take a closer look at the social robot Phi and then I continue with the Art robot. As I use the social robot as a contrast to the Art robot, because robot Phi overlaps with the well-known humanoid appearance of robots, the analysis of Phi is more compact than the analysis of the Art robot as the latter has a more experimental form. In both analyses, I start by introducing the robot. After outlining the setting, I analyse the anatomy, material, and way of moving. Thereby, I do not directly include the content told by Dehaes about the Art robot. I do include the scenography, therefore I approach this robot with earplugs in my ears, so to speak. This allows me to analyse only the meaning evoked by the embodiment of the robot. The next step is then to identify which element is most explicit within the robot design. From there, I argue which image schema and, in relation to it, which conceptual metaphor is linked to the design and what both entail. I then examine whether the evoked CM contrasts with or complements the way embodied cognition is encultured to perceive robots and argue what meaning arises from it. After analysing what meaning is created by the embodiment of the robots through an embodied and embedded perspective, in case of the Art robot, I remove my earbuds and include the content the setting adds to the robot and see if this information changes or reinforces the already analysed bodily meaning. Finally, I compare the results of the two different robots. This allows me to draw a conclusion in which I derive insights in bodily meaning-making processes for the field of HRI from the enactive approach in the analysis.

3.1 Case study 1: *Robot Phi*

The first robot I analyse is the social robot Phi, a robot working for care institution Philadelphia, whose headquarters is located in Amersfoort and has more than 600 care locations throughout the Netherlands (Philadelphia 2023). Philadelphia's goal is to help people with disabilities live as independently as possible. For example, people with Down syndrome, autism, people with diabetes, dementia or people who are deaf or blind. To create the best possible care, Philadelphia is researching various innovative ideas to optimise their services. One of these innovations is the robot Phi.

Robot Phi is a Pepper robot made by the Japanese company Aldebaran Robotics[30] and is considered a semi-humanoid robot because it has a slightly different shape from a human being

[30] This company was formerly known as SoftBank Robotics.

(Aldebaran n.d.). The robot is the first social robot that can recognise faces and basic human emotions.[31] Through conversation and a touch screen on its chest, the robot can engage in small conversations with people. The screen displays content that serves to emphasise messages and support speech. Besides verbal interactions, the robot can also adjust its position and body posture to suit the person it is interacting with. The Pepper robot is used in more than 2,000 companies around the world, performing tasks such as assisting people by informing them and guiding visitors.[32]

Philadelphia has been experimenting with using this social robot for more than three years to see in what ways the robot can be of value within their care services for people with intellectual disabilities (Philadelphia 2023). The aim is to support people with their daily tasks to help them get the most out of their lives. Help is provided by, for example, giving sports exercises, giving a notification for when the person needs to go shopping, clean the house, or take medicine and by cheering the person up by playing a nice song when the person feels upset. Philadelphia's research takes the form of sleepovers, using a social robot to complement the client's daily life. After a sleepover, ranging from two weeks to a year, the team analyses the data collected from the test situation showing how the robot has influenced the person's daily life and develops the robot further.

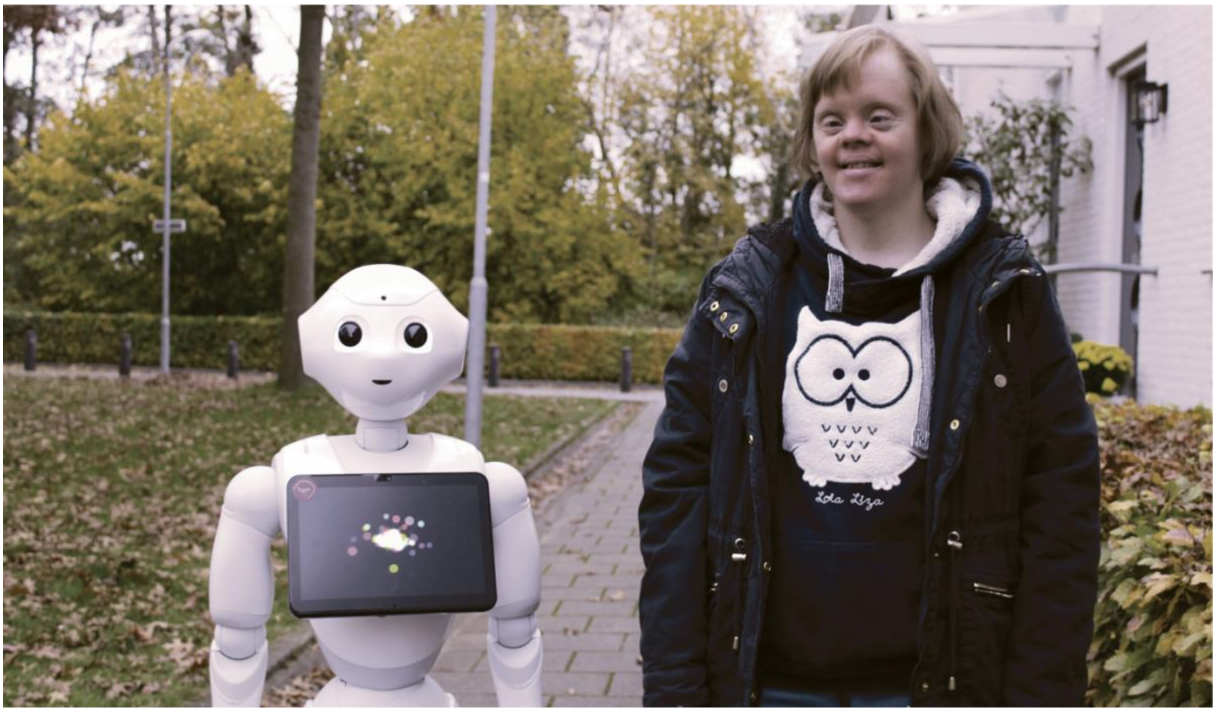


Figure 12. Robot Phi besides Lydia, n.d. (Photo: Philadelphia)

[31] The emotions are recognised by analysing facial expression and the pattern in the human voice. Because all Pepper robots are connected to a Cloud, they learn from each other's experiences.

[32] If this information has got you excited and you want a Pepper robot for yourself, prices start at around 20,000 euros, not including the software, training, service, and maintenance.
A video where robot Pepper functions as host: https://www.youtube.com/watch?v=ti7nAnDtx_M.

Having not seen Phi live myself, I analyse the robot from images and recordings of the robot. Because the embodiment of robot Phi is fixed and the context, although every client is different, is always a form of care, the analysis is not limited to a specific situation. In this analysis, however, I focus on one specific video from Philadelphia to provide a real-life reference point: a video in which Lydia is visited by robot Phi. Lydia (42) receives care from Philadelphia because she cannot live independently due to her intellectual disability. [33]

Lydia

Lydia sits down in front of robot Phi and asks if the robot slept well. However, although the robot is unable to respond to her questions, the small talk continues with Phi telling Lydia that she looks nice and wishing her a good day at work. Back home, Phi asks how her day went and when Lydia answers verbally and via the touchscreen tablet, they start listening to a song. "If Phi leaves, I would be super sad."[34], says Lydia indicating that she sees Phi as a friend.

Description

I begin the analysis with a closer look at the anatomy. As mentioned earlier, the Phi robot has many physical elements in common with a human being. The robot has a head with elements referring to eyes and a mouth, a bulge where people have a nose and two speakers where people have their ears. The head is connected to the torso by a neck and at sides of the torso, the robot has two arms. At the end of each arm is a hand with five fingers. The shoulder and elbow joints also resemble those of a human being, as do the small joints in the fingers. However, the hand itself is a little different, as the robot has no wrist joint. Furthermore, the torso and lower body together have somewhat of an hourglass shape, corresponding to the anatomy of some human beings with a narrower waist than upper and lower body. The lower body is joined with the 'legs' like a mermaid, as the legs are not separated. As there is a slight depth difference in the material, creating a kind of groove in the middle of the lower body, two legs seem to be formed. The lower part of the robot consists of three humps combined as a triangle-shaped stand. From the front, these look a bit like two large bulbous feet in the first position of a ballet dancer. Underneath this stand are wheels. Overall, the robot is 120 centimetres tall. Finally, the robot has a touch screen display mounted on its chest.

