Reconceptualizing Autonomy in Elderly Care in the Robot Era

A Relational Perspective

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Reconceptualizing Autonomy in Elderly Care in the Robot Era: A Relational Perspective

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Reconceptualizing Autonomy in Elderly Care in the Robot Era: A Relational Perspective

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1 Introduction

"A (robot) company came to us to try out a product. That robot they brought was not good because when it takes care of the users' urination and defecation, the users must lie in bed in a specific position and keep still. There were many restraints and the robot rubbed on the users' skin. The job was eventually ours because the robot did not work well."

— A quote from a caregiver I interviewed in 2019 in a nursing home in Suzhou, China on their experience with the care robot they used at work.

1.1 A technological response to the elderly care crisis

The growing population of elderly people worldwide, along with a shortage of human caregivers, makes it challenging to provide care. To address this widespread challenge, care robots are considered as a technological solution. This thesis critically examines some of the important ethical issues associated with the deployment of robots in settings where human beings provide care to elderly people. More specifically, I will study how robotic innovation in healthcare affects the autonomy of the human beings involved. With philosophical reflection on the potential ethical issues that arise through technological evolution, I propose a reconceptualization of autonomy in elderly care and make recommendations for the future design of care robots.

1.1.1 A looming demographic change and severe challenges in healthcare

Increased life expectancy is an encouraging outcome of unprecedented socio-economic development worldwide. This is well known and evident across the world, and it is projected to increase even further in the future (World Health Organization, 2015). In 2019, the United Nations estimated that the proportion of elderly people aged 65 or older in the total population (which represented approximately 9% of the world's population at that time) will exceed 16% by 2050. The number of people in this age range is projected to

rise rapidly from 703 million in 2019 to 1.5 billion by 2050 (United Nations, Department of Economic and Social Affairs, Population Division, 2019). The steady increase of elderly population coupled with the lagging social services and infrastructure to accommodate the demographic change is causing various challenges in several sectors, such as environment and healthcare in many countries (Bloom et al., 2015; Menz & Welsch, 2012). In this thesis, I will focus on some of the most significant issues that result from aging populations, by focusing on elderly care.

Elderly people commonly undergo deteriorations of physical, mental, and social capabilities in their older age. Deterioration of body functions, such as hearing, vision, coordination, mobility, and immunity is inevitable for the elderly. They are also at high risk of suffering from disability and chronic diseases, such as hypertension, diabetes, and arthritis, which makes it difficult for them to live independent lives (World Health Organization, 2015). Moreover, elderly people with physical health problems are often at higher risk of developing mental and cognitive disorders, such as depression, anxiety, and dementia.

The social environments of elderly people further complicate their situation. In older age, there tends to be a substantial reduction in social connections due to factors such as living alone and being disconnected with old colleagues and friends after retirement. Social isolation and loneliness are highly correlated with health risks (Jaremka et al., 2014). A lack of social connection is associated with an increased risk of dementia, heart disease, and stroke (National Academies of Sciences, Engineering, and Medicine, 2020).

Besides the impact of the above on elderly people at an individual level, the consequent demographic change also has a profound impact on healthcare systems at large. One of the most challenging aspects of an aging population is the increasing pressure on the healthcare sector to meet the demand for elderly care. However, there is currently a global shortage of caregivers. There are two kinds of caregivers: 1) medical professionals, such as doctors and nurses; and 2) informal care workers, such as family and friends. These

caregivers provide care in various care settings, including clinical facilities, nursing homes, residential communities, and private homes. The general concept of "caregivers" I use in the following chapters mostly focuses on professional caregivers, while family members are also discussed as informal caregivers.

A report from the International Council of Nurses indicates that there is a global shortage of 5.9 million nurses (Buchan & Catton, 2020). Facing the shortage of nurses and relevant funding, many overburdened nurses often work in sub-optimal conditions and tend to have longer working hours (Bae et al., 2018). Furthermore, the quality of care that nurses provide varies widely depending on their vocational education and training (International Labor Organization, 2020). Inadequate vocational education and insufficient care training can lower the quality of care that caregivers provide, which jeopardizes care receivers' health. This begs the question of how the healthcare sector across the world can overcome the challenges that result from population aging.

1.1.2 Care robots as a possible solution

In order to address the challenges faced by healthcare and socio-economic systems, many countries turn to robots as a technological solution to narrow the gap between the increasing demand for care and the shortage of human caregivers. Here, care robots are understood as including embodied robots, AI, avatars, and chatbots, which are used by care receivers and/or caregivers to promote the quality of care in various care settings, such as hospitals, nursing homes, and personal residences (van Wynsberghe, 2013b; van Wynsberghe & Li, 2019). Despite the relatively high costs of design, development and implementation, delivering care without temporal and physical restrictions is still a distinct advantage of care robots in areas where there is limited access to healthcare (Jang et al., 2020).

With the technological advancements in care robots and the resulting contribution to care practice, the introduction of care robots is leading a revolution in healthcare worldwide. There was a surge in the unit sales of medical robotics from 7,000 units in 2019 to 18,000 units in 2020 (International

Federation of Robotics, 2021), and global policy changes were adapted to boost the development of care robots. For example, in 2013, the Japanese Ministry of Economy, Trade and Industry initiated the "Project to Promote the Development and Introduction of Robotic Devices for Nursing Care" to bolster self-sufficient living among the elderly population in Japan (Japan Agency for Medical Research and Development, 2019). In 2017, the Chinese Ministry of Industry and Information Technology and the Ministry of Civil Affairs issued the "Action Plan for the Development of Smart Health and Elderly Care Services (2017–2020)" (Xinhua, 2017). This is the first specialized national policy for developing and deploying care robots in elderly care in China. In the European Union's research and innovation framework program, "Horizon 2020", research on developing new products and services to age well, including care robots in elderly care, was prioritized with a budget of €80 billion from 2014 to 2020 (European Commission, 2016).

The ongoing COVID-19 pandemic continues to necessitate caregivers that can interact with patients while maintaining a safe distance to lower the risk of infection. To this end, there has been a tremendous surge in the past two years in virtual care for elderly patients, which can be provided by care robots. To reduce the potential risk of infection in healthcare facilities, ultraviolet-disinfection robots are deployed in nursing homes and hospitals to eliminate pathogens (Holland et al., 2021; Zemmar et al., 2020). In hospitals, delivery robots are delegated with food and medication delivery tasks to keep caregivers safe from high-risk situations (Arthur & Ruan, 2020). Furthermore, various socially assistive robots have been used in elderly care facilities to mitigate the socially negative effects of the pandemic, such as loneliness and isolation. For example, the robot SARA, recently introduced in the Dutch market, aims to facilitate elderly care receivers' social connection with family and friends via video calls, thereby improving their quality of life—especially when the pandemic disproportionally hit nursing homes (The European Institute of Innovation and Technology, 2020). Pepper, a monitoring robot usually used in hospitals and nursing homes, has also played a crucial role in the battle against COVID-19. Human caregivers delegate care tasks to Pepper to minimize the potential risks of infection in human interaction. With its telepresence application, Pepper can be remotely controlled by medical

professionals to monitor and record the personal health conditions of patients (Getson & Nejat, 2021). Coupled with 5G and other technological breakthroughs, care robots are predicted to play an even more significant role in a post-pandemic world.

1.2 Autonomy as a central value in elderly care through care robots

In the current philosophical debate on elderly care through care robots, the values of privacy and safety are frequently discussed. However, a thorough examination of the value of autonomy is absent. This is an obvious lapse, given the centrality of the value of autonomy in ethics—specifically bioethics. Thus, I suggest that the value of autonomy is overlooked in robot care and merits closer scrutiny. This section highlights the main research gaps in light of the significance of autonomy in elderly care through care robots and discusses why it is paramount that researchers pay closer attention to the value of autonomy.

1.2.1 The impact of care robots on the autonomy of both elderly care receivers and caregivers

According to several theories of ethics and human values, autonomy entails that people can make their own decisions and execute them to realize their goals (Friedman & Kahn, 2002; Sorell & Draper, 2014).

Autonomy is a fundamental value that is prominent in the guiding principles in the influential bioethics publication, the Belmont Report (US Department of Health, Education, and Welfare, 1979). This report identifies ethical principles and guidelines on protecting human research subjects. The principle of respect for autonomy is also one of the four main principles of biomedical ethics identified by Tom Beauchamp and James Childress (Beauchamp & Childress, 2001). Compared to the ethical challenges of deception, isolation, privacy, safety, and vulnerability (Körtner, 2016), autonomy is pertinent to both elderly care receivers and caregivers. This makes the present study's focus on autonomy even more urgent. In order to comprehend the impact of care robots on the value of autonomy in care

relationships, I first conduct an in-depth examination of the ethical issues associated with the autonomy of elderly care receivers and caregivers in robot care.

Ethical issues of autonomy centered on elderly care receivers

There is a growing body of research examining the ethical impact of care robots on elderly care receivers, as elderly care receivers are usually at the center of care practice and relationships due to their vulnerability. For example, Aimee van Wynsberghe (2013) argues that robots that assist people with daily activities aim to help them overcome practical problems. This, in turn, promotes their autonomy and independence, and ultimately allows them to live on their own. For example, with the help of monitoring robots equipped with a walking frame, elderly care receivers with mobility issues can walk without depending on human caregivers for help, which enhances their autonomy.

Nevertheless, the focus on autonomy in elderly care through care robots is disproportionate to its significance and urgence in healthcare. Most of the literature in the ethics domain of care robots focuses on the ethical issues related to the autonomy of elderly care receivers (Getson & Nejat, 2021; Pirhonen et al., 2019; Sharkey & Sharkey, 2012; Stahl & Coeckelbergh, 2016). Umbrello et al. go one step further to propose certain design requirements for care robots in elderly care by using the approach of value sensitive design (Umbrello et al., 2021). However, the literature does not address detailed ethical challenges to autonomy in certain contexts. For example, it remains unclear to what extent care receivers who struggle with decision-making due to severe mental impairment can exercise autonomy and freedom. Furthermore, the robot may pose risks to the autonomy of its user, which creates conflicts between the enhancement and/or decrease of different aspects of autonomy concurrently. Let us consider a situation in which the robot restrains the user from leaving the building for safety reasons. On the one hand, delegating decision-making to the robot can enhance their autonomy in such circumstances if they cannot make safe decisions on their own to ensure their safety. On the other hand, the assurance of safety that

results from the robot's intervention may jeopardize the user's free decision-making (Sharkey, 2014). Such conflicts within the autonomy of elderly care receivers require further scrutiny of the meaning of autonomy in the specific robot context and detailed analysis on the impacts of care robots on elderly care receivers' autonomy.

Ethical issues of autonomy centered on caregivers

In mainstream academic discussions on autonomy in elderly care and healthcare systems, the emphasis is usually on the autonomy of elderly care receivers, while the autonomy of caregivers is overlooked. As one of the predominant role-players in care practice and care relationships, professional caregivers' autonomy is associated with their job satisfaction, work performance, and more importantly, the quality of care they provide (Papathanassoglou et al., 2012; Rafferty et al., 2001).

However, caregivers' autonomy is also profoundly impacted by the advent of care robots in healthcare. Similar to care receivers, caregivers are also direct users of many care robots. These robots can have several positive and negative effects on the professional autonomy of caregivers. For example, delegating disinfection tasks to disinfection robots in nursing homes during the COVID-19 pandemic helps to minimize caregivers' risk of exposure to the virus. In operating rooms with surgical robots, caregivers may be obliged to take on additional tasks, such as robot equipment connection and set-up (Raheem et al., 2017). However, assigning these responsibilities to caregivers can diminish their autonomy if they are imposed on them without their consent. Considering their central role in care practice and the new tasks that emerge in robot care, caregivers' autonomy deserves adequate attention in the robot era. Furthermore, robot-assisted surgeries with robots such as da Vinci, often incur high costs of acquisition, maintenance, and training. Therefore, the average cost of robot-assisted surgeries is higher than laparoscopic and open surgeries (Baek et al., 2012; van Dam et al., 2011). If a medical facility allocates more funds to robots, then the budget for its caregivers is likely to be cut, which may further impede caregivers' voluntary participation in robotic surgeries.

In such a scenario, the interaction goes beyond the traditional human caregiver-human care receiver model. The dominant dyadic human-robot interaction (HRI) model fails to include the human care receiver, the care robot, and a group of medical professionals involved in the surgery, such as surgeons, nurses, and other assistants. To deal with the deficiency in the HRI model, a more advanced model that focuses on the intertwined relationships between a care receiver, care robot, and a system of caregivers is proposed to reveal new ethical issues in the more complex, multi-directional, and reciprocal relationships in triadic interactions.

1.2.2 The mainstream philosophical discussion on autonomy

Tracing back the definition of autonomy in philosophical traditions, it is clear that Immanuel Kant's characterization of the close connection between a human being's uniqueness and their autonomy and John Stuart Mill's view on individual liberties have had a profound impact on contemporary discussions on the value of autonomy (Campbell, 2017; Ho, 2008b). Most accounts of autonomy embedded in the design of care robots tend to focus on the individualistic understanding of autonomy, such as that developed by Kant and Mill. However, this understanding of autonomy neglects other perspectives from non-Western cultures and ethics of care, which emphasize the relational aspects of autonomy. For example, the care robot KOMPAÏ embedded with the individualistic interpretation of autonomy may diminish human relationships in care practice. The relational perspective is especially significant in the healthcare context, where an individualistic understanding of autonomy falls short, given the care receivers' dependence on caregivers and other aspects of their surroundings. Such an individualistic understanding of autonomy also falls short in other contexts, as indicated by relational accounts of autonomy. For the purpose of this thesis, I focus on the healthcare context.

Embedding such a one-sided understanding of autonomy in robot design could lead to biases. An alternative perspective with more cultural diversity and inclusivity needs to be employed as a complement to better maintain and enhance the autonomy and overall wellbeing of elderly care receivers. Importantly, non-Western approaches to relational autonomy are not only

relevant in non-Western countries because of their cultural background; instead, they also highlight urgent issues in Western countries, where relational aspects of autonomy have not gained sufficient attention.

In sum, current studies on elderly care through care robots have four main research limitations (RL). First, although there has been a shift from the traditional caregiver-care receiver interaction to HRI in order to keep up with robotic development in healthcare, the HRI model fails to capture the complex relationship between single or multiple care receivers and care robots, and a multi-faceted healthcare system consisting of various caregivers (RL1). Second, there is a lack of in-depth research on the impact of care robots on elderly care receivers' autonomy (RL2). Third, caregivers, especially relatively underpaid and underrecognized nurses, have not received adequate attention to their professional autonomy in the robot era, despite the central role they play in care practice (RL3). Fourth, the dominant Western philosophical tradition of an individualistic perspective on autonomy, which prioritizes independence and self-sufficiency, cannot explain elderly care receivers' actual needs in care relationships (RL4). This calls for a different, but complementary relational perspective on autonomy, grounded in non-Western (e.g., Confucian) and feminist approaches, which should be embedded in the design of care robots.

1.3 Research questions

This thesis aims to bridge the gaps that stem from the aforementioned four research limitations in existing studies on elderly care through care robots. Thus, I formulate my main research question as follows: ***How should we reconceptualize the value of autonomy with regards to the relational aspects of elderly care in the context of care robots?*** This central question gives rise to four sub-questions, each corresponding to a particular research limitation in sequential order:

(1) How should we understand the complex relational aspects of elderly care through care robots?

(2) How should the autonomy of elderly care receivers be considered in robot care?

(3) How to conceptualize caregivers' autonomy in elderly care in the robot era?

(4) Which conception of autonomy should be embedded in the design of care robots?

1.4 Outline and methodology of the thesis

To investigate the ethical issues related to the value of autonomy in robot care, I first examine the multiple interactions in the context of robot care and the ethical impact of inserting a care robot into these relationships. In Chapter 2, a literature study and normative analysis are conducted to critically evaluate the limits and strengths of the HRI model for robot ethics. Chapter 2 answers the first sub-question (RQ1) "*How should we understand the complex relational aspects of elderly care through care robots?*" by proposing an advanced human-robot-system interaction (HRSI) model to understand the complicated interactions in elderly care through care robots. This innovative HRSI model addresses the complexity of the triadic interaction between single or multiple care receivers and care robots, and a multi-faceted healthcare system of human caregivers. Compared to the conventional dyadic HRI model, the proposed HRSI model serves as an advanced evaluation tool for the ethical assessment of care robots. It can also reveal additional ethical impact on the healthcare system that go beyond HRI.

After developing a better understanding of the relational aspects of elderly care through care robots, I answer the question "Whose autonomy should be considered in elderly care in the robot era?" by focusing on both elderly care receivers and caregivers in Chapters 3 and 4 respectively. For the scope of this thesis, the question of whether care robots might also have autonomy is not discussed, as it is at this point in the development of robotics not a likely and relevant consideration.

Chapter 3 responds to the second sub-question (RQ2) "*How should the autonomy of elderly care receivers be considered in robot care?*" by proposing a conceptual investigation of the autonomy of elderly care receivers in the context of robots. Such an investigation is based on the taxonomy of autonomy developed by the bioethicist Bart Collopy (Collopy, 1988). Collopy presents six pairs of polarities of autonomy in human care settings. This

taxonomy is extended from human care settings to the robot care context in Chapter 3. This application is subsequently recommended as an instrumental tool for evaluating the impact of care robots on the autonomy of elderly care receivers, both retrospectively and prospectively.

To address sub-question 3 (RQ3) "*How to conceptualize caregivers' autonomy in elderly care in the robot era?*", Chapter 4 pays sufficient attention to caregivers, particularly nurses, by arguing that their professional autonomy should be taken into consideration in elderly care through robots. As care robots become more prevalent in elderly care to enhance the care quality and the autonomy of elderly care receivers, caregivers are more likely to work with and be affected by care robots, both directly and indirectly. Chapter 4 begins with an individual perspective to investigate how the professional autonomy of nurses is performed in practice in the robot era and to uncover the impacts of care robots on their autonomy through the HRI model. A collective angle is also employed to reconceptualize nurses' professional autonomy and assess how it is affected through the HRSI model.

Value sensitive design (VSD) serves as the main theoretical framework in Chapters 3, 4, and 5. VSD aims to encourage consideration of the value of autonomy in the care robot design process. I modify the original tripartite methodology for VSD, which consists of conceptual, empirical, and technological investigations (Friedman et al., 2002), to integrate normative, conceptual, empirical investigations, and design recommendations as the argumentative line of these three chapters. In Chapters 3 and 4, conceptual investigations are used for analyzing the value of autonomy of elderly care receivers and caregivers. Normative analysis is also used to make recommendations for better assessment of the impact of care robots on the autonomy of elderly care receivers and caregivers.

Chapter 5 answers the sub-research question (RQ4) "*Which conception of autonomy should be embedded in the design of care robots?*" by highlighting that the mainstream understanding of autonomy in VSD is often perceived as individualistic. It criticizes the implementation of individualistic autonomy in VSD in care robots. Furthermore, this chapter explores how the current

design of care robots either supports or hinders the value of autonomy in elderly care. My observations from an exploratory empirical study conducted in a nursing home in Suzhou, China reveal that the interviewees place greater emphasis on interpersonal relationships than the individualistic aspects. This divergent view further substantiates the need for a complementary relational perspective of autonomy that can be adopted by multiple cultures. A proactive design that embeds the relational understanding of autonomy in care robots is recommended to enhance the value of autonomy identified in the conceptual investigation.

Relational accounts of autonomy found in non-Western philosophical traditions such as Confucianism; as well as in feminist ethics approaches such as in ethics of care, can provide important insights concerning the role of robots in elderly care. It enriches further philosophical discussions about autonomy and sheds light on robot design to enhance the value of autonomy in elderly care. Based on the ethical considerations of this PhD research, proactive design recommendations for care robots are made to promote autonomy in elderly care.

Chapter 6 concludes the main findings and summarizes the main contributions of this PhD project. In addition, it discusses the limitations of this thesis and offers some suggestions for future research works.

Chapter	Title	Methodology	Existing research limitations	Research questions	Fill the gap
1	Introduction				
2	A paradigm shift from HRI to human-robot-system interaction (HRSI)	Literature study & Normative analysis	RL1	RQ1	HRSI is proposed to capture the full picture of relationships in robot care
3	The complexity of autonomy: A consideration of the impact of care robots on the autonomy of elderly care receivers	Conceptual investigation & Normative analysis	RL2	RQ2	A taxonomy of autonomy is employed to analyze robots' impact on elderly care receivers' autonomy
4	Reconceptualizing the professional autonomy of caregivers in robot care	Conceptual investigation & Normative analysis	RL3	RQ3	Focusing on the professional autonomy of nurses and care robots' impact thereon
5	Individualistic perspective vs. relational perspective: How to improve autonomy in value sensitive design in care robots	Empirical investigation & Normative analysis & Ethics design recommendations	RL4	RQ4	A relational perspective on autonomy is introduced to be embedded in VSD in care robots
6	Conclusion				

Figure 1.1 The structure of the thesis

2 A paradigm shift for robot ethics: From HRI to Human-Robot-System Interaction (HRSI)[1]

2.1 Introduction

The healthcare system of 2019 uses a variety of "bots"[2] in the provision of care from physical robots, embodied AI, to avatars and chatbots. According to the International Federation of Robotics (2018), robot sales are at $ 1.9 billion for the year 2017. Beyond this, the global market of chatbots, a kind of software used to communicate with users, is expected to reach $ 2.1 billion by 2024 and a large share of it will be in healthcare (Zion market research, 2018). Developers claim these bots promise to mitigate the shortage of healthcare workers and resources; however, another school of thought criticizes the introduction of bots for their potential to threaten ethical and societal values such as privacy, wellbeing, social isolation among others (Lin et al., 2012; Sharkey & Sharkey, 2010; Sparrow & Sparrow, 2006; Vallor, 2011; Veruggio & Operto, 2008). We suggest in this chapter that the traditional forms of ethical evaluation, which rely on a dyadic human-robot interaction, ought to be re-thought in order to account for the impact that robots have on

[1] This chapter is based on the following article:

van Wynsberghe, A., Li, S. A Paradigm Shift for Robot Ethics: from HRI to Human-Robot-System-Interaction (HRSI). (2019). Medicolegal & Bioethics. 9, 11–21. DOI: https://doi.org/10.2147/MB.S160348.

[2] In this thesis, "robots" and "bots" are used as umbrella terms and are interchangeable. Both cover embodied robots, avatars, chatbots, and algorithms.

the healthcare system as a whole, rather than the individual caregivers and/or care receivers.

In July 2019, a collaboration between the UK National Health Service (NHS) and the technology company Amazon, which makes the embodied AI product known as Alexa, was announced (Department of Health and Social care, 2019). This collaboration aims to provide consumers of the Alexa the ability to seek medical advice from the device. To realize this, NHS has shared medical data with Amazon. Such a collaboration confronts society with the challenge of understanding the boundaries between a bot - as a technology embedded in a network of funders and tech developers - and bot as a part of the healthcare system - understood as a network of care providers governed by regulatory boards and bioethical principles. When thinking about the wellbeing of patients, preventing harm and respecting autonomy, what are the responsibilities of the company making a robot and accordingly what are the responsibility of the healthcare system? Which stakeholder group assumes stewardship over the beneficence of patients?

To date, the fields of human-robot interaction (HRI) and robot ethics, takes as the starting point a dyadic interaction between a human and a robot with the goal of creating intuitive and safe encounters. It is clear, however, that the impacts of robots in healthcare far exceed the individual with whom the robot is interacting. One of the most critical aspects of introducing robots in healthcare is how such a bot will re-structure the healthcare system in a variety of ways: roles of healthcare staff will change once bots are delegated tasks, certain professions may no longer exist (e.g. cleaning robots may remove the need for janitorial staff), the education of healthcare staff will need to include bot training, resources will be re-allocated to account for the purchasing of bots, the expertise of healthcare staff will be called into question (e.g. when an AI algorithm predicts something that the physician doesn't). A well-developed care system that includes bots of all kinds should predict and balance the ethical impact equally between not only caregivers and receivers, but for the system within which these actors function. This chapter proposes a model for doing just this, the Human-Robot-System Interaction (HRSI) model that allows for the ethical assessment of "bots" as

mediators between a care receiver and a healthcare system. This new framing makes explicit the potential for impact on the system and not just the individual patient or healthcare personnel interacting with the robot.

In the following sections, we begin by reviewing current trends in healthcare bot technology covering robots, avatars, and software (including chatbots and various AI algorithms). We continue with a discussion of HRI and the current forms of ethical analyses using the HRI paradigm and show that their dyadic nature leaves them inadequate for addressing the scope of ethical issues pertaining to the healthcare system. We conclude by proposing a model for HRSI and explain it using various interaction scenarios. With a view of the HRSI model, and thus a better approximation of the complexity of care interactions, we identify unique ethical issues that arise surrounding issues of trust, accountability, responsibility, and conflicting preferences between care receivers and caregivers.

2.2 Current technology trends in healthcare "bots"

Each of the bot applications discussed here, are meant as interaction partners between a care receiver and the healthcare system. By "interaction partners" we mean to suggest that humans will engage with the bot using different means (e.g., verbal, visual, and/or written) and that this interaction is more complicated than pressing buttons on the robot to get it to function.

Chatbots are generally used to provide verbal or written communication to care receivers and/or physicians about symptoms, diagnoses, medication, and weight or health coaching (Hill et al., 2015; Huang et al., 2007). These chatbots are software; they are not embodied in the real world; they are not physically interacting with their human counterpart. Woebot, for example, is a chatbot designed to provide mental support to users by communicating via text in an application on the smartphone (Fitzpatrick et al., 2017). Another chatbot, Your.MD, acts as a health consultant by asking questions about users' symptoms and their personal information. It makes preliminary diagnosis and provides users with medical information on the likely cause to help them find the suitable treatment (Orrell, 2018).