[33] Lydia lives in her own flat in a residential home and receives home care. Robot Phi has already stayed with Lydia four times (Philadelphia 2023).
The link of the video: https://www.youtube.com/watch?v=gIKt1BgLi1Y&t=2s.
[34] The original Dutch text: "Als Phi weggaat zou ik dat super jammer vinden."

There has been research into whether this anatomy is considered a specific gender. Interestingly, Aldebaran Robotics itself mentions that Pepper is "neither male nor female" (SoftBank Robotics n.d.), however, in their description, they use the pronunciation "he" (Aldebaran 2022). A study on the use of pronouns for Pepper, which examined how Pepper was gendered by researchers and participants in research, showed how the use of pronouns varied widely (Frank and Seaborn 2022). How Pepper's gender is received depends heavily on the task being performed and the context, including society, the domain in which the robot is acting, the user's gender, and so on (Schiebinger 2019, 19-20; Frank and Seaborn 2022).

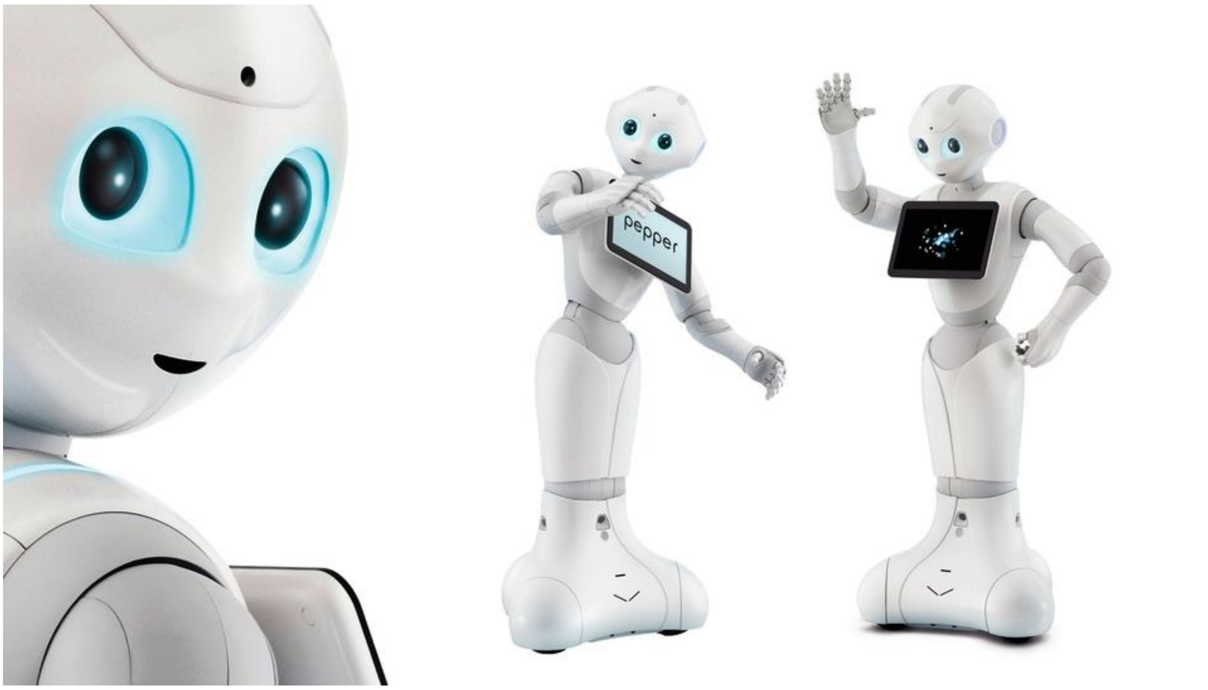


Figure 13. Pepper Robot, n.d. (Photo: Platform Robots.nu)

I continue with the materials used in the design. The whole robot is largely made of plastic materials. Phi is mainly white and the moving elements such as the joints are light grey. The eyes have lights that allow them to change colour. Throughout the robot are microphones, cameras and multiple laser, sonar, and infrared sensors, most of which are visible as black dots or slits (see Figure 14). The robot also has tactile sensors on its head and hands, all of which are integrated into the white plastic material. Phi's touchscreen is made of the same material as a tablet and thus has a glass touchscreen screen with a metal casing.

Thirdly, I look more closely at Phi's movements. Starting with the head, this can Phi move horizontally and tilt up and down. The neck cannot move separately. As mentioned, Phi has similar joints in its arm as humans, except in its wrists, which allows it to make similar movements as a human being. The robot can lift its arm, bend its elbow, and move its fingers. However, the movements are more mechanical, as (some) people can move the different parts of their body extremely smoothly. Phi can move different parts of its body at the same time, though, which makes the entire body movement more dynamic. The torso can bend slightly forward and the wheels under the robot allow it to rotate 360 degrees and move autonomously on flat surfaces. Because Phi has multiple cameras, it can turn its body towards a person in the room, and when interacting, its head faces the person with whom Phi is interacting. Finally, the lights in its eyes create the illusion that Phi can blink, making its face look more like a human being.

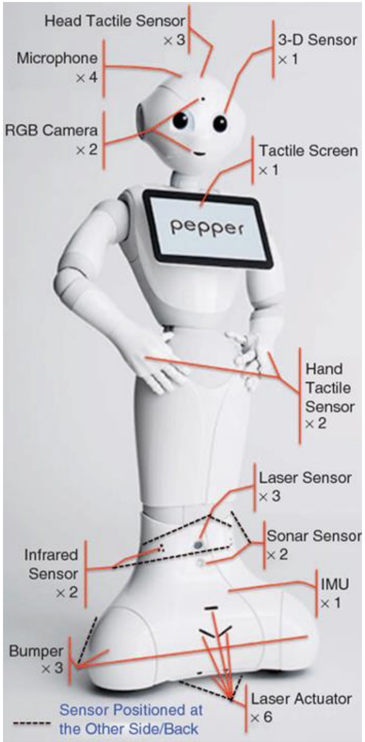


Figure 14. Overview of all technical elements incorporated in the Pepper Robot, n.d. (Photo: Samer Al Kork)

Interpretation: half human - half machine

As we can conclude, both anatomy and movements are in many ways made to simulate a human shape. However, with the material and the lack of constant movement, we see the opposite.

In anatomy, the face has several aspects that refer to a human face, and the neck and arms also resemble those of a human being. The main differences are the tablet and the 'legs' that are not really there but are simulated. In addition, the robot's height resembles that of a child. Because of the similarity in anatomy, the movements also partly resemble those of a human being. However, they tend to be less complex and less smooth than a human being. For example, the way Phi can move its head is very basic in contrast to the multitude of movements human beings can make with their heads. Also, the fact that sometimes the robot does not move at all makes it less human since people are always moving.

Viewed from the perspective of embodied simulation, I argue that because the movements are similar in purpose to those of a human being, they are highly recognised as human-like movements. Therefore, our mirror neuron system reinforces the human-like nature of the robot.

As mentioned, the material provides a contrast within the human embodiment of the robot. Because the material is mechanical, hard and has a white colour, it looks nothing like a human being. There is no such thing as for example a skin or the softness of a living organism. Looking at the presence this material creates, the robot looks more like a piece of furniture than a human being. The fact that the robot sometimes does not move or is even turned off reinforces this. And because the robot stands in a corner of the room and does not relocate, this is further emphasised.

Image schema 1: 'BODY'

Since the anatomy and movements of the robot resemble a human body, I argue that the image schema 'BODY' is the most appealing within Phi. This design therefore responds to the phenomenon called anthropomorphism, the tendency people have to assign lifelike characteristics to objects. Much research has been done on how anthropomorphism affects HRI. Some of these findings include that anthropomorphism provides more empathy (Riek et al. 2009), a more fun and lifelike experience (Kiesler et al. 2008) and more trust in relation to the robot (Natarajan and Gombolay 2020). Although most studies include humanoid robots, the last-mentioned study specifically uses the Pepper robot as one of its case studies.

Image schema 2: 'OBJECT'

The second image schema is evoked by the material. I argue that the robot's material appeals to the image schema 'OBJECT' because the robot consists entirely of unnatural elements. The material is hard and shiny and the moving joints along with the cameras and sensors are visible. This makes the robot the opposite of a living being, an object. The touch screen adds to the concept that the robot is just an extension of a computer. In addition, the mechanical way of moving and the lack of constant motion also reinforces the idea of an object.

From image schemas to conceptual metaphors

I now explain the image schemas mentioned above and relate them to conceptual metaphors. This allows us to explore how meaning is partly created through our bodies interacting with Phi. In the next section, I discuss which meaning is evoked.

BODY

The ‘BODY’ schema as described by philosopher Shaun Gallagher (2005), known for his work on embodied cognition, is not a static mental representation, but rather a process involving ongoing sensorimotor integration and bodily engagement. The ‘BODY’ image schema enables human beings to sense spatial boundaries, posture, and orientation of the body in relation to the environment. Characteristically, the schema underpins a sense of ownership and control over our bodily actions and experiences. Moreover, the image schema allows people to distinguish their bodies from the external world.

Because this image schema shapes our perception of the robot Phi, we experience the robot as a body with agency and ownership of its bodily actions and experiences. Therefore, I argue that the conceptual metaphor 'Personification' is evoked by the image schema. This CM described by Lakoff and Johnson involves seeing a physical object as a person (1980, 33). Hence, the CM ‘Personification’ can be made more specific by looking at the aspects and function of the robot. In the case of Phi, I therefore argue that the function of the robot provides a more specific CM, namely: 'Robots as Assistants'. Since the context is a care situation in which the robot is a caregiver and therefore an assistant. I consider the role of assistant to be the most present, but other roles may also be experienced by clients, as Lydia, for example, saw Phi as her friend.

OBJECT

The image schema 'OBJECT' mentioned by Johnson (1987) is perceived as a bounded entity in the world. It provides a cognitive framework that helps us perceive, categorise, and understand the objects we encounter. The characteristics of an object are its boundedness, wholeness, as we perceive objects as unified and complete entities, and their persistence. In addition, the ‘OBJECT’ schema includes recognising perceptual features that define and distinguish objects. These features may include shape, size, colour, texture, and other sensory qualities that contribute to our understanding and identification of objects.

Since the image schema ‘OBJECT’ aims at understanding and identifying the elements we encounter, I argue that in combination with the material used of the robot, the conceptual metaphor ‘Robots as Machines’ is evoked. I argue this because the schema 'OBJECT' invites the viewer to classify the robot as an object, rather than a living entity as we have seen above, and therefore define it according to its perceptual characteristics. The sum of these features, on the one hand, as we have seen, leads to the perception of a human body, but on the other hand, the colour, texture, and material of the robot lead to that of a machine.

3.1.1 What does it mean?

Embedded bodies

Comparing the two evoked CM to how our bodies have been encultured, both CM seem to fit this pattern. The first CM 'Robots as a Person' frames the robot as a person, which is in line with how people often think of a human-like artefact when hearing the word 'robot' (Alves-Oliveira et al. 2021). Although the CM 'Robots as Machines' suggests the opposite of the first CM, it too corresponds to how our embedded bodies have been cultivated to look at robots. So, the metaphors used in relation to robots include both robots seen as a person as well as a machine (Alves-Oliveira et al. 2021).

Bodily meaning

A great contrast emerges from both CM in how the robot invites the viewer to perceive the robot. The first CM 'Robots as a Person' invites the viewer to see the robot as alive, while the second CM 'Robots as Machines' invites the viewer to see the robot as a lifeless machine. From this contradiction, different meanings and expectations arise regarding the same robot.

The first difference lies in the agency and ownership of the robot. In the case of a 'person', the robot is given agency of what it does, because it is seen as a person and because the robot is not (seen as) owned by anyone. In the other case, the robot is seen as a machine without agency and programmed by someone. A difference in intentions arises here, because in the first case, the illusion is created that the robot acts out of its own suggestion (and thus its own 'will'), while the second perspective offers the idea that the robot's actions are 'merely' programmed.

A second difference is the relationship and expectations created by the two perspectives. When the robot is seen as 'alive', the idea is suggested that the robot gets to know you, which creates empathy and may lead to building a bond with the robot. Moreover, the robot is expected to think for itself. As a result, the good things but also the mistakes the robot makes can be attributed to the robot itself. However, when the robot is seen as a machine, the mistakes are attributed to the robot's designer and programmer. And because the robot is seen as an object, the bond between the human being and the robot will be less than in the person CM.

As a conclusion, I can say that the embodiment of the Phi robot contradicts itself resulting in two opposing approaches to which the client is invited to relate to the robot. This creates a contradiction in intention and expectation of the robot. In addition, this causes the robot to be perceived as something more than a machine and something less than a human. Thus, the combination of the two CM creates empathy on the one hand but avoids the Uncanny Valley on the other, the area where empathy suddenly shifts to dislike if the robot becomes too human (Mori 2012, 98-99). Moreover, this combination of CM could be advantageous in the sense that a client would feel less presence of the robot than with a human being, thus not invading too much privacy.

3.2 Case study 2: *Simple Machines*

Ugo Dehaes

The second robot I analyse is the Art robot presented in the performance *Simple Machines* (2021). The creator of this performance is dancer and choreographer Ugo Dehaes. At the age of eighteen, he started taking theatre and dance classes which led to attending the international dance and choreography school P.A.R.T.S. under the direction of Anne Teresa De Keersmaeker. After working as a dancer for several years, he founded the dance company *kwaad bloed* with dancer and choreographer Charlotte Vanden Eynde. From 2018, Dehaes began focusing on becoming, as he describes it, a "Choreographer of Things" which entailed, among other artworks, the moving sculpture *Stalactiet* (2018) and robots such as the self-learning robot *Runner* (2020)[35] or a series of robots in glass jars *Pickled Punks* (2021) (see Figures 15 to 20).

The work *Simple Machines* was made in the context of this focus on 'things'. The performance has the form of a lecture-performance in which Dehaes takes the audience on his (fictional) journey into using robots as his dancers in order to become rich. Dehaes tells his story seriously, but you feel the ironic tension because his story is strongly counterintuitive. Within this theatrical reality, he touches (implicitly) on several elements within the discussion and perception of robots in society such as the theme of forced labour and people's fear that robots will replace them. In addition, the story can be seen as a critique of capitalism by using a capitalist attitude in an ironic way. The performance lasts 42 minutes and is registered and viewable online, however, this does not include the invitation to visit the *Arena* (2020) exhibition after the performance, which serves as a backdrop for the performance.[36] Having introduced the creator and establishing a general contextual background of the performance, we may now proceed to delve into the intricacies of the performance.

Figures 15 and 16. *Stalactiet* by Ugo Dehaes, 2018. (Photos: Ugo Dehaes)

[35] The *Runner* (2020) at Zomertank, Leuven, an experimental city art festival founded by production platform Werktank: https://www.kwaadbloed.com/?type=robots&txt_id=227&searchterm=&lng=nl.
[36] This is the link to the registration: https://www.kwaadbloed.com/?type=work&txt_id=223&lng=nl.

Figures 17, 18, 19 and 20. *Pickled Punks* by Ugo Dehaes, 2021. (Photos: Ugo Dehaes)

Simple Machines

With a group of about 25 people we sit around a large wooden table with a white plastic cloth above it illuminating the surface. Then Dehaes starts talking, creating a kind of campfire atmosphere (see Figure 21). “Hello and welcome everybody. My name is Ugo, I am a choreographer.” He tells us how he has worked as a choreographer for more than twenty years. He continues: “I was hoping by now to be rich but unfortunately I am not.” He loves his work, but it is tough and expensive because of all the dancers he must hire for his performances. In his quest to earn more, as he rather ironically mentions, he came up with the idea of replacing his dancers with robots, as big companies seem to do.