More traditional bots in healthcare are embodied robots that have a range of appearances and capabilities (Yang et al., 2018). Some of the more common examples of care robots are the surgical robot da Vinci, delivery robots TUG, Helpmate and Hospi, and the lifting robot Muscle Suit. Other robots serve more companionship ends, such as Paro for reducing anxiety in elderly care receivers, AIBO, NeCoRo, iCat which provides company to people who live alone, and the feeding robot iEAT that can help with eating (Kachouie et al., 2014). Examples of embodied AI include the previously mentioned Amazon Alexa, another example is Mabu, the personal healthcare companion "whose conversations are tailored to each patient she works with" (Kidd, 2015). These robots are embodied in the world but are distinct from the more traditional robots listed above insofar as they cannot engage with their surroundings (i.e., they cannot move), they are only meant to engage with a human counterpart.

In between the physically embodied robots and the strictly software bots are avatars. These are images of people or animals presented on a computer screen intended to interact with a human counterpart without the option to reach out and touch them. One example is Patty, a virtual physician's assistant developed by Cisco in 2009. Patty is a female character playing the role of doctor and/or nurse to provide medical information on diseases and medication to the care receiver and family. Patty also helps to arrange daily schedules of doctors (Earnhardt, 2009). Another avatar is the virtual assistant Molly designed to mimic doctors and/or nurses taking care of people with chronic diseases. This animated female caregiver called Molly checks in on care receivers every day to collect health data of users, and to provide recommendations to them accordingly (Sensely, 2018). Avatars are considered more engaging than chatbots because they combine both verbal and visual interaction with users which is expected to achieve better results (Sheth, 2003).

2.3 Understanding the robot as external to the healthcare system

The applications listed above are wide and varied but the common link between all these technologies is that they become integrated into a care

receiver-healthcare system relationship. This interaction between human and healthcare system through the bot can happen in a variety of ways with a variety of ends that the bot is serving. The bot may be used to collect information about the care receiver, about his/her symptoms, care plan, or health information which is then used by the system (one or more professionals working within) to make a decision about how to proceed. Or the bot may be integrated into post-operative care to follow-up on care receiver recovery after a care receiver has received treatment (and established a therapeutic relationship with healthcare professionals in person). Or the bot could be used as part of a care receiver's care while a care receiver is in a healthcare facility. In each of these instances the bot acts as an instrument to provide care from the healthcare institution to the care receiver and yet it is still somehow connected to the tech company from which it came.

In order to create governance mechanisms to protect patient data (among other things) one must understand whether the robot is part of the healthcare system or belongs to a third party, the tech developers. We suggest that the healthcare bot is neither entirely part of the healthcare system nor entirely part of the tech company. Instead, it exists in a fluctuating state in which at moments it is part of either, i.e., when in development it belongs to the tech company and yet when used in healthcare it partially belongs to the healthcare system until there is a malfunction and it must return to the tech company for repair (or a technician from the tech company visits the hospital to repair). We say "partially" above because most bots are constantly collecting data on patients and this data is most often stored and used by the company for upgrades etc. Thus, the bot is more often than not connected to the tech company even when introduced into the healthcare system. For this reason, we suggest understanding the bot as separate from the healthcare system insofar as it remains connected to the tech company responsible for its development. In this way the bot mediates between patient and healthcare system.

We acknowledge that understanding the ontological status of the bot is also dynamic – once the bot has been in the system for an extended period of time it is possible to suggest that the bot truly becomes part of the system (e.g.,

with technicians in the healthcare system, with the healthcare system responsible for data collecting, storage and usage, with the healthcare system responsible for upgrades and so on). At this moment in time, however, this is not the situation for most "bots" commercially available. Therefore, we consider it paramount to frame the robot as external to the healthcare system in order to raise awareness of policy makers, caregivers, and patients that the traditional moral codes governing the healthcare system may be in jeopardy when interacting with a bot.

2.4 The HRI paradigm as an evaluative tool

Given that any bot in healthcare is sure to confront the healthcare system, and society at large, with ethical concerns, the question at the axis of this work is how to evaluate the interaction between the system of human actors, i.e., the healthcare system, and the bots. The idea to study humans interacting with robots is not new; human-robot interaction (HRI) as a field of study emerged in the 1990s with, among others, the canonical work of Kazerooni (1990, 1993), Held and Durlach (1992), Breazeal (1998), as well as Dautenhahn (2007). It centers on the study of many forms of verbal and non-verbal interactions between human and robots with multidisciplinary approaches combining insights from robotics, cognitive science, psychology, biology, language, and design (Goodrich & Schultz, 2007).

In a 2002 paper by Yanco and Drury (2002), and an updated version in 2004 (Yanco & Drury, 2004), a taxonomy for HRI is presented. This overarching taxonomy was created using the following categories: task type, task criticality, robot morphology, ratio of people to robots, composition of robot teams, level of shared interaction among teams, interaction roles, type of human-robot physical proximity, decision support for operators, the time/space taxonomy, and autonomy levels/amount of intervention (Yanco & Drury, 2004). All figures used to illustrate the taxonomy of Yanco and Drury show humans on one side and robots on the other side. In some instances, one human may interact with one or more robots and in other instances one robot may interact with one or more humans. In essence, HRI is about the human and the robot interacting and how best to design the robot as an

intuitive interface in order to achieve a predetermined goal successfully. Based on this paradigm come the majority of ethical evaluations of healthcare robots to date.

2.5 Ethical reflections on healthcare robots to date

The first discussions on ethical issues surrounding robots in healthcare can be traced back to 2005 (Veruggio, 2005). Roboticist and robot ethicist Gianmarco Veruggio pointed out that the advance of surgical robots and robotic prothesis gave rise to medical ethics and bioethics problems. Veruggio (2007) created an overview of robot ethics based on the application domain and posited that healthcare robots faced ethical issues such as the impact of a robots' dexterity, dependability and functionality on care receivers and on surgeons.

Since then, the list of ethical concerns has grown. Generally, most ethical issues examine the risks in the interaction between the care receiver and the robot: the safety concerns to care receivers posed by large-sized robots, especially those receivers who do not know how to operate the robots properly (Sparrow & Sparrow, 2006); the risk to privacy and data security of the person when being monitored by robots with sensors and cameras to record and monitor his/her vital signs and daily activities (Calo, 2011; Denning et al., 2009); the potential deception of both the caregiver and the care receiver that may result in an undue assignment of greater intelligence than the robot is actually capable of (Feil-Seifer & Mataric, 2011); the risk to the care receiver's autonomy when being stopped from performing certain actions, such as moving outside of the building freely for safety reasons (Borenstein & Pearson, 2010; Sharkey, 2014); the problem of infantilization of elderly people (Körtner, 2016; Sharkey & Sharkey, 2011; Sharkey & Wood, 2014); the potential reduction of human contact when robots can take over care tasks from family and caregivers (Parks, 2010; Sparrow & Sparrow, 2006); the issue of disregard for informed consent if the caregivers use robots for care receivers with dementia who cannot voluntarily make their own decision to either accept or decline to participate (Friedman & Kahn, 2002).

Some roboticists have studied such interactions in a more nuanced manner than strictly according to the taxonomy of HRI again emphasizing the concern for patients in the HRI. Riek and Howard, for example, observe multiple ethical challenges arising in HRI: the therapy recipients in HRI are inclined to develop emotional and psychological bonds with the robot, which may result in negative effects on their psychological health and physical therapeutic treatment (Riek & Howard, 2014). Several empirical studies in HRI focus on the interaction between robots and children. Belpaeme et al. draw attention to the social bonds built in child-robot interaction, in particular, that robots need to function as peers to play together with children in the interaction (Belpaeme et al., 2013). A study conducted by Vallès-Peris and colleagues in a children's hospital shows that care interactions happen in a bidirectional way in the imaginations of children, namely, the robot and the child take care of each other (Vallès-Peris et al., 2018). Additionally, Arnold and Scheutz distinguish the soft robots from hard-bodied robots within HRI ethics. They propose that soft-bodied robots should develop a balanced tactile engagement rather than psychological deception and help users to realize their bonds with a tool but not a person to mitigate the ethical challenges in HRI (Arnold & Scheutz, 2017).

Robot ethicists have also focused on the caregiver in the HRI. Normally, it is acknowledged that robots can help caregivers to relieve physical burdens by taking over manual tasks such as lifting, which benefit the care receivers' bodily health (Sharkey, 2014; Sharkey & Wood, 2014). But the replacement of caregivers by robots raises concerns for a potential threat to the caregiver's ability to gain the skills required of a good caregiver, described by robot ethicist Shannon Vallor as a risk of "deskilling" workers (Vallor, 2015). This can happen in both technical and non-technical ways, e.g., technical skills like losing the ability to lift at an appropriate speed; non-technical skills like losing the ability to perceive suffering in care receivers.

Although some believe that healthcare robots will remove caregivers from the dull and burdensome portions of care, freeing up the time of caregivers for emotional support of care receivers (Coeckelbergh, 2010), Borenstein and Pearson (2010) are skeptical about the actual effects that care robots may have

on human caregivers' capabilities. To exemplify this, they make reference to the case of household appliances; household appliances did not free women from staying home but instead cost them more time on other tasks. From this they suggest an indication that care robots may not necessarily always promote caregivers' capabilities but may alternatively lead to more personal sacrifice instead.

A third approach to ethical evaluations of care robots centers on care practices. In this approach, called Care Centered Value Sensitive Design (CCVSD), van Wynsberghe (2013, 2015) insists that care robots need to be evaluated according to their impact on care practices rather than on the impact of either care receiver or caregiver alone. In this way the robot's evaluation centers on its ability to enhance (or weaken) elements of care practices, such as the attentiveness of healthcare personnel or the reciprocity between caregiver and care receiver, as necessary conditions for good care.

A focus on the impacts of care practices brings us closer to recognizing that there are external considerations to the care receiver + caregiver relationship that need to be considered. Yet still, what is needed is a way to understand the bot as an extension of the healthcare system of human caregivers (in so far as care is provided through the bot) that has substantial impacts on the healthcare system, namely a re-arrangement of the healthcare system. What is needed now is a way to account for this unique ontological status of the bot, the re-arrangement of the healthcare system that inevitably accompanies the bot, and the ethical issues this raises in a healthcare context.

2.6 A paradigm shift to capture the complexity of healthcare "bot" + healthcare system interactions: the HRSI model

In short, the traditional dyadic model of HRI serves as a useful tool for conceptualizing the interaction between humans and bots; however, it fails to account for the complexity of the network which the bot is stepping into and which the bot also adds to. There is an urgency to understanding that bots in healthcare will have significant downstream effects on the healthcare system, for example the various forms of re-structuring we have raised, given the lack of attention to this topic in the robot ethics or HRI space. Seeing that

robot ethics has relied on the HRI model for developing ethical analyses, we suggest the need for a paradigm shift in conceptualizing human and robot interactions in the healthcare sector. To that end we suggest a Human-Robot-System Interaction (HRSI) model, one in which the robot is placed in between a human care receiver on one side and a healthcare system of human caregivers including professional medical staff such as doctors and nurses and informal caregivers such as family and friends on the other. Along these lines, Parviainen et al. have suggested a triadic model of Human-Robot-Human-Interaction (HRHI) as a way of showing the complexity of interactions in healthcare that go beyond traditional HRI representations. One of the examples they use is nurses escorting care receivers to the operating suite on the mechanical bed. They suggest that having a mechanical bed capable of traveling to the surgical suite without a nurse is possible but fails to account for the significant role the nurse plays in reducing anxiety, in other words the role the nurse has in the care practice of escorting care receivers to surgery. This example, for the authors of this chapter, should still be considered an illustration of robots and humans interacting within care practices and can be accounted for in the HRI taxonomy of Yanco and Drury or the CCVSD approach in general.

The necessity of emphasizing the healthcare system in ethical evaluations are many and center on the ways in which the bot will force a re-structuring of the healthcare system: roles of nurses and doctors in healthcare settings will change since robots can take certain tasks from human medical staff and as such the distribution of responsibilities will also change; some professions, e.g. deliverymen and janitors in healthcare settings, may no longer exist since these manual and repetitive tasks can be delegated to robots; the education of healthcare professionals will change to teach healthcare staff the necessary skills of working with the bots; the expertise of healthcare staff may be called into question or re-structured insofar as certain bots will be considered the experts rather than the humans; bots will change the flow of money in healthcare sector in order to purchase and maintain them. The HRSI model is meant to highlight the various ways in which humans and bots can interact in order to understand the complexity of introducing bots into healthcare and

to come closer to framing the ways in which the healthcare system will be re-arranged.

2.7 Types of interaction scenarios in the HRSI model

In general, the bot functions as a bridge between the caregiver and/or the healthcare system of a network of human caregivers and it is important to remember this to avoid misrepresentations of the bot – it is not conscious, sentient, or capable of caring in the humans' sense of the word. Rather, it provides a new kind of access to the care provided by the healthcare system. We refer to the healthcare system because there are instances in which healthcare professionals provide data that is in turn used to train the algorithm of the chatbot. Thus, a care receiver is not interacting with one healthcare professional but is interacting with a collection of data from a broad group of professionals. Given the variety of types of bots and the variance in types of interactions it is necessary to outline the HRSI model in more detail.