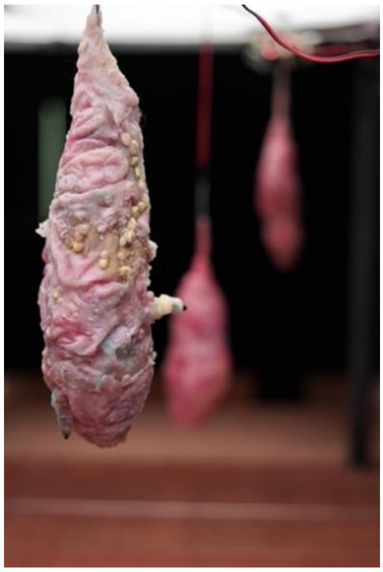
Then the first robot, bought from the online shop Amazon, is placed on the table; a moving box, which makes the audience chuckle slightly. Dehaes goes on to talk about how, after this first robot, he became excited to work with it as a choreographer, which again causes me to chuckle, but since robots are expensive to buy (and his goal was still to get rich) he figured out that he should breed robots. And that is where the adventure of this performance begins: with the birth and growth process of a so-called robot. After this first robot, Dehaes puts older versions of the same robot on the table as he addresses them in his narration. He says things like: "This one is still a baby" and "this one is a full-grown robot". After showing the audience all the robot's growth stages, Dehaes shares how disappointed he was when, after the robots were finally fully grown, he found out that the robots were "very very bad dancers". Moreover, they had no agency and creativity to help choreograph, so Dehaes had to make all the movements himself. "It takes me more or less a whole night to make one minute of dance", he explains. Soon, however, he continues, he found a solution to that problem. Inspired by the self-scanning supermarket checkouts where people scan their own groceries, doing unpaid work, Dehaes created the artwork *Arena* (2020) where visitors were invited to create robot choreographies by moving the robots themselves. When one last issue is solved, namely making the robots self-learning, the performance ends with a dance of several different robots coming from above and inside the table. The largely parallel moving robots, accompanied by music-making robots, and provided with coloured lights seem to make the performance end up as a 'real' dance performance.

Strictly speaking, the Art robot I analyse is not a real robot as defined in Chapter 1, as it is not self-directed. In this study, however, I think it is not important whether a robot is a robot, but whether it is perceived as such. And since Dehaes frames his ‘machines’ as robots, contrary to his title, I analyse them as such. Therefore, the analysis can be seen as an experiment asking, ‘What *if* this were a robot?’.

I now proceed with the analysis and forget temporary the content of the robot I have just described. As mentioned, robots are bred by Dehaes and within the performance, the same robot is shown in different ‘ages’ where the robot's appearance changes significantly. When analysing this robot, I therefore analyse three different (age) phases of the robot: the initial, middle, and final stages. The relevance of the three separate analyses is the major change in embodiment, as all these three stages represent part of the robot's development process.

Figure 21. Setting of performance *Simple Machines* by Ugo Dehaes, n.d. (Photos: Arne Lievens)

3.2.1 Stage 1: the Cocooning naked mole rat

Figures 22 and 23. Robots in, what I label as, stage 1 of their growth process, presented in *Simple Machines* by Ugo Dehaes, n.d. (Photos: Arne Lievens)

I call the first stage the 'Cocooning naked mole rat' stage. I do this not out of irony, but because the anatomy is rather complex to describe as it does not resemble anything I know. However, the combination of a cocoon of a butterfly with a naked mole rat did, in my opinion, although strange, offer a clear image (see Figures 24 and 25). In this first stage of the robot's growth process, we see a hanging object of about fifteen centimetres. The cord from which the robot hangs is a thin electric cable.

The robot's movement at this stage is minimal, and the movement there is a subtle floundering motion partly caused by the robot hanging from the ceiling. Like a cocoon, the robot seems to be inside the object we see, because when it moves, the object moves like a bag with a living organism inside rather than the bag being the organism itself.

This idea of a cocoon is reinforced by the material used in this phase of the robot's ‘life’. The material looks soft, slimy, and skin-like when the robot is slightly 'older' (see Figures 22 and 23). In addition, the material is jagged and uneven as wrinkles, lumps and bumps are present (like a naked mole rat). The colour of the material is a series of pinkish colours that lighten as the robot ‘ages’. Within this colour change, the material also becomes less shiny, so you can no longer see through the skin, something that was almost possible at the beginning of this stage.

Interpretation: an unborn living being

The interpretation of all the elements described forms a reasonably coherent whole, namely the perception of an *unborn living being*.

Starting with anatomy, the electric cable brings the association of a silk thread from the tiny caterpillar of a moth and that of an umbilical cord. The latter is reinforced by the robot's material and movements. The combination of pinkish colours, the soft, slimy, and skin-like material and the uneven wrinkles, lumps and bumps create the association of an embryo protected by parental tissue. The wrinkles as blood vessels supporting the robot with nutrients to grow. Because of this, and at the same time as reinforcement, the simple undefined movements the robots perform resemble a baby kicking in its mother's belly. However, because there is no such presence as a mother's belly, the robot seems vulnerable and exposed like a new born organism that should not have been born yet. This makes looking at it an ambiguous experience because, besides the fact that its appearance will already provoke shudders in some, it feels wrong to be able to see it. Besides this baby association, the fact that the robots are suspended also supports the association of that of a cocooning caterpillar, making the movements reminiscent of a caterpillar turning into a butterfly.

If we look at movement according to the concept of embodied simulation, I argue, since we relate the movements we see to movements we have seen before, that the movements in this phase reinforce the idea of a kicking baby or of a caterpillar turning into a cocoon. However, I consider the latter image to be less prominent in people's memories.

Figure 24. Multiple cocoons that will become butterflies, 2013. (Photo: G. Lady)

Figure 25. A naked mole rat, 2021. (Photo: Mint Frans Lanting)

3.2.2 Stage 2: the Colourful Centipede

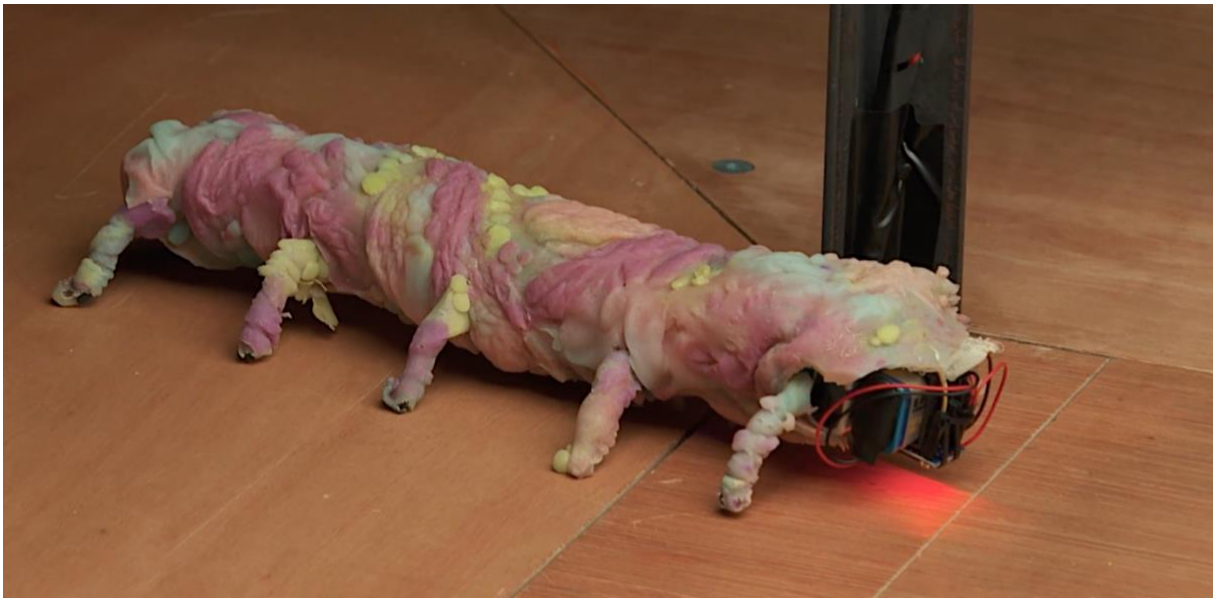


Figure 26. Robot in, what I label as, stage 2 of it's growth process, presented in *Simple Machines* by Ugo Dehaes, n.d. (Video: Ugo Dehaes)[37]

Hanging from a cord, the robot slowly develops tiny legs, after which it literally stands on its own. Meet: 'the Colourful Centipede'. Its anatomy now looks much like a centipede, but with five 'legs' on either side. There is a visible electronic component at one of the ends which shows the first mechanical element of the robot. The robot is now about 30 centimetres long.