In the following, we will demonstrate three levels of interaction scenarios in which robots/chatbots/avatars have a critical role based on the complexity of interactions involved (see Figure 2.1). These scenarios consist of the following actors: a care receiver (e.g., a patient or a user of an app); a bot; and a healthcare system (which can be a variety of professionals in the system or one nurse or one physician, or one family or one friend who provides care). The scenarios sketch the divergent ways in which interaction can happen. It should be noted that in each scenario the bot is at the center place indicating that it functions as a mediator between the caregiver and the care receiver. The arrows in the figures below represent interactions between the actors and the direction or flow of data. The one-way arrows indicate unidirectional interaction, or flow of data, from one partner to another while the two-way arrows mean reciprocal interactions, meaning data flows in both directions.

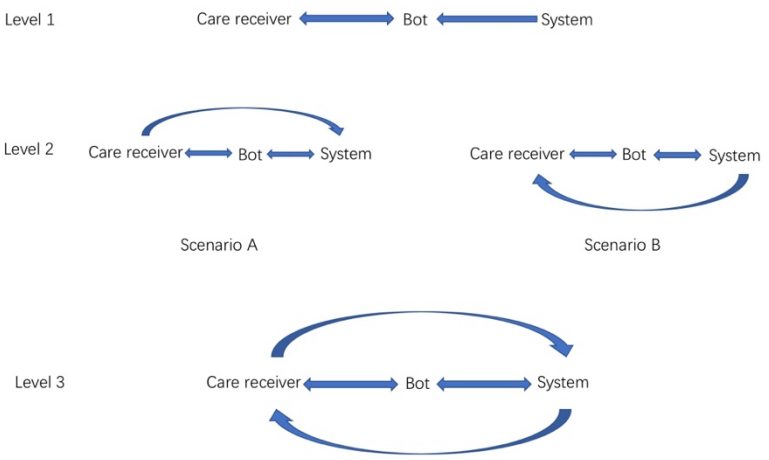

Figure 2.1 Interaction scenarios of the HRSI model in the healthcare system

Level 1 –HRSI with limited dyadic interactions

The illustration at Level 1 shows a primitive interaction scenario of HRSI. The one two-way arrow indicates there are reciprocal "care receiver + robot" interactions and the one-way arrow suggests the interaction from the caregiver to the robot. To exemplify this type of interaction, consider Woebot, a chatbot is developed by clinical psychologists from Stanford University. Researchers expect the chatbot to help with people's mental health using cognitive behavioral therapy techniques. The input into the chatbot, e.g., clinical experience and therapy theories, is the one-way interaction from the healthcare system to the robot. The two-way interaction will be formed if/when a conversation starts between the care receiver and the bot. Each conversation starts by the chatbot checking in with the user to know his/her feeling and then asking what areas the user wants to be helped with. This form of interaction scenario appears most similar to the traditional HRI model; however, in making clear that the data provided to the bot which guides its functioning comes from the healthcare system and as such the bot is communicating on behalf of the healthcare system to the care receiver.

Level 2 – Intermediate HRSI with unidirectional human interactions

Comparing with the first scenario, level 2 shows an extra arrow between the care receiver and the caregiver along with the two-way arrow between the bot and the healthcare system. In type A, the one-way arrow shows the interaction from the care receiver to the caregiver. An example to illustrate this in practice is Your.MD, a chatbot using AI to help users better understanding of their symptoms. The data input from the healthcare system to the bot is the large amounts of health information databases from the healthcare system. To be sure, the health information has been checked by certified doctors in advance. According to the symptoms listed by the care receiver to the chatbot, the users can find information about causes, diagnosis, and/or actionable treatment to make choices for himself/herself e.g., taking specific medication and/or making changes to one's diet. The chatbot can also help make appointments with physicians when necessary (Your.MD, 2018).

The interaction between the care receiver and the bot forms when the user starts typing a question. The interaction continues as long as the user asks questions to the chatbot. Input from caregivers is fed to the chatbot in advance, stored, and recalled to provide the care receiver with medical knowledge. When the user is diagnosed as having a serious illness, he/she will most likely prefer to go to a doctor to receive proper treatment. As Your.MD can help make an appointment with a doctor, the care receiver can visit a doctor or nurse and an in-person interaction between the care receiver and caregiver is formed (i.e., as indicated by the additional arrow from healthcare system to care receiver).

Distinct from type A, the arrow in the diagram of B is pointing from the caregiver to the healthcare system to show a different way of bots used to draw healthcare professionals into a direct interaction with the care receiver. Monitoring bots – chatbots, avatars and embodied robots – are the best case to reflect this interaction scenario. They are designed and used to help prevent falls in care homes and private homes. Monitoring robots such as AILISA and Care-O-bot are equipped with sensors and cameras to keep an eye on the movement of the care receiver. This interaction is between the care

receiver and the bot with the purpose of the bot to relay important information to the healthcare system. If/when the bot alerts a caregiver and/or the care receiver's relatives to notify that a fall or other frailty has occurred, the caregiver is able to communicate to the care receiver directly through the bot interface. In some instances, after the warning has been received, the caregiver and/or the relatives will travel to the care receiver's location to check the situation and provide help. This kind of immediate reaction from the caregiver to the care receiver is very common in HRSI involving monitoring and is a central reason for which the traditional HRI model is not adequately equipped for ethical evaluations of such scenarios.

Level 3 – Advanced HRSI with triadic reciprocal interactions

Level 3 of the HRSI model allows for a representation of the more complex, multi-directional and reciprocal forms of interaction. In this figure care receivers may have had initial interaction with a healthcare professional, such as a surgery in hospital and then be monitored in their home afterwards through a chatbot. Or the care receiver may engage with one or more healthcare professionals through a bot while at the same time the bot is collecting physiological information to share with the caregiver and/or the care receiver is at the same time engaging with caregivers present in a care facility.

Consider, for example the remote presence robot RP-7, a telepresence robotic system designed by Intouch Health. The top of the RP-7 robot is fitted with camera and microphone for real-time two-way audio and video communication between the care receiver and the expert clinician who is off-site and with whom the care receiver is interacting with (Sharkey & Sharkey, 2012). The expert clinician uses a joystick to control the locomotion of the robot to have a further detailed observation of the care receiver as well as the environment in the ward. The robot can also record the care receiver's vital signs and send the data to the clinician. Thus, the bot is providing data to the healthcare professional while at the same time being used as an instrument for direct communication. With the information retrieved and sent by the

robot and the real-time video consultation, the expert clinician can make suggestions to the medical staff present on the actions to be taken.

In this scenario, the RP-7 robot makes the remote consultation possible by providing the care receiver and the expert clinician with direct contact (noted as the two reciprocal interactions between the care receiver and the robot). There are also direct interactions between the care receiver and the medical staff present. They can help to perform tests on the care receiver according to the expert clinician's instructions that cannot be achieved remotely by the robot (noted as the two arrows between the care receiver and the caregiver are also clarified).

2.8 The contribution of HRSI to the field of robot ethics

There are many instances in which it is important to provide an ethical assessment of the bot's impact on individuals or on the ability of caregivers to provide good care. Yet there are also moments in which such an isolated assessment of this kind fails to capture the complexity of the situation (e.g., the re-arrangement or responsibilities associated with data collection and/or ownership) and consequently the additional ethical issues that go beyond a dyadic HRI. As briefly noted earlier, in most instances, the healthcare system is not the institution who has developed the bot product; instead, the healthcare system is the technology implementer and/or the user. In other words, a novel party is being introduced into the care receiver + healthcare system relationship – the bot designer, developer, or distributer. This third party is not in the practice of making "traditional healthcare tools" but is making data collection tools. Thus, we must question the ethical practices, assessments, and safeguards for this new actor in the care receiver + healthcare system interaction. For this reason, robot ethics should now begin to engage with the significant role that the bots play as a mediator between a care receiver and a healthcare system. In the remaining section our aim is to raise awareness of certain ethical issues resulting from the bots' introduction and to build on these in future work.

Trust in the healthcare system, the robot, or…?

Trust is paramount in any healthcare situation. Caregivers and more importantly the healthcare system as a whole must be trusted. In fact, trust is the cornerstone of the professionalization of medicine and nursing. In general, it is easy for care receivers to understand and accept medical instruments such as scalpels and stethoscopes since the doctors understand, endorse, and directly use them. When introducing the robot in between the care receiver and the healthcare system, the question is whether the care receiver is being asked to trust the healthcare system, the robot, or the third party involved in the robot's implementation. Given that most care receivers will have no idea who the third party in question is we can assume that their trust in the healthcare system will extend to the robot. Consequently, the healthcare system ought to ensure high standards of the bots.

It should be noted here that for the FDA most robots fall under Class II medical devices in terms of risks and are regulated accordingly, meaning the FDA will enforce oversight. In October 2016 the surgical robot da Vinci, categorized as a Class II medical device, was recalled via the FDA (FDA, n.d.) because of "a software anomaly in the da Vinci Xi P5 software that can result in unexpected master movement and potential instrument tip movement under certain circumstances". In such instances companies must communicate with and through the FDA to inform consumers of anomalies. Alternatively, most of the chatbots discussed in this chapter are classified as Class I mobile medical apps meaning they present minimal risk to patients and in these cases the FDA has enforcement discretion meaning the FDA does not intend to pursue enforcement action for violations of the FD&C Act and application regulations (FDA, Center for Devices and Radiological Health, 2015). If something goes wrong, there is not the same need for companies to communicate with or through the FDA to inform users. Such a divergence is representative of how the bot re-structures the traditional mechanisms in place for oversight of healthcare technologies. In these instances, then, care receivers are unknowingly placing their trust in the third-party companies making or distributing the bots and these companies are not held to the same standards at the hospital (or healthcare system for that matter). To ensure

care receivers are given ample opportunity for informed consent along with placing their trust in the correct institution they ought to be informed of who and what they are being called upon to trust when interacting with the healthcare bot.

Responsibility and accountability

There are three aspects associated with responsibility and accountability that need to be discussed; the first concerns data provenance issues and the third party. The second concerns the responsibility of the healthcare system when care interactions are reduced to the bot and the care receiver. Thirdly, given the reality that bots will re-structure the healthcare system in a variety of ways it is paramount to consider how responsibilities are also re-structured and further, who is accountable when things go wrong.

Consider, for example, the use of chatbots for preliminary diagnosis. These chatbots persuade users that the diagnoses and ensuing advice are made based on analyses of large datasets with input from medical professionals. Yet, many of these applications insist that the diagnoses and the medical advice are merely a guide and for reference only. In this case, who will be responsible when a user exclusively follows suggestions provided by the chatbot, but his/her medical situation deteriorates? In traditional doctor-care receiver relationships, the doctor (supported by the healthcare institution where he/she works) bears responsibility for medical accidents, but if the chatbot assumes the task of initial assessment then who is responsible when things go wrong? This invites a discussion of the quality of the training data used and the reliability of the algorithm used for prediction, issues concerned with the ethics of AI in general, but which are increasingly critical when AI is used in a healthcare context. To ensure highly reliable diagnoses all chatbots should be subject to rigorous validation standards and regular IT and procedural auditing. As discussed above chatbots in particular are still considered Class I medical apps and as such are not required to follow such criteria.

Another kind of re-structuring has to do with the bots taking on certain roles or tasks of healthcare staff: when bots are introduced as mediators between

the care receiver and the healthcare system there may be an impoverished interaction between patient and healthcare system (i.e., when the bot is acting on behalf of the healthcare system). First, there will be technological limits to both what the robot is capable of taking in from the care receiver and what the robot is capable of conveying to the healthcare system. The loss of contextual details when using a bot as mediator in healthcare may in turn lead to imprecise and unsatisfactory care. Chatbots used for preliminary diagnoses may not fully capture external factors related to a care receiver and/or a chatbot may not ask the same set of questions as the professional caregivers will ask, which may lead to mis-categorizations of a care receiver's needs.

Another instance in which the loss of contextual details may have serious repercussions is when care receivers are suffering from abuse and the only way to know this is by observing them in person. While there may be practical limits to how much a doctor or nurse can take in from a care receiver, they are free to "go the extra mile" when they deem necessary. A pediatrician may suspect that a child is being abused and if pressed the pediatrician may claim that his/her suspicion is simply a "hunch". However, this hunch may lead to the pediatrician to act in a way which may confirm or refute that hunch. The pediatrician may feel responsible for this child in a way that a 'bot' never could. The addition of the robot as mediator may unintentionally reduce care interactions to a simple exchange of physical details rather than paying tribute to the holistic view of a care receiver or worse the distance between care receiver and healthcare system may lead to absolving (either symbolically or casually) the healthcare system of legal, moral, and any feeling of responsibility.

Conflicting preferences

There may be instances in the near future in which care receivers neither trust in the technology nor wish to interact with it. This could create a conflict between the needs of healthcare systems or institutions to systematize portions of care processes and care receivers who wish to interact with humans for each portion of the care. Consider, for example, the Japanese

lifting robot ROBEAR for lifting care receivers. When the healthcare system of the network of caregivers has decided on the use of the robot for reasons of efficiency and the nurse (also a caregiver) must implement this choice, what happens when the care receiver refuses to be lifted by the robot? How can care receivers make choices about their care if caregivers are bound by the choices of the institution? While this may seem commonplace, nurses are frequently asked for alternative options, it does not diminish the fact that caregivers and care receivers should still be provided the autonomy to make choices about the provision of care especially without proper evidence showing that robot care is superior to human care.