Apart from the first glimpse of electronics, the material is soft rubber and consists of the colours pink/purple, blue and green. The surface is matt and cannot be seen through. The structure of the material is still uneven. Both the 'body' and 'legs' are covered with this rubber skin-like material.

The movements become more distinct. Although its appearance may resemble a centipede, its movements are more like those of a caterpillar. The robot can move its body up and down like a caterpillar (see Figure 27) and not horizontally like a centipede can. The legs are fixed to the body and cannot move individually. The movements are performed mechanically rather than fluidly and make a mechanical sound like a robotic arm in a factory would make. And finally, the robot cannot move forward, but only in place.

Interpretation: a young living creature

Whereas the first stage created the perception of an unborn living creature, the Colourful Centipede appears to be a *young living creature*.

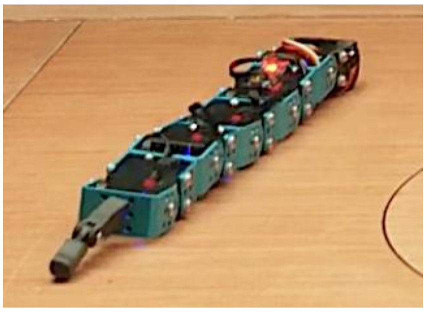
[37] Since no clear images were available of the robot in this growth phase, I obtained this image by taking a screenshot of the performance recording.

As mentioned, the anatomy of the robot at this stage resembles a centipede with fewer legs. Now that the robot is standing on these legs, it looks more like an insect than a human-like embryo as in the first stage. The colours of the material contribute to this idea, as the blue and green colours and their combination are not known within the context of a human but are when looking at different insects. Moreover, with the robot standing instead of hanging, the idea that the robot is 'born' is reinforced. The electronic component at one of the ends could be interpreted as the front, which contributes to the idea that this robot is 'alive', as it has some kind of head. In addition, the fact that the movements become more explicit but the robot cannot move forward makes it look helpless and therefore endearing. This enhances the concept of a young living creature, as the curious and seemingly aimless movements are reminiscent of a young animal.

The concept of embodied simulation, I argue, reinforces this helpless perception of the robot. This is because we recognise the presented movements from animals that can move forward, so our interpretation of the observed movements is a movement that 'must' be forward. Since this is not the case with this robot, we interpret the movement as incomplete. The robot is therefore seen as helpless and young, as it has yet to learn how to move properly.

Figure 27. A caterpillar moving its body vertically, n.d. (Photo: Twenterand)

3.2.3 Stage 3: the Rubik's snake

Figures 28 and 29. Robots in, what I label as, stage 3 of their growth process, presented in *Simple Machines* by Ugo Dehaes, n.d. (Video: Ugo Dehaes)[38]

The last stage I discuss I call 'the Rubik's snake'. The anatomy has changed again, as the robot no longer has legs and there is now a thin black extension on one side of the robot. Moreover, the anatomy has altered in the sense that the robot now visibly consists of a chain of interconnected links instead of a single object.

The material has also changed; the robot has shed its skin like a snake. Now all that remains is a hard and electronic structure made up of tiny wires, plastic, and metal. The colours present are black, silver, dark blue/green and some red details.

As there is no longer any 'skin' around the robot that used to form with its movements, the way it moves becomes more visible and therefore more mechanical. The movements the robot can make have not changed from the previous phase; the robot can still only move up and down in place.

Interpretation: a grown-up

The Rubik's snake is no longer an embryo or any other kind of animal, the robot is now a *grown-up*.

Through its material, colours and its anatomy made up of links, the robot has become a mechanically moving object. Since a 'mechanically moving object' corresponds to the common definition of a robot, the robot is considered finished. Within this stage an obvious front of the robot seems to have appeared, as the attachment can be interpreted as a kind of nose/beak or as a tail. Either way, the robot has a front. As the legs have disappeared and the robot's possible movements have not changed, it has become more like a snake than a centipede, although it cannot move like a snake. In addition, the skin is gone, which has a visceral effect because there seems to be no 'new'

[38] Since there were again no clear images available of the robot in this growth phase, I again obtained these images by taking screenshots of the performance recording.

skin. Moreover, because the robot can still only move up and down but is no longer in a colourful ("cute") jacket, the robot looks even more helpless (and useless).

Given the movements, I argue that through embodied simulation the same phenomenon occurs as in the last stage, where, because the robot could not move forward, we interpret the movement as incomplete and thus the robot as helpless. However, the motion memories from which our body interprets this movement have probably become different because the robot no longer has legs. Instead of a caterpillar or a centipede, the robot now looks more like the body of a snake.

In addition, this discrepancy between movement and expectations also creates a difference in the way the audience perceives the robot. In the first two stages, the robot is still 'young' and its seemingly random movements fit the pattern of a young animal, reinforcing the idea of a living being. The final 'old' robot, however, does not fit the pattern of our expectations of an adult in control and purposeful handling of the movements performed. Since the appearance at this stage is also the least animal-like, the movements therefore seem to support the idea that a change has taken place at the final stage and the creature is now 'just' a robot rather than a living creature.

Figure 30. All robots that are part of the growth process positioned in the order of 'growing up', presented in *Simple Machines* by Ugo Dehaes, n.d. (Video: Ugo Dehaes)[39]

[39] As there were no overview photos of the entire growth process, I obtained these images again by taking screenshots of the performance recording.

Image schema 1: 'PART-WHOLE'

The robot embodiment in the three different robot stages invites the spectator to see the robots as living beings. The organic and skin-like materials, the different animal anatomies and the movements that mimicked living beings all contribute to the idea of robots as living beings. However, the final stage raises the question of whether the robot is still an animal if it no longer looks like one.

More specifically, we have seen that the different stages also represented a specific phase within the process of growing up. Namely: an unborn living being, a young living being and an adult. This is addressed through the embodiment of the robots, as the robot evolves from 'naked/slim/pink' (embryo), to a 'soft-skinned' creature (baby) that then turns into a robot made of plastic, metal and wires as we know it from the working (adult) robots in a factory.

Because these phases are so explicit in this performance, I argue that within the embodiment of the robots, the image schema 'PART-WHOLE' is widely addressed. This is also supported by the performance as a whole, as you see the robots develop physically, which invites the viewer to think in a linear way of 'growing up' and thus see them as living growing entities. The fact that Dehaes presents one robot after another at the table reinforces this, literally building the development process by adding a new robot to the chain each time.

Image schema 2: 'PATH'

Another image schema addressed in this performance is the image schema 'PROCESS' as the performance shows a growth process of the robots.

As a second image schema, however, I consider a more specific image schema which specifies the robot development process, namely the image schema 'PATH'. Instead of a process, a path has a clear destination, which is very present in this performance. The whole development process seems to be working towards an end goal, namely: mature robots. This goal is seen within the embodiments of the robots. As mentioned, bodies represent different stages in the process of growing up, so each stage is related to the next stage: an unborn creates the goal of being born and a baby to eventually mature. This linear way of thinking invites the viewer to think in terms of maturity as a goal. In addition, the image schema 'PATH' is appealed to because the viewer knows that the process of growth is a relatively defined one because all children, for example, start walking at some point and experience growth stages such as puberty.

From image schemas to conceptual metaphors

We ended with two image schemas: 'PART-WHOLE' and 'PATH'. To analyse *how* meaning is evoked through these image schemas in our bodies, I first explain what the image schemas entail and then argue which conceptual metaphors emerge from them. Next, I explore *what* meaning emerges from these metaphors.

PATH

As Johnson (1987) writes, our lives are filled with all kinds of paths: physical ones, such as those from your bathroom to your bed or from your house to the bus stop nearby, but also a projected path created by a bullet shot into the air or even a path in your imagination. What all these paths have in common is that they always consist of the same components: "(1) a source, or starting point; (2) a goal, or endpoint; and (3) a sequence of contiguous locations connecting the source with the goal" (113). A path can thus be seen as a vast route from one point to another.

This 'PATH' schema forms the basis for the conceptual metaphor 'Purposes are Physical goals', which is a very important metaphor because it comes about through everyday use and is "vital to our successful functioning" (115). In our everyday life we thus unconsciously interpret things often using this metaphor. Besides that, I also see this metaphor reflected in the analysis of the robot as the goal of the robot is a physical one, namely a mature robot body. Therefore, from both arguments, I argue that the conceptual metaphor that arises in relation to this robot is 'Robots have a Purpose'.

PART-WHOLE

As the name suggests, the 'PART-WHOLE' schema is one that structures a whole into parts. Lakoff (1987) describes how important this schema is: "In order to get around in the world, we have to be aware of the 'part-whole' structure of other objects." (273). Indeed, our awareness of this structure allows us to recognise how to use the parts of the whole. For example, our body, which we experience within the 'part-whole' structure as a whole with parts, can move in different ways because we understand the different parts that can move.

I argue that this image schema underpins the conceptual metaphor 'Robots as Growing entities'. Indeed, the image schema 'PART-WHOLE' makes each stage of the robot perceived as part of the whole: 'growing up'. This is emphasised by the performance as the different stages (parts) are represented as connected and thus configured into the whole namely adulthood.

3.2.4 What does it mean?

Embedded bodies

Looking at how human bodies embedded in society are likely to have been encultured to look at the conceptual metaphors found, they seem to confirm a prejudice we have about robots, while refuting another image we have of robots. Indeed, on the one hand, the robot within the performance confirms the idea widespread in society that robots must have a purpose (Alves-Oliveira et al. 2021; Yolgormez and Thibodeau 2022). On the other hand, the performance invites the viewer to see robots as a living and growing entity, which contrasts with how robots are seen as objects or machines in society (Alves-Oliveira et al. 2021).

Bodily meaning

The CM 'Robots as Growing entities' creates a similarity to humans in that they are growing beings. This makes the robots resemble people, not by their appearance but by how they *become* a robot, which then creates a form of empathy. Furthermore, the suggestion of mutability and impermanence is created by this CM.

In addition, the embodiment of the 'adult' robot looks like a finished robot in the sense that it now looks like a robot as we know it. However, it looks helpless because it can only move up and down in place. So, this 'uselessness' contradicts the way the CM 'Robots have a Purpose' invites the audience to see a robot as useful. Therefore, I argue that the embodiment of the robot raises in the spectator the question of whether a robot should be useful and what that means. In addition, I argue that this contradiction evokes empathy because the robot fails in its task and thus evokes pity.

Finally, because the conceptual metaphor 'Robots as Growing entities' is based on the image schema 'PART-WHOLE', the phases of the robot as it grows up are experienced as part of a whole (maturity). This invites the audience to see an adult (robot) as a whole consisting of all the different stages of growing up. As this perspective contrasts with the idea that growing up involves 'passing through' the various stages of growth, it evokes the idea that an adult is also still a young child. This can be interpreted as a provocative notion as some adults look down on these earlier phases. On the other hand, it also raises the idea that every experience in a person's life is also part of who a person is today including, for example, past trauma.

Content: Dehaes' story

In the case of the Art robot, the content provided by the performance also plays a major role in how spectators perceive the robots shown in the specific situation. Therefore, I would like to discuss what this content is and its effect on the meaning that emerges from just the embodiment of the robot.

A closer look at the content provided by Dehaes, demonstrates that the given content in the performance contributes to the same image schemas that also emerged from the analysis of the robots' embodiment, namely: the image schemas 'PATH' and 'PART-WHOLE'. Indeed, in the performance, Dehaes narrates and performs several elements that reinforce the idea of a living growing creature. He tells how the robots are "born" and "grow" until they are an "adult", he calls the robots "cute" and a "little baby robot" and asks the audience to "be careful". Moreover, Dehaes also behaves as if the robots are alive, for example when he carefully takes a robot out of the box, strokes it and holds it as if it were a small baby; against his chest with two arms supporting it (see Figure 32).

Second, the uselessness of the robot in the analysis of embodiment is also highlighted by Dehaes. Indeed, the goal of getting cheap dancers to get rich is emphasised, while when the robots are mature and ready to work, they turn out to be poor dancers.

However, this futility combined with the purpose of work that Dehaes states adds an extra layer of meaning to the robot. Indeed, related to CM's combination of 'Robots have a Purpose' and 'Robots are Growing entities', this makes the robot not only resemble human beings as growing entities, as seen, but also a living entity whose purpose is to work. From here, as Dehaes ironically frames the goal of working and getting rich, this parable can be seen as a critique of how people often put work at the centre of their lives. And additionally, as a critique of capitalism because in this system almost everything revolves around money.

A second new meaning also has to do with the question of 'usefulness'. Since several robots have already been shown, all of which could only perform very basic movements, the problem Dehaes poses that the robots cannot dance properly takes on a hilarious tone, as the audience could have seen the naively posed problem coming from miles away. This raises the question of utility beyond just in relation to these robots. Implicitly, it asks whether robots are capable of creativity. And zoomed out more, the robot seems to become a philosopher asking the audience to think about the role of 'utility' in society.

Lastly, the idea that robots will take over the world or people's jobs seems undermined, as the robots to replace dancers are unlikely to be such good dancers. This also raises the question of what kind of work robots could and could not do and how we as human beings should relate to them.