Alternatively, care receivers may desire impersonal interactions with care bots over personal human interactions whether it's providing convenient and timely answers to their questions or assisting with toilet time. Having a bot available could be more convenient or could provide a more dignified form of intervention. In either case, in a study done by Parviainen et al. (2018), the authors conducted empirical research to demonstrate how care workers perceive robots: "the caregiver and care receiver make use of a technological device in ways that suit their needs without losing the possibility for human touch and interaction". Considering that the robot is an access to the healthcare system, it is paramount for the institution to provide care workers with the freedom to navigate these situations as they see fit. Healthcare professionals should be actively involved in the technology design, development, implementation, and evaluation. We suggest that explicit and proactive efforts be made to include care staff (e.g., physicians, nurses, porters, cleaners, managers among others) to be made a part of the design process insofar as their experiences and voices are included in the conceptual thinking about the bots.

2.9 Conclusion

In view of the growing applications of bots in healthcare the various ethical analyses common to HRI in the healthcare space now seem inadequate. Specifically, we argue that the HRI label fails to pay tribute to the system of healthcare workers in place or the re-arrangement of responsibilities and complexities that a bot in healthcare introduces. To overcome this limitation,

we propose the HRSI framework for evaluating the impact that the robot will have not only on the individual patients and/or care providers but on the entire healthcare system.

We suggest that the introduction of the range of bots in healthcare (e.g., embodied robots and AI, avatars, and chatbots) will create a re-structuring within the healthcare system in a variety of ways, from a re-distribution of roles and responsibilities (i.e., that bots will take on jobs previously done by human workers) to the new ways in which financial resources will be allocated and/or health professionals will be trained. The impact on healthcare staff will also require new kinds of empirical studies that go beyond the traditional framework found in HRI. Based on these forms of re-structuring we suggest empirical research to assess the subjective experience of care workers following the introduction of the bot regarding their previous and new roles; tracking of educational changes over time (e.g., new courses offered and older courses dropped). Moreover, we also suggest transparency on the part of healthcare institutions concerning the financial reports when bots have been purchased. This final point allows for an assessment of the re-structuring of hospitals pre and post "bot".

3 The complexity of autonomy: A consideration of the impacts of care robots on the autonomy of elderly care receivers[3]

3.1 Introduction

In recent decades, the gap between the demand for elderly care and a significant shortage of caregivers has widened. Care robots, the robots used for care purposes in general, have been introduced in healthcare as a solution to enhance the quality of care and autonomy of elderly care receivers. The term "elderly care receivers" refers to elderly people who receive care in various care settings, such as hospitals, nursing homes and private homes. Robot developers may focus on the perceived benefits of care robots for elderly care, but ethicists often remain cautious about the potential ethical issues with such technology (Sharkey & Sharkey, 2012; Sparrow & Sparrow, 2006).

Elderly care receivers are acknowledged as the priority in care discourse, given that the essential aim of caring is to improve care receivers' health and

[3] This chapter is based on the following article:

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preserve their autonomy and dignity in care practice (US Department of Health Education and Welfare, 1979). Several scholars have empirically investigated elderly people's autonomy in care settings (Calnan et al., 2005; Hall et al., 2014; Pirhonen et al., 2019). Furthermore, autonomy is a core value that is frequently discussed in value sensitive design, a research approach to the design of technologies that incorporates ethical values in the design process (Friedman et al., 2003; van Wynsberghe, 2013a). Friedman (1996) investigates aspects of computer systems that may affect user autonomy and suggests protecting this autonomy by value sensitive design. However, user autonomy can vary depending on the situation, which has to be examined further. To address autonomy in the context of care robots that are used in elderly care, this chapter clarifies the complexity of autonomy itself. Bioethicist Bart Collopy (1988) points out that autonomy is a frequently studied value that is actually highly complex. In this chapter, we apply Collopy's conception of autonomy to the context of robot care and introduce a taxonomy of autonomy to examine its complexity. This taxonomy sheds light on how to adequately manage the impacts that care robots have on autonomy in elderly care. Attention to the complexity of autonomy in elderly care is crucial in providing robot designers with an in-depth understanding of the intricacy of this core value.

We begin by discussing the importance of autonomy in elderly care. Subsequently, we unpack the taxonomy of autonomy inspired by Collopy and extend its application from traditional human care settings to elderly care through care robots. By using a systematic autonomy-centered framework, we use specific care robots to illustrate how they affect the autonomy of elderly care receivers. We conclude by suggesting that the taxonomy of autonomy can be instrumental in robot designers' retrospective and prospective impact assessments of care robots on care receivers' autonomy.

3.2 Autonomy in the healthcare context

3.2.1 The roles of autonomy in care

Autonomy is considered a fundamental value at the heart of guiding principles in bioethics. It is a core component in the Belmont Report (US

Department of Health Education and Welfare, 1979), the canonical reference from which much bioethics literature is derived. Acknowledgment of autonomy, and protection of people with diminished autonomy, are two requirements of the principle of respect for people stated in the Belmont Report. Autonomy also plays an essential role in the four principles of biomedical ethics developed by Beauchamp and Childress (2001). The principle of respect for autonomy requires that people not deceive one another, respect others' privacy, help others with decision-making, communicate well with patients and request informed consent before any medical intervention, and not leak others' confidential information, such as their medical records (Beauchamp & Childress, 2001). Autonomy can also pertain to self-determination and liberty of rights (Scott et al., 2003). It refers to individual control over decision-making and other activities, such as deciding whether to accept specific treatment or not after being given adequate and understandable information and the freedom to make a decision (Lothian & Philp, 2001).

The significant role of autonomy is not only highlighted by bioethicists in normative considerations, but also apparent in empirical studies. In the literature on ethical values in elderly care, the value of autonomy for elderly care receivers is prevalent (Calnan et al., 2005; Hall et al., 2014). Elderly care receivers require a sense of autonomy to take control of and decide on their care (Krajcik et al., 2005). Specifically, clear and simple information on examination and/or treatment is required to reassure elderly care receivers that they are in control (Lin et al., 2011). Some elderly care receivers indicate that caregivers should have informed them of potential options for their situation and empowered them with adequate knowledge to make sound decisions (Ferri et al., 2015). Furthermore, Lothian and Philp (2001) emphasize the importance of how information is provided. For example, the autonomy of elderly care receivers can be diminished if caregivers do not understand and respect cultural sensitivities. In some countries and communities, caregivers may only speak their official language, which may not be understood by some elderly care receivers who can only speak and understand specific dialects (Ebrahimi et al., 2012). These cases indicate that

elderly care receivers' autonomy can be violated in various ways in care practice, which diminishes the quality of the care they receive.

3.2.2 Autonomy in elderly care in the robot era

In the era of population aging and technological advancement, care robots have been introduced in healthcare to enhance the quality of care and address the shortage of caregivers. As a result, several scholars have examined the ethical issues of using robots to improve the quality of care.

Various empirical studies clearly indicate that elderly care receivers regard autonomy as an indispensable value in care, with or without care robots, which highlights the importance of scrutinizing the autonomy of elderly people in care, especially when care robots are involved in care practice. Sorell and Draper (2014) construct an ethical framework for developing companion robots for elderly people who live alone. Of all the values that have been incorporated, autonomy is prioritized. In their qualitative study, which was conducted in four countries, elderly care receivers and caregivers were asked to comment on specific scenarios of robots caring for elderly people. The researchers (Draper & Sorell, 2017) discover that their participants regard autonomy as the paramount value for elderly care receivers in most cases. Only in certain cases where there is potential for serious harm to elderly care receivers may their safety be considered as important as their autonomy. A focus group study (Vandemeulebroucke et al., 2019) conducted in Belgium indicates that elderly care receivers feel concerned about losing some of their autonomy when robots are used in care. They insist that they should be able to turn the robots off when they infringe on their autonomy. In addition, Sharkey and Sharkey (2012) illustrate that care robots can improve elderly care receivers' sense of control and enhance their autonomy. When elderly care receivers are far from family and friends, robots with video functions can help them feel connected via video calls. Assistive robots that can take them to the toilet can also significantly boost their sense of control over their daily lives, as they do not have to rely on caregivers' assistance with these intimate and essential tasks.

On some occasions, based on an informed discussion, the care receivers may refuse certain types of care, in which case their autonomy should be respected. Therefore, a systematic ethical examination of elderly care receivers' autonomy is critical when introducing robots to elderly care.

3.2.3 The taxonomy of autonomy in elderly care

Collopy (1988) identifies six polarities of autonomy to comprehensively explain the conflicts of elderly people's autonomy in care, which serves as a start point for our discussion on the impacts of care robots on the autonomy of elderly care receivers. Collopy (1988) distinguishes the following polarities: (1) decisional and executional autonomy; (2) direct and delegated autonomy; (3) competent and incapacitated autonomy; (4) authentic and inauthentic autonomy; (5) immediate and long range autonomy; and (6) negative and positive autonomy. According to the dictionary (Cambridge Dictionary, n.d.), taxonomy is defined as a system that organizes things into groups of similar qualities. We use the notion of "taxonomy" in a liberal sense to summarize the six pairs of polarities within autonomy in systematic order. This taxonomy enhances Collopy's conceptual definition with a classification of similarities and differences within these polarities of autonomy, which are tailored for discussing robots used in elderly care.

3.3 The impacts of care robots on the autonomy of elderly people

In this section, we present a definition of care robots along with representative examples of the care robots used in elderly care. We unpack the value of autonomy in more detail and use a tailored taxonomy of autonomy to demonstrate the complexity of autonomy in robot care by a systematic autonomy-centered analysis.

3.3.1 What is a care robot?

In the literature, care robots are defined as robots that are directly used by caregivers or care receivers to meet a variety of care needs in different settings (Vallor, 2011; van Wynsberghe, 2013b). In current technology trends, robots, avatars, and software all play a crucial part in healthcare (van Wynsberghe & Li, 2019). With consideration of the scope of this study, we mainly discuss

embodied care robots in this chapter. Care robots have been divided into three categories according to the ways in which they are used in care: assistive robots, social robots, and socially assistive robots. Assistive robots are robots that provide purely physical assistance; while social robots are designed to meet people's social needs, such as communication; and socially assistive robots provide both social and physical assistance (Feil-Seifer & Matarić, 2005; Vandemeulebroucke et al., 2018). In order to see how autonomy is affected by each of these, we will analyze all three through the taxonomy of autonomy.

3.3.2 Assessing the impacts of care robots in elderly care with the taxonomy of autonomy

Decisional and executional autonomy

According to Collopy (1988), decisional autonomy refers to the ability and freedom to make choices on one's own. Everyone should have the freedom to make decisions without external coercion. Executional autonomy requires the ability and freedom to carry out choices freely and personally. In the context of elderly care, elderly people may be limited in decisional and/or executional autonomy due to physiological deterioration, such as progressive loss of muscle and neurological functions. In these situations, elderly people are heavily reliant on the assistance of multiple care workers and family members for daily activities such as walking and eating. Therefore, they may feel vulnerable and at risk of losing their capacity for decisional and/or executional autonomy.

Specific care robots have been designed to help enhance care receivers' autonomy. The assistive robot My Spoon is designed for people who cannot eat and drink on their own due to disability in their arms and/or hands. Users can move the joystick to control the direction of the spoon and select a food item, after which the spoon will grasp the food and feed the user automatically. It enables people who struggle to use utensils to feed themselves with the help of a joystick instead of relying on caregivers, which can largely enhance their executional autonomy. Granting this kind of autonomy, as the ability to execute an action, also relates to decisional autonomy, as the care receiver who has lost some executional autonomy may

also suffer from a loss of decisional autonomy—if someone cannot act on their wishes, it is possible that they lose control over their decision-making. With the help of the robot, not only can someone who has lost the ability to feed themself regain autonomy over that activity, but if the robot can respond to their real-time demands, it could potentially strengthen their decisional autonomy too.

Direct and delegated autonomy

In Collopy's work (1988), direct autonomy refers to whether care receivers can make informed decisions independently and have strong direct control over their decisions and actions. Direct autonomy is similar to executional autonomy, but its emphasis is on the absence of mediated caregivers or instrumentality in making personal decisions and executing them. It is often the case that certain loss of body functions and chronic diseases inevitably undermine the elderly people's direct autonomy, which forces them to delegate certain tasks to others to maintain their daily lives. Delegated autonomy applies when care receivers may not be able to take specific actions directly and self-sufficiently but can authorize a proxy to make decisions and execute activities when necessary (1988).

Some care robots are designed to benefit people who have difficulty making decisions and/or directly executing certain tasks by enhancing their direct and/or delegated autonomy. KOMPAÏ is a socially assistive robot that helps infirm and dependent people with mobility and social connection (KOMPAÏ Robotics, n.d.). Equipped with a wheeled walking frame, KOMPAÏ helps people with mobility issues to maintain balance and stability when they walk or move between their bed and a chair. When holding on the top of the walking frame and following KOMPAÏ's movement, elderly care receivers with muscle weakness or joint pain can walk directly without relying on a human caregiver, which indicates that this robot can strengthen their direct autonomy.

In addition to physical support, KOMPAÏ can also play a role in monitoring and supervising in elderly care. It records the activities and vital signs of care receivers and sends the data to medical professionals and/or family members.

KOMPAÏ reminds users to avoid the potential risks of falling and performing certain actions, such as leaving the building. After analyzing the data of the environment and the elderly care receiver's mental and physical signs, which are collected by sensors and cameras, the robot may generate suggestions on staying in the room. In this case, the elderly care receiver may decide to follow the robot's advice and not go outside. Such a scenario highlights the fact that elderly care receivers could delegate decision-making, such as whether to go outside or not, to a robot, especially when they are not self-sufficient enough to detect the potential risks of such decisions. This delegation of decision-making highlights the enhancement of elderly care receivers' autonomy. However, the robot may have some limitations in gauging the environment and estimating the feasibility of elderly care receivers' movement to specific areas. The robot may recognize the obstacles that can be directly perceived through its sensors, but it may not be able to provide navigation as flexibly as human caregivers can, and it may unnecessarily prevent the elderly care receivers from walking around due to its technological limitations, which could decrease their direct autonomy.

Competent and incapacitated autonomy

Collopy (1988) argues that "competent autonomy" refers to a decision or activity that is substantially informed, rationally reasonable, and judgmentally sound. However, this is not the case in incapacitated autonomy. For those elderly people suffering from dementia, their mental functions, such as the ability to focus and pay attention, communicate, reason, and make judgments, can be gradually impaired (Cummings & Cole, 2002). People with severe dementia can make decisions that are harmful to them due to critical incapacity.

Therapeutic robots have been invented to help these people. Paro is a social robot that looks like a toy seal, which is designed to help elderly people with dementia. It is equipped with various sensors and actuators to mimic a real seal's behavior, such as blinking and crying (Wada et al., 2003). A study on the psychological and social effects of care robots indicates that interacting with Paro can improve elderly people's mood and decrease their levels of

depression (Wada et al., 2005). Thus, it is possible that Paro could improve the elderly's competent autonomy and decrease their incapacitated autonomy, as people are more likely to think rationally when they are in a better mood.

However, in some cases, Paro may also decrease elderly care receivers' competent autonomy and enhance their incapacitated autonomy. A major issue could result from the gap between what a care robot is actually capable of and what it appears to be capable of (Sharkey & Sharkey, 2012). Paro's seal-like appearance and programmed responses could create the expectation of it being a real seal, which it cannot be. Its appearance may mislead elderly care receivers to believe that the robot has emotional capabilities and could have a wide range of responses. Consequently, elderly care receivers are not well informed due to the deception taking place, even if it is unintentional, which decreases their competent autonomy. For the purposes of company and interaction, Paro is designed to appear to have emotions and even give the impression that it cares for its elderly users. Roboticists Feil-Seifer and Mataric (2011) caution that this deliberate design may result in emotional manipulation and deception of users, even if this may not be the designer's intention. Thus, the elderly care receivers' incapacitated autonomy can be exacerbated by the misleading design and interaction with Paro without awareness of potential deception.

Authentic and inauthentic autonomy

As Collopy (1988) states, authentic autonomy refers to making decisions that are consistent with one's character and moral code expressed throughout one's life while inauthentic autonomy refers to behaviors and decisions that contradict one's personal history and character. This can happen to an individual after a radical change to their life, such as being diagnosed with severe or terminal disease. Rankin et al. (2005) illustrate that people with dementia have issues with certain behaviors, such as submissiveness and extraversion, which could deviate from their authentic character. Elderly care receivers may underestimate their emotionally cold and introverted

behaviors, which increases their inauthentic autonomy and diminishes their authentic autonomy.

Care robots, such as Paro, may help in this case. Concerns about elderly people suffering from dementia have led healthcare providers to search for robotic solutions that can realign elderly care receivers with their authentic personalities and choices. It has been shown that people suffering from dementia may experience calming effects when interacting with Paro. A study conducted by Wada et al. (2005) confirms that interaction with Paro could reduce elderly care receivers' stress levels. This implies that Paro could be conducive to elderly care receivers' authentic autonomy, as people tend to act more authentically when they are less stressed.

However, some people may query how a robot would promote elderly care receivers' authentic autonomy as the interaction between human and robot is not authentic. Turkle (2006; 2010) investigates the interaction between humans and robots and criticizes the authenticity of robotic companions. As previously discussed, the anthropomorphized Paro and its possibly misleading design may create the illusion that it can provide the elderly care receivers with social relationships. However, robots cannot have genuine or reciprocal emotions, which may make Paro seem inauthentic.

Immediate and long range autonomy

Immediate autonomy refers to present and limited freedom of choice and behavior in a specific situation, while long range autonomy means the long-term freedom of decision-making and action in a broad range of situations (1988). Ideally, both immediate and long range autonomy should be preserved and enhanced in elderly care.

The social robot Buddy is a good example of care robots' impacts on both immediate and long range autonomy in elderly care. Buddy can recognize some human emotions and adapt its vocal responses and expressions according to that of the interlocutor (Blue Frog Robotics, n.d.). These intuitive and simple expressions displayed on Buddy's screen serve the social purpose of keeping elderly care receivers active and engaged. Buddy also allows

elderly care receivers who live alone or in nursing homes to communicate with family and friends via video calls, which relieves their feelings of loneliness and isolation. Buddy enables elderly care receivers to immediately conduct online communication with loved ones the moment they feel lonely. Buddy's rich expressions can also make people feel accompanied and cared for in those short interactions. With its monitoring function, Buddy can record elderly care receivers' health status and send them to medical professionals. Continuous digital transmission of their health status enhances elderly care receivers' immediate autonomy. However, in certain circumstances, Buddy could diminish elderly care receivers' immediate autonomy while maintaining their long range autonomy. For example, similar to KOMPAÏ, Buddy can monitor the environment and elderly care receivers' activities. Therefore, elderly care receivers' immediate autonomy can be restrained if Buddy cautions them against certain activities. This may not be a problem if the alert is based on substantive risk, but if it is based on a false positive, it can reduce care receivers' immediate autonomy without good reason.

Furthermore, special attention should be paid to care robots' potential harm to care receivers' long range autonomy. For example, elderly care receivers will perhaps not see their family and friends as frequently when they can meet virtually via the robot. Ultimately, elderly care receivers may gradually lose the long range autonomy related to the interpersonal interaction they desire, which may aggravate their feelings of loneliness and isolation. The second concern is that elderly care receivers may lose control of the data gathered by the robot. After a long period of monitoring, the elderly care receivers' vital signs, daily activities, and environment of their residence are recorded. Ultimately, it is likely that it would be out of their control how the data is collected, stored, and used. Overall, robots such as Buddy can promote both immediate and long range autonomy. However, in some cases, the enhancement of immediate autonomy could ultimately diminish long range autonomy to a certain degree, and vice versa.

Negative and positive autonomy

According to Collopy's definition (1988), negative autonomy forbids others from interfering in an individual's free decision-making and activities, albeit with good intentions, whereas positive autonomy encourages others to become actively supportive and promote an individual's self-determination.

From a positive perspective on autonomy, elderly people's autonomy is enhanced when care robots support them in autonomous choice and behavior. However, it is considered a threat to elderly care receivers' autonomy if care robots interfere in their daily lives, despite the beneficent purposes from a negative perspective. For example, the social robot Stevie (Akara, n.d.) can be used in healthcare for monitoring purposes. Stevie monitors elderly care receivers, collects their data, and generates reports, which provide them with a better understanding of their health and leads to better decision-making. The robot's assistance can strengthen the elderly care receivers' positive autonomy by supporting them in autonomous decision-making and actions. However, it can be seen as unpleasant interference, especially in cases where the monitoring is mandatory. For the elderly care receivers who have difficulty with mobility and predicting risks, being monitored by a robot can be a solution to a shortage of medical staff. The elderly care receivers may not necessarily agree with being monitored at all times, but their families and caregivers may insist and want to be continuously informed, so that they can help immediately when there is an accident. In this case, the elderly care receivers' negative autonomy can be violated, despite good intentions.

3.4 Reflection on the taxonomy of autonomy in elderly care

In the previous section, the taxonomy illustrated the complexity of autonomy and offered an in-depth analysis of the potential impacts of care robots on elderly care receivers' autonomy. This taxonomy based on Collopy's work becomes a suitable instrument, both retrospectively and prospectively, for examining the complexity of autonomy.

When used retrospectively, the taxonomy serves as an evaluation tool to illustrate how each care robot would affect elderly care receivers' autonomy in different ways. By examining the complexity of autonomy using the taxonomy, we reveal that a care robot can enhance certain categories of autonomy while concurrently diminishing others. As demonstrated previously, a care robot can enhance elderly care receivers' delegated autonomy through the function of monitoring and supervision of daily activities. However, if care robots intervene too much (albeit with good intentions) and care receivers are unwilling to be monitored all day, this may also result in a decrease in negative autonomy. When receiving excessive assistance and delegating too many tasks to robots, care receivers may become so dependent on robots for daily tasks they could have executed themselves that this gradually leads to physical deterioration, which in turn diminishes their long range autonomy. There should be greater awareness of incapacitated and inauthentic autonomy, as they jeopardize elderly care receivers' genuine autonomy, instead of enabling them to make decisions freely and execute actions autonomously. To optimize care robots' impacts on autonomy in elderly care, we suggest that anything that could potentially harm elderly care receivers' autonomy should be explicitly considered in specific contexts to mitigate negative effects.

When used prospectively, the taxonomy provides robot designers with a better understanding of the value of autonomy in elderly care. Autonomy is much more than an abstract notion; instead, it is a fundamentally important value for individuals who can make decisions and take actions to achieve their goals. The taxonomy specifies the value of autonomy and informs robot designers of the role it plays in care practice. With a better understanding of the complexity of autonomy, robot designers will be more likely to promote the value of autonomy in their designs.

3.5 Conclusion

In this chapter, the impacts of using care robots in elderly care are analyzed in terms of the value of autonomy. Based on Collopy's work on autonomy, we created a taxonomy of autonomy to reveal the complexity and richness of

this value. This taxonomy was subsequently extended from traditional human care settings to elderly care through robots to assess how care robots might affect the autonomy of elderly care receivers. This leads to an enriched account of autonomy in elderly care, which highlights the complexity of this abstract value for robot designers. After a systematic autonomy-centered analysis, we conclude that this taxonomy can be used as an instrumental tool to assess the impacts of care robots on the autonomy of elderly care receivers both retrospectively and prospectively by discerning the complexity of autonomy.

4 Reconceptualizing nurses' professional autonomy in robot care

4.1 Introduction

In debates on care ethics and robot ethics, concerns about autonomy tend to center on care receivers as they are particularly vulnerable and largely rely on caregivers to make decisions and take actions (Feil-Seifer & Mataric, 2011; Gallagher et al., 2016; Sorell & Draper, 2014). However, it is paramount to acknowledge the ethical impacts of care robots on the professional autonomy of caregivers, as they play a focal role in care practice. Their professional autonomy is not only linked to job satisfaction and work performance, but also significantly associated with medical outcomes and care quality (Papathanassoglou et al., 2012; Rafferty et al., 2001; Rao et al., 2017). With the advancement of robot technology in healthcare, the impacts of care robots on professional autonomy are no longer limited to individual nurses within the dyadic human-robot interaction (HRI) model, but also deeply felt in the entire healthcare system. Thus, to gain a comprehensive understanding of how professional autonomy is affected, we consider the human-robot-system interaction (HRSI) model appropriate.

Caregivers can be medical professionals, such as doctors and nurses, or they can be informal supporters, such as family members and friends. In this chapter, we focus on nurses in medical facilities including hospitals and nursing homes, for the following reasons: First, they form an integral part of the healthcare system and ensure the smooth daily operation of any medical facility, and they outnumber doctors. Second, in many institutions, they are commonly underpaid, underrepresented, and undervalued compared to other medical professionals (Clayton-Hathway et al., 2020; Mcilroy, 2020).

Third, some of their jobs are increasingly at risk with the introduction of care robots, for example, robots that replace them in certain roles (Sparrow & Sparrow, 2006). In short, we place great emphasis on nurses and call for greater attention to them in ethical discussions and society in general. Consequently, the professional autonomy of nurses as a significant value in elderly care has to be examined, as it is integral to a nurse's ability to provide care. Nurses' professional autonomy is currently challenged by care robots in the multi-partite interaction between elderly care receivers, care robots, and the entire healthcare system. Thus, it is important to explore the professional autonomy of nurses in the robot context and how it will be affected by care robots.

We begin by reviewing the theoretical and empirical research on the professional autonomy of nurses. Following the discussion on professional autonomy in nursing, we explore the impacts of care robots thereon, as little research has been done in this field since the introduction of care robots in healthcare. We conduct this analysis at the individual level by using a five-step nursing process through the HRI model, and at the collective level through the lens of the HRSI model. We advocate that such analysis should be a mandatory part of care robot evaluation. We close with recommendations for institutional efforts made by hospitals and/or nursing associations for medical professionals in general, and nurses in particular, to maintain and enhance their professional autonomy in the robot era.