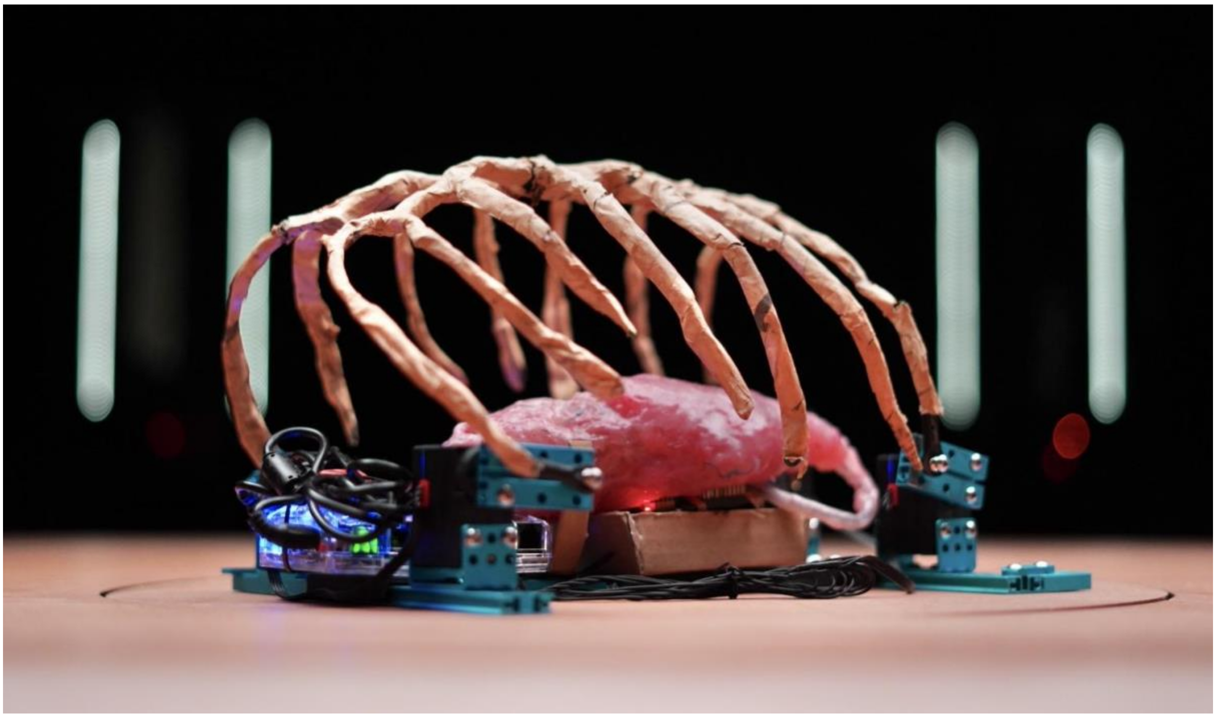


Figure 31. 'Mother' robot breeds a new robot, presented in *Simple Machines* by Ugo Dehaes, n.d. (Photo: Arne Lievens)

Figure 32. A robot gently held by performance creator Ugo Dehaes as part of the performance *Simple Machines*, n.d. (Photo: Arne Lievens)

3.3 A comparative analysis

Analysing two very different robots, both in embodiment and setting, resulted in different image schemas evoked by the robots that structured the way our bodies make meaning of the robots. In the analysis of the Art robot, I distinguished between the embodiment of the robot and the embodiment of the robot in relation to its content. This allowed me to analyse, on the one hand, what meaning is created by just the embodiment of the robot. And on the other hand, whether and if so, how the content would reinforce or change the meaning evoked by the embodiment. Now I compare the two case studies and reflect on what these different robot bodies offer for insights into HRI research.

Evoked meaning vs. embedded bodies

As could be seen in the analysis, there was a difference in whether the conceptual metaphors (CM) evoked by the robots differed from or corresponded to the way bodies have been encultured to look at robots. The CM evoked by robot Phi corresponded to the way we have been cultivated to look at humanoid robots and therefore reinforces the idea that a robot is both a machine and a person. However, the CM linked to the Art robot only partially corresponded to how humanoid robots are usually presented. The idea that robots must have a purpose is reinforced, on the other hand, the CM 'Robots as Growing entities' contrasts with how robots are normally seen. Our embodied experience of the Art robot thus contradicts how our bodies have been cultivated to look at robots. Consequently, our perception of robots is questioned and challenged and thus enriched.

Empathy

Another difference became apparent when looking at how both robots generate empathy in relation to a human being. The embodiment of robot Phi evokes empathy mainly through its anatomy and partly its movements as both resemble those of a human being. A distance seems to be created in terms of empathy by the robot's material, allowing the robot to stay out of the Uncanny Valley and not be seen as an invasion of privacy. This empathy 'method', because Phi has the appearance of a humanoid robot which is widely used in HRI, is widely used within HRI. In contrast, the Art robot creates empathy through being a growing entity combined with its animal material and anatomy. As the robot loses its skin in the final stage, the degree of empathy therefore decreases as it makes the robot less of a creature.

Since the setting of social robot Phi and the Art robot are very different, it is not possible to directly implement the empathy 'method' of the Art robot in the social robot. That is because Phi has a concrete function within the care situation that requires specific criteria. This means that, on the one hand, the Art robot would not be able to replace Phi and, on the other hand, the empathy method of the Art robot could also turn out very differently if applied to Phi. Therefore, I do not argue that robots should adopt a similar 'method of empathy'.

Taking this into consideration, I would like to explore what it might mean if the 'method' of empathy used in the Art robot design is used in robots like Phi and more broadly in HRI. Starting with the animal appearance of the Art robot, it is evident that this appearance cannot be used within the setting of social robot Phi, because the task Phi performs cannot be performed if Phi would not have, for example, arms (sports exercises) and a touchscreen screen (communication). However, in other forms of social robots that have other tasks, this animal appearance may be useful because this form can lead to a less threatened perspective on robots because an animal robot looks like a small harmless creature. In fact, this form is already being used, as seen with the social robot Paro in the form of a stuffed seal (Robotzorg n.d.).

Second, I look at what the suggestion that the robot is growing might mean within the design of Phi or other social robots. The notion of a growing robot makes the robot vulnerable because the robot is seen as changeable and impermanent. In addition, the fact that the robot is seen as growing also makes the robot an entity that is still learning and therefore imperfect. The notions of vulnerability and imperfection are thus generated by this other ‘method’ of creating empathy. Interestingly, I know from my few encounters with robots that robots like Phi are also very fragile and imperfect because robot technology is still developing. For example, my encounter with robot NAO showed that the software often failed while working with it and that the robot quite often fell while moving if the movements were too large or too fast. However, these robots are not seen as fragile, so expectations of social robots like Phi are usually higher than they can live up to. An embodiment of robots that does evoke the ideas of vulnerability and imperfection could therefore raise realistic expectations of robots.

If we focus on the social robot Phi, however, several counterarguments can also be given for creating the suggestion of a growing robot. For example, clients helped by the robot want to feel safe while being helped. Therefore, instead of the perception of robots as vulnerable, people should feel that robots are reliable and functioning well. And since robots are still quite expensive, robots might be used less if their vulnerability is emphasised. Moreover, the material used in the Art robot, which reinforces the idea of a growing being, is very impractical in a care situation like Phi's because the robot must be easy to clean because of hygiene as people's health is vulnerable.

In other environments, however, fragile, and imperfect social robots may have more advantages. In particular, if the robot would have a less practical function than robot Phi has. For example, if the purpose of a robot is to entertain people and make them laugh, an imperfect robot could probably work very well.

Utility

This fragile and imperfect approach to embodiment is related to the next element in this reflection, as it brings out the notion of utility. As seen by robot Phi, and commonly seen within HRI, a social robot has a concrete useful function, namely assisting its clients. The Art Robot, on the other hand, has no such concrete useful function because it is a bad dancer. As mentioned, this raises a question about utility. Whereas we usually think of robots as useful if they have a concrete purpose, the Art robot invites us to see if robots with non-concrete purposes can also be useful. In the case of the Art robot, this could be 'challenging the idea of what a robot should look like'. Broadening the scope of what constitutes useful purposes could lead to a shift from task-based robots within HRI to the use of robots with more philosophical or otherwise abstract applications. An example of this is the robot Bassie presented in the art exhibition *Robots in captivity* (2019) by artist Bram Ellens.[40] Bassie is a classic care robot from the early 1910s. However, as presented in the exhibition, Bassie started stuttering due to an error in his software update and could no longer perform his old tasks (Ellens n.d.). Instead of being a useless robot now, his appearance addresses the phenomenon of stuttering and how annoying it can be for the person who stutters. The robot thus brings attention to a problem that some people may experience. The embodiment of both this robot and the Art robot thus broadens thinking about what utility can mean within robotics.

Within the theatre

Finally, I reflect on the role of the medium of theatre as a self-reflexive meaning machine. First, as a narrator, Dehaes added more meanings to that of the embodiment of the Art robot. Second, the self-reflexive mode adds a second perspective on the meanings created by the embodiment of the Art robot and the content provided by Dehaes. Moreover, staging robots as Dehaes does, invites looking at social robots like Phi as a performer and an HRI as a performance. On the one hand, this brings a perspective that focuses on what robots evoke within interactions with people. On the other hand, the issues of utility, work, and capitalism raised in the performance offer a critical perspective on the way we design and use robots. Just as the same themes also offer a critical perspective on the way we live our lives, because theatre is, in a way, always a reflection of our own lives.

[40] Ellens is collaborating as an artist on the aforementioned project *Acting Like a Robot*.

Conclusion

What insights into processes of meaning-making can an enactive approach to HRI offer for the embodied design of social robots?