4.2 The professional autonomy of nurses in healthcare

4.2.1 Discussions on the definition of the professional autonomy of nurses

The significance of professional autonomy of nurses has been extensively discussed in the nursing literature, but there is no clear consensus among scholars on its definition (Baykara & Şahinoğlu, 2014; Kaplan & Brown, 2006; Kramer & Schmalenberg, 2008; Traynor et al., 2010). Pankratz and Pankratz (2018) define professional autonomy in nursing as individual nurses' willingness to act as professionals who are responsible for their patients.

Schutzenhofer's definition (1987) focuses on independent professional development. She proposes that professional autonomy is "one's occupation in accordance with one's education, with members of that occupation governing, defining, and controlling their own activities in the absence of external controls." MacDonald (2002a) claims that professional autonomy allows nurses to exercise their judgment. These definitions have developed over the years, but they share several key components, such as the nurse's ability to advocate for patients and for discretionary decision making about the treatment plans of patients. However, this does not mean that nurses could impose paternalistic treatment on a patient without their consent. Instead, high quality care is the result of joint efforts, including doctors' medical expertise, nurses' professional judgments, the patient's consent, and so on.

According to MacDonald (2002b), two dimensions can be distinguished within the concept of nurses' professional autonomy: an individual perspective and a collective perspective. Each perspective has commonalities and distinctive features that are necessary for our analysis. From an individual perspective, professional autonomy means that every nurse has the right to exercise discretion and professional judgment. In care practice, this means that a nurse can decide when to remind a care receiver to take their medication or undergo a physical examination. This discretion is, of course, not arbitrary, as nurses undergo extensive training to acquire decision-making abilities and learn the preferences of each patient.

From a collective perspective, professional autonomy is used to emphasize "the privilege of self-governance accorded to a profession" (MacDonald, 2002b). It indicates that nurses are a self-governing occupational group that is granted the power by national and/or international regulations to set their own technical and ethical standards, which are shared by members in the nursing field based on their professional skills and knowledge. While nurses receive orders from doctors on the implementation of certain nursing processes, they often know more than doctors about how to execute certain tasks, such as administering intravenous injections due to their extensive

professional training and working experience gained through daily practice. When doctors make mistakes or attempt to interfere in nursing practice, this professional autonomy empowers nurses to discuss with doctors and to make professional decisions and carry out judgements according to their expertise.

This distinction in the scope of nurses' professional autonomy is necessary to understand the complexity of the subject and promote respect for nurses' professional autonomy to execute their role to the benefit of the patients.

4.2.2 Empirical evaluation of professional autonomy from nurses' experience

In addition to this conceptual discussion, there is a growing body of empirical research that examines how nurses evaluate their professional autonomy and discusses their experiences of violation of their professional autonomy. We now turn our attention to some of these issues to understand how the professional autonomy of nurses was already threatened before the introduction of care robots. In other words, we wish to create a representative account of the threats that nurses face to their professional autonomy, rather than argue that the introduction of care robots is the sole reason for this occurrence. We categorize the relevant studies into two groups according to MacDonald; that is, from an individual perspective accounts for nurses as single entities and a collective perspective of the nursing profession in general (MacDonald, 2002a).

From an individual perspective, a study by Skår (2009) shows that in order for a nurse to gain autonomy in their daily practice, they must have a holistic view of how nursing is organized in their working institutions. This means that a nurse has to know who is responsible for which patient and which tasks. They also has to spend time getting to know each patient, which is a crucial factor in gaining a holistic view. For some nurses, this means taking time to discuss treatment plans with patients, whereas in many instances, getting to know the patient happens naturally through the several tasks over which the nurse and patient interact, such as bathing, feeding, and moving the patient (van Wynsberghe, 2015). Being confident and professionally knowledgeable are necessary to solve problems by following standard procedures, taking

initiative or keeping communicating with the patients to gain their trust, which could enhance nurses' professional autonomy (Skår, 2009).

When asked about their experiences of their autonomy and privacy being violated, nurses report that managers' interference in relationships between colleagues is a violation of their privacy (Khademi et al., 2012). Losing control of one's privacy can jeopardize one's autonomy. Disregarding someone's right to make decisions on working schedules and mandatory overtime results in a lack of autonomy as well (Khademi et al., 2012). This illustrates that the violation of nurses' professional autonomy may occur at both the individual and collective level, as it occurs between managers and nurses in an organizational context.

From a collective view, the level of education and vocational training of individual nurses positively correlates to their level of professional autonomy. Surveys identifying the relationship between nurse characteristics and professional autonomy illustrate that continuing professional education is a major factor in the improvement of nurses' professional autonomy (Motamed-Jahromi et al., 2015). Labrague et al. (2019) suggest that the healthcare system should provide nurses with adequate resources, organizational support, and developed policies to strengthen both their professional autonomy and enrichment. Continuing professional education would play a significant role in promoting the professional autonomy of future nurses.

4.3 Professional autonomy of nurses when care robots enter healthcare

4.3.1 Professional autonomy of nurses challenged in the robot era

In recent decades, care robots have been introduced in medical facilities, such as hospitals and nursing homes, to narrow the gap between the growing population of elderly care receivers and a huge shortage of caregivers. It is debatable whether this is the best solution to the problem at hand; that is, resources could instead be allocated to hiring more care workers. However, under certain circumstances, such as the current COVID-19 pandemic, there

are good reasons to pursue the development and use of care robots. Care robots efficiently complete tasks that can be dangerous and exhausting for nurses in the current situation. For example, the robot nurse Tommy is used in hospitals to decrease nurses' infection risk by helping to take the blood pressure and oxygen saturation measurement of patients who are in the epicenter of the outbreak in Italy (Romero, 2020). Ultraviolet disinfection robots equipped with short-wavelength ultraviolet lights are used in Chinese hospitals to disinfect wards and operating rooms (Ackerman, 2020). This frees caregivers from dull and hazardous disinfection tasks, which minimizes their exposure and allows them to focus their time and energy on professional decision-making and care practice.

Despite these benefits, the introduction of care robots also alters nurses' roles and responsibilities, which challenges their professional autonomy. Nurses play a crucial role in society as critical medical professionals. Their main responsibilities include performing physical exams, conducting health counselling, administrating medication, and collaborating with other medical professionals to coordinate care (American Nurses Association, n.d.). In the robot era, some nurses may have to adjust their individual workflow to sync with care robots, or they may have to do additional work, despite the original goal of care robots relieving their burden. An empirical study reveals that a delivery robot that had been intended to reduce physical burdens and improve nurses' efficiency was actually met with resistance from nurses. This new application may help nurses with delivery, but it yields several new tasks to them, such as loading the robot (Forlizzi, 2008). When the robot continues beeping after delivery or breaks down due to high traffic, the nurses have to reprioritize their tasks and attend to the robot to fix it to avoid potential problems that might be caused by delay. As such, when a robot enters a hospital, nurses' roles and responsibilities will be redistributed and their professional autonomy will be challenged, as they need to take robots' presence, potential malfunctioning, and corresponding resolutions into consideration in their workflow, instead of making decisions based on their established expertise and practice.

4.3.2 The potential impacts of care robots on professional autonomy in HRI at the individual level

As MacDonald (2002a) suggests, when the concept of professional autonomy applies to individual nurses, it emphasizes the right and responsibility of a particular nurse to make discretionary decisions and act according to the shared standards of the profession. According to the American Nurses Association, individual nurses follow a five-step nursing process to deliver care. First, they make a holistic assessment of patients based on various aspects, such as physiological condition and lifestyle. Second, they make a diagnosis by taking physical symptoms and patient behaviors into consideration. Third, they make plans for patients' recovery based on their professional knowledge. The fourth step is to carefully implement the treatment and document the course of the disease. Finally, they evaluate the effectiveness of the care plans and determine if the optimal outcome is being achieved.

In the context of elderly care through care robots, several robots have been designed and deployed in hospitals to relieve nurses' burden and help them with decision-making. Following the five-step process of care delivery, we discuss several care robots to illustrate how they would impact nurses' professional autonomy during different processes from an individual perspective.

At the step of assessment, the monitoring robot KOMPAÏ can help with general monitoring of elderly care receivers' medical data, after which it collects, aggregates and eventually sends the data to nurses and other relevant medical professionals. Based on the data from KOMPAÏ, an individual nurse can amass a whole picture of the health of care receivers and assess it without checking in on them in person multiple times a day. In doing so, nurses can conduct more accurate assessments based on the raw data and processed information, which can boost their autonomy by providing them with more potential options in their decision-making.

However, when a monitoring robot works as a mediator between a care receiver and a nurse by collecting the care receiver's medical data and

transmitting it to the nurse, the robot may also give rise to potential ethical issues regarding nurses' professional autonomy at the assessment step. First, the nurse may need to verify the data to ensure that no errors were made, which may be a tedious additional task in their busy schedule. Second, the robot may not be able to monitor all the relevant medical information promptly due to the limitations of current robot technology. Even if it can capture all the objective information, it may be unable to process the information and make decisions after comprehensive consideration, as a human would (Li et al., 2020). In some circumstances, inaccurate or incomplete information provided by monitoring robots may restrict nurses' decision-making, as they remain uninformed. Thus, care robots could have negative effects on nurses' professional autonomy and jeopardize the patient's health. In addition, nurse managers may distribute other tasks to the nurses as some of the time that was normally spent checking on patients can be saved by the robot. It may threaten the professional autonomy of nurses by interrupting their working schedule or neglecting their preference for checking on patients in person.

As applications for diagnoses, many robots and algorithms are developed to improve the accuracy of diagnosing disease. The AI software developed at Stanford University can detect deadly skin cancers by using deep convolutional neural networks (CNN) to classify skin lesions with accuracy comparable to that of dermatologists (Esteva et al., 2017). By delegating the task of detection to these algorithms and robots, dermatologists and nurses could save time and effort in diagnoses and have more room for accurate decision-making and exercising professional judgment. On the other hand, nurses' protocol would change in the robot era. In traditional clinical skin examinations, nurses usually explain the process to the patient and their family. This is followed by assessment of the patient's skin in a private space, which entails identification of parameters such as temperature, color, texture, and integrity (Holloway & Jones, 2005). When robots and AI software have been incorporated into the diagnosis process, nurses need to perform new tasks and acquire new skills, such as instructing the patients on taking pictures of their skin. After collecting the pictures, the nurses would send them to certain digital platforms for classification by CNN.

Taking on the role of a health consultant, the chatbot Healthily/Your.MD asks users questions about their symptoms to spot less serious conditions, and consequently makes preliminary suggestions for their recovery. Since the start of the COVID-19 pandemic, the job of a hospital nurse has become much more demanding than usual. The chatbot can take over some consulting and planning tasks from nurses by providing patients with information about certain medical conditions, which enables nurses to focus on higher-level decisions that cannot be supported by the chatbot. This, in turn, can enhance nurses' professional autonomy.

At the implementation step in the nursing process in traditional human-human interaction in elderly care, nurses have a heavy workload due to the repetitive nature of routine tasks, such as food preparation, feeding, mobility assistance, and so on. With the introduction of care robots, nurses have more freedom to delegate certain daily tasks to robots instead of doing everything themselves. For example, the delivery robot RoboCart can share the burden of delivering medication and sheets throughout hospitals, which would be normally part of nurses' daily duties. Being provided with the option to delegate this task to the robot or execute it themselves, nurses may gain greater autonomy in exercising their discretion.

When nurses evaluate the effectiveness of the care plan, monitoring robots such as KOMPAÏ can also help. As mentioned previously, KOMPAÏ can collect and store elderly care receivers' health data in the cloud. By analyzing the aggregated physiological, mobility and behavioral data, nurses have accurate information to study the patient response. Thus, they are more likely to conduct a better assessment of the care plan based on comprehensive data and can subsequently optimize the care plan for the best patient outcomes.

In the above analysis, we use the five-step process that nurses follow in delivering care to illustrate at which steps care robots could assist and how their involvement would affect nurses' professional autonomy in the dyadic HRI model at the individual level.

4.4 Professional autonomy through the lens of HRSI

4.4.1 The human-robot-system interaction (HRSI) model

In the current technology trends in healthcare, care robots that have been designed for various functions not only affect individual nurses' daily tasks, but also have a profound impact on the nursing profession at the collective level. The HRI model focuses on the dyadic interaction between humans and robots, which fails to account for the multi-dimensional reality of robots actually interacting with a whole system of human and non-human actors in contemporary healthcare. Thus, we propose the human-robot-system interaction (HRSI) model to capture the important downstream effects of care robots on a complex healthcare system (van Wynsberghe & Li, 2019). The application of HRSI in the present work allows for an exploration of the impact of care robots on the professional autonomy of nurses at the collective level.

The HRSI model, which captures the complex multi-partite interaction between elderly care receivers, care robots, and a system of caregivers, is employed to emphasize that the focus of robot analysis must include interaction with the healthcare system, which contains both human and technical elements (van Wynsberghe & Li, 2019). Understanding that robots not only affect the humans with whom they interact, but also the various ways in which healthcare functions (i.e., how resources are allocated, how experts are trained, etc.), HRSI serves as a robust framework to understand professional autonomy in elderly care in a socio-technical system. Thus, we use the advanced HRSI model to conceptualize the triadic interaction between an elderly care receiver, a care robot, and a healthcare system of nurses and non-human actors, which also helps to reveal and address complex ethical issues at the collective level (van Wynsberghe & Li, 2019).