To answer this research question, in this study I combined the fields of performing arts, robotics and cognitive science and proposed a fairly new perspective on human-robot interaction (HRI). As fun and exciting as this is, implementing such a new proposal also creates some challenges. As a conclusion, I therefore reflect on my proposal and look at the insights I took from it in this research. Finally, I outline some of the questions the research encountered and raised within the wider field of robotics and share my thoughts on what I suggest for future research.

Looking back

In this research, I analysed the embodiment of two physically extremely different robots. I did so with a dramaturgical embodied cognitive approach with as goal to gain insights in the field of HRI. I started by analysing which image schemas were evoked, how these image schemas linked to conceptual metaphors (CM) and how they structured the way we make meaning of the robots. This allowed me to dissect how our bodies are involved in the meaning-making process of the two case studies. Instead of only analysing *what* meaning is constructed, which I could have done without using cognitive science, I analysed *how* this meaning is constructed within our bodies. This dissection created insights into what the different elements of the robot's embodiment evoked and what the sum of the elements communicated. Because both robots were very different in terms of environment and their functions, I used the insights I gained from the Art robot to explore what they might mean in a social robot environment.

By looking at how the design of the social robot Phi 'worked' within our human bodies, I discovered that the anatomy and partly the way it moved resembled people, while the material the robot was made of did not. This resulted in two opposite CM ('Robots as machines' and 'Robots as assistants') that led to both empathy and a sense of distance, which resulted in avoiding the Uncanny Valley.

The Art robot challenged our idea of what a robot could be and do through its embodiment. Indeed, the physical experience of the Art robot contrasts (in part) with the way our bodies are encultured to perceive robots, meaning that our unconscious bodily processes of the embodiment of the robot do not match the way we are cultivated to make meaning of robots. This robot therefore challenges our perception of robots. Indeed, there is a clash between the way we relate to robots and the way performance invites us to relate to robots. In addition, through CM's 'Robots as Growing entities' and 'Robots have a Purpose', the Art robot invited us to think about the topics of 'utility' and 'empathy'.

An embodied perspective on a performing robot

The intersection of the three areas created a layered perspective on the embodiment of robotics. Through the eyes of a dramaturg, I proposed an embodied cognitive perspective that led to a focus on what robots evoked in our bodies and how that happened. Instead of focusing only on what a robot 'is' or 'looks like', the performing arts perspective allowed me to indicate what the robot 'does'. In doing so, I approached the robot as a performer. The cognitive side added that I could also analyse what elements in the embodiment caused this 'doing', allowing me to gain specific insights into the embodiment and its effect.

The approach I developed in this research provides a relevant perspective for robot designers, as both the fields of embodied cognition and performing studies value the role of the body in meaning-making. Since the body plays an important role in meaning-making, this is also an important element within HRI. My approach provides a perspective and tools to incorporate this bodily meaning-making process.

For artists reading this research, I hope Dehaes' performance and my analysis showing the relevance of such work, as the power of imagination opens new ways of thinking, inspires them to explore the use of robots in art. In addition, this research provides an example of how cognitive science can dissect a bodily experience within a performance, which can be useful for an artist who wants to understand more about the physical experience of their work.

Discussion

In addition to the potential of the intersection in this study, there are of course a number of critical comments to be made.

A first limitation of my research is that within my case studies, I only focused on the form of the robot and its function. I had to limit my research and thus choose what to focus on, however, choosing to focus on the embodiment and function of the robots had the consequence that the social robot was less interesting to analyse as its appearance is quite unambiguous. Analysing what the robot says and how it says something in relation to embodiment would have created a more dynamic perspective of the robot. This lack of dynamism did not occur in the analysis of the Art robot because the robot itself did not say anything and because the embodiment consisted of multiple layers.

Second, I must point out that my use of Conceptual Metaphor Theory to dissect how our bodies create meaning for robots is highly simplified. I carefully analysed the case studies and argued why a specific image schema was addressed. However, because image schemas are highly interconnected, focusing on only two image schemas per case study, as the scope of this research allowed, gives an incomplete analysis. Therefore, this thesis offers an analysis of the most explicitly addressed image schemas. If I had included more addressed image schemas in the analysis, I would have obtained a more nuanced meaning which arises in interaction with the robots.

Furthermore, the research would have benefited greatly from more case studies, as many different robot bodies already exist in the field of social robotics. Analysing different social robots could have given more insight into the variation of existing forms of social robots and the differences in what these robots would evoke in terms of meaning in the human body. Hence, I hope my research provides a model for further analysis of different robots.

Finally, the results of this study are limited by my standpoint because both Conceptual Metaphor Theory and the way bodies are encultured to look at robots are culture-dependent. Thus, the results cannot simply be applied across the globe. An analysis of the same robots from a different cultural perspective would be interesting to see in what ways bodily meaning would be different as a result. A critical comment can be made on Conceptual Metaphor Theory from here, as Lakoff and Johnson do address the role of culture within their theory, but do not emphasise their own point of view and seem to assume that their reader is in a context of Western culture.

Zooming out

If we zoom out further and look at what this research means for the broader field of robotics, in addition to the earlier mentioned questions about 'empathy' and 'utility', questions arise related to the concept of 'growing robots'.

Firstly, the idea of a robot growing up raises the question of what it would do if a robot were labelled based on a specific age. Will people address a 'senior' robot as an elderly person? And what would be the benefits of doing so? Would a ‘senior’ robot be seen as having more authority and thus perform better in a consulting role than a robot labelled 'junior'? Or would a robot of 'your age' perform better in an advisory role because you assume more from someone in the same stage of life? Would people expect a 'senior' robot to be slower and would people therefore be more patient when encountering it? And would people be more lenient towards 'junior' robots when they make a mistake?

Second, growing up robots also raises the question of human responsibility, since in the performance Dehaes himself grew robots (making him the 'father') that were quite helpless. When a robot seemed to fall off a table because it could not navigate properly, Dehaes asked the audience to help the robot by moving it in another direction. As people created the robots, it seems our mistake to let the robot fall to the ground while they are still young, just like when we don't pay attention when a child climbs a tree and falls. Therefore, the question arises when we experience robots as living beings what that does to people's responsibility towards robots. Should we care for young and old robots as we do for people? Could the need to care for something be useful for some, for example to give people structure and purpose?

Age labelling is also related to the idea people usually have of intelligence, as people often see young children as uninformed or at least still learning, while an old person may be seen as oblivious. So, would an 'adult' robot be perceived as smartest? And would a young robot that is 'still learning' be turned off less to make it more experienced? On the other hand, the concept of intelligence is also closely linked to the idea of usability discussed earlier. So, would an adult useless robot then be seen as a dumb robot? And a young useful robot as gifted?

Linked to utility is also the question Dehaes raises with his quest for dancing and self-learning robots. Since he mentioned that robots are unfortunately not such good dancers because they have limited movement capabilities and lack creativity, he brings up the question of whether robots could be artists or whether they are ultimately useless in the creative sector.

Future research

On a final note, I would like to put forward some ideas for further research. First, as mentioned, there are many different forms of social robots that would be worth analysing. Furthermore, the concept of gender in relation to robots is an ambiguous topic, as we have seen with the Pepper robot. Therefore, it would be interesting to analyse social robots based on my approach to perhaps get a better understanding of how gender is evoked. Additionally, since my proposed method focuses on the body of robots, it could also be worthwhile to explore whether and how this approach could be useful once elements such as the robot's voice are also analysed. Finally, further research can be done on the ethical side of robot design, as this was not within the scope of this study.

Ultimately, I hope this research contributes to the emerging debate recognising the relevance of the role of the human body in making meaning. In doing so, I hope to have provided a model for analysing the affect and meaning of various robotic bodies evoked within human bodies. A model that, on the one hand, helps to dissect the meaning of existing robot bodies and, on the other, invites artists and other researchers to use it as a tool to analyse the potential of new forms of robots. This research thus seeks to contribute to enriching the scope of thinking about robot design.

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