4.4.2 The potential impacts of care robots on professional autonomy at the collective level through HRSI

In this section, we use a surgical robot as an example to illustrate that a care robot does not merely affect the individual nurses who work alongside it, but also restructures the entire healthcare system. Observing this through the

lens of the HRSI model, the extensive impacts on nurses' professional autonomy at the collective level is analyzed in terms of three main aspects: professional roles and responsibilities, professional education, and resource allocation in healthcare.

Professional roles and responsibilities

Normally, nurses follow standard nursing process to care for patients. However, since the introduction of surgical robots in operating rooms, nurses' roles and responsibilities have begun to change. In addition to traditional tasks in daily care practice, nurses now have to undertake additional tasks for successful robotic surgeries, such as patient positioning and robot equipment connection. Their collaboration with surgical robots in operating rooms clearly illustrates the emergence of the robotic nurse coordinator. Thus, a new division of labor that requires both professional nursing skills and robot operating expertise has been generated in the robot era (van Brenk, 2009). In contrast to traditional scrub nurses, who perform tasks in human-human care practice, robotic nurse coordinators would perform technical tasks in operating rooms and take care of the administrative arrangements for robotic surgeries.

As a new type of nurse in robot surgeries, the robotic nurse coordinator's duties and responsibilities, inside and outside of the operating room, can be categorized into four aspects. First, they need to manage the scheduling of the robotic surgery team and the availability of the surgical robot. The limited number of robots require additional attention to balancing operating room scheduling and robot schedules. Second, before the surgery, they have to prepare and manage the operating system. Third, during the surgery, they have to provide clinical support and professional help when technical issues arise. And fourth, they have to take responsibility for new members' education and training in the robot surgery team (Raheem et al., 2017).

When the use of robots is promoted in hospitals, it is likely that nurse managers would persuade nurses to acquire certain technical skills so that they could work with care robots with more proficiency. If nurses are willing to learn new skills, the robots could share their physical burdens and improve

their efficiency, which promotes their professional autonomy. However, in some circumstances, nurses may feel obliged to adapt to a new working environment with care robots, regardless of their personal willingness, which could result in a violation of their professional autonomy understood as discretionary decision-making in the working environment.

Professional education

When surgical robots affect nurses' work in operating rooms by performing complex tasks, current nursing education and vocational training will be insufficient. A new range of specialized skills and protocols become necessary. Compared to a time without robots in operating rooms, nurses working in the robot era are assigned many additional tasks. They need to undock the robot for changes in patient position and change the position of the robotic cart at any time. In addition, they need to learn and follow extra skills and new procedures of robot surgeries, such as connecting the surgical robot and remote console, calibrating and setting up the robot, and managing specialized instruments (van Brenk, 2009). As new tasks are generated in the nursing profession, professional education should include relevant robot training, as nurses have to prepare the robot operating system and be on standby in operating rooms.

Since many nurses have specific areas of expertise, such as cardiology, oncology, or trauma, nursing education will need an even more specialized curriculum to meet the requirements of a wide range of knowledge and skills in robotic surgery, which will require highly qualified students. Thus, the new division of labor in healthcare, namely robotic nurse coordinators, would undergo extensive technical training to acquire adequate knowledge of robotic surgical procedures. Robot surgeries would not be successful without a thorough understanding of how to control the robots and handle unexpected malfunctions in critical surgeries. Following MacDonald's definition of professional autonomy from the collective perspective, it is evident that the previous technical skills and knowledge required for the nursing field are no longer fit for the nurses working in operating rooms alongside surgical robots. The education that nurses would receive and the

evaluation of their performance will be closely associated with various robotic skills, which differs greatly from traditional nursing training. The case of surgical robots clearly demonstrates the huge impact of care robots on the professional autonomy of nurses at the collective level. It calls for (continuing) professional education that is adapted to the robotic breakthroughs in healthcare, so that nurses can preserve their professional autonomy in the changing working environment.

Resource allocation

When a robot enters the healthcare sector, nurses' responsibilities and roles change, their education changes, not to mention the reallocation of funding to purchase expensive robots. A da Vinci surgical robot costs approximately $2 million at installation and requires additional funds to have technical experts on standby and for regular maintenances (Bec, 2020). The funds for this have to come from the current budget and will undoubtedly influence the number of human personnel hired. Professional autonomy is vital to nurses, but they are constantly under threat of budget cuts and organizational hierarchies, which may be exacerbated by care robots. If a hospital purchases expensive robots but does not increase its total budget, then other divisions and staff, including nurses, may be at risk of lower income but more overtime, regardless of their preferences or free decision-making. We raise these issues because it is crucial for scholars, hospital administrators, and nurses to realize that the introduction of care robots in healthcare should be evaluated in a more robust manner in order to determine what effects it would have on human users.

When an AI-based robot recognizes physical signs and gives instructions while nurses do not, the expertise of nurses may be called into question, and their authority and professionalism may be challenged. Medical professionals make decisions based on their knowledge and individual work experience, but a robot is programmed based on a database that may include a huge amount of data. Robots may not provide a well-developed, comprehensive report on the patient's condition, but they may have higher accuracy and precision in certain diagnoses than nurses. In some scenarios,

nurses may perceive they are competing with robots, which can impede their discretionary decision-making.

4.5 Recommendations

By conducting analyses at both individual and collective levels, we demonstrate how the professional autonomy of nurses can be reconceptualized in the robot era, as this value is challenged by care robots. In addition, we raise concerns of how the professional autonomy of nurses would be affected when they are examined by the human-robot-system interaction in working environment.

Facing these potential challenges to the professional autonomy of nurses in the age of care robots, we suggest that new policies and regulations should be developed to provide detailed guidance to the healthcare sector and nurses in particular. In these regulations, nurses' roles and responsibilities should be codified as clearly as possible before they start working with robots. It is also worth noting that the categorization of nurses' roles and responsibilities is an evolving practice that requires committees at every level in healthcare systems to re-evaluate nurses' performance, along with the development of robotics at regular intervals. The future distribution of responsibilities among stakeholders in the vast socio-technical system of healthcare, such as Institutional Review Boards (IRBs) or Ethics Committees, nurse managers, professional education institutions, and robotics companies, has to be specified in case of potential accidents in the use of care robots. To minimize the potential negative impact on nursing education, nursing associations and healthcare institutions should provide updated curriculums to adapt to the ever-evolving technological development in healthcare. Nursing programs should train students in sophisticated technical skills, teach them how to work with state-of-the-art care robots, and provide hands-on training for potential emergencies when working with robots. Additional organizational support within the healthcare system, such as adequate financial resources, supportive policies, and continuing professional education in care robot control and surgical procedures are encouraged as they are fundamental for nurses to adapt to the rapid technological advancements in healthcare.

We believe that such analyses conducted at both the individual and collective levels should not be an afterthought in the evaluation of care robots. Instead, scrutiny of the steps of the nursing process at which care robots would enter, the consequent impact on the professional autonomy of individual nurses, how robots would alter nurses' professional roles and responsibilities, professional education and training, and resource allocation in healthcare should be mandatory elements of any care robot evaluation or assessment in future.

4.6 Conclusion

This chapter highlights the professional autonomy of nurses in the context of care robots being used in elderly care. Through the conceptual and empirical findings of nurses' professional autonomy in the literature, two dimensions, namely the individual and collective perspectives, are applied for an in-depth understanding of the professional autonomy of nurses and examination of how care robots could influence nurses' professional autonomy through the HRI and HRSI models respectively. At the individual level, care robots have both positive and negative effects on nurses' free decision-making in dyadic HRI contexts. At the collective level, care robots can influence the nursing profession and restructure the healthcare system in profound ways.

We conclude that it is fundamental to construct a nurse-friendly environment in healthcare so that nurses' professional autonomy can be maintained and enhanced. Healthcare institutions should provide more opportunities for nurses to receive adequate professional training to keep up with the rapid development of care robots. Organizational efforts should be devoted to empowering nurses to take control of their nursing practice, which promotes their professional autonomy and ultimately improves the quality of care they provide.

5 Individualistic perspective vs. relational perspective: How to improve autonomy in value sensitive design in care robots

5.1 Introduction

The technological advancement in robotics, in conjunction with the huge gap between the growing population of elderly people and the shortage of caregivers, necessitates the use of robots in elderly care. In current care settings in many countries, the introduction of care robots, the robots used for care purposes in healthcare settings, are increasing. According to the International Federation of Robotics, the robotics turnover in the medical field reached $5.26 billion in 2019 (International Federation of Robotics, 2020). Various types of care robots have been designed and introduced in elderly care to improve the quality of care and enhance the autonomy of elderly care receivers.

Value sensitive design (VSD) serves as a tool to embed the value of autonomy in the design process of care robots. However, VSD implicitly adopts an individualistic understanding of autonomy, which focuses solely on care receivers' self-determination and self-sufficiency, but it neglects the social relationships on which the care receiver's quality of life depends as well.

By following the individualistic concept of autonomy, the current discussion on autonomy in VSD appears to be inadequate to address those fundamental needs of elderly care receivers that can only be met through meaningful relationships with others. This individualistic concept of autonomy is dominant in Western philosophical, cultural, and societal discourse.

However, in other cultures such as Asia, there is a much stronger focus on the relational aspects of autonomy. Owing to these cultural differences, elderly care in East Asia, especially China, reveals an important facet of autonomy. It is therefore essential to collect data in elderly care systems outside of Europe and North America. Thus, an exploratory empirical study was conducted in a nursing home in Suzhou, China to investigate which factors elderly care receivers view as crucial to high-quality care.

In this chapter, I start with clarifying the significance of autonomy in elderly care in the robot era. Subsequently, I analyze the functions of a specific care robot, KOMPAÏ, to illustrate that the common individualistic conception of autonomy in VSD is insufficient. Following this, I discuss the main critiques of individualistic autonomy and use my exploratory empirical study on elderly care as an indication of the need for a more contextualized interpretation of autonomy. Based on care ethics and insights from Confucian philosophy, which is deeply ingrained in Chinese culture, relational autonomy is proposed to remedy the limitations of individualistic autonomy. Finally, I recommend that embedding a relational perspective in robot design is crucial to enrich the discussion on autonomy in VSD and enhancing the autonomy and care quality of elderly care receivers.

5.2 The significance of autonomy in elderly care in the robot era

Autonomy is generally understood as the ability to make individual and fully informed decisions and execute these decisions freely. In bioethics, autonomy is a core component in the Belmont Report, the canonical reference from which much bioethics literature is derived. Acknowledging autonomy and protecting people with diminished autonomy are the two requirements of respect for persons (US Department of Health, Education, and Welfare, 1979). Autonomy is also a core guiding principle in bioethics, as introduced by Beauchamp and Childress. The principle of respect for autonomy entails respecting the decision-making capacities of autonomous people (Beauchamp & Childress, 2001).

In the specific context of elderly care, the consideration of respect for autonomy focuses on situations in which decisions about elderly people's care should be made by themselves (Lothian & Philp, 2001). Empirical studies indicate that the value of autonomy is essential for elderly care receivers to receive good care (Calnan et al., 2005; Hall et al., 2014; Krajcik et al., 2005). Due to their physical and mental conditions, elderly people easily encounter disempowerment and diminished autonomy in care settings (McWilliam et al., 1994). The huge gap between the growing population of elderly people who need care and the ongoing shortage of caregivers jeopardizes the quality of care they receive. In turn, receiving poor quality care can diminish elderly care receivers' autonomy.

To bridge this gap, care robots, the robots used for care purposes in general, are designed, developed, and deployed in various healthcare settings (van Wynsberghe, 2013b). Assigning a variety of tasks, such as feeding and lifting, to care robots offers huge benefits to elderly care. For example, it can save caregivers' time and physical efforts and promote the care quality of elderly care receivers. However, the introduction of robots in elderly care also gives rise to social and ethical issues, particularly due to the sensitivity and complexity of elderly care, which has generated philosophical discussions on the value of autonomy. Feil-Seifer and Mataric extend the biomedical principle of autonomy to the context of robot care and suggest that care receivers should be able to make informed decisions on the care they receive from robots. To avoid diminishing autonomy, the roles, functions, and possible misconceptions of the care robot need to be thoroughly clarified to the users (Feil-Seifer & Mataric, 2011). Sharkey and Sharkey take assistive robots as an example to illustrate that elderly care receivers' autonomy can be promoted and diminished in different situations. In some cases, the enhancement of autonomy may be at the expense of other values, such as safety. Thus, a balance between autonomy and other values has to be achieved to increase the advantages of care robots and minimize potential risks (Sharkey & Sharkey, 2012). Li et al. propose a detailed taxonomy of autonomy to examine the complexity of the autonomy of elderly care receivers in the robot era. The taxonomy serves as a tool to evaluate the impacts of care robots on elderly care receivers' autonomy. With a better

understanding of what the value of autonomy would look like in care practice, robot designers would be more likely to embed autonomy in the design process by following the VSD approach (Li et al., 2020).

5.3 The implementation of autonomy in value sensitive design in the context of elderly care

According to Batya Friedman et al., VSD proactively serves as "a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process" (Friedman et al., 2006). To identify which values should be embedded in the design of new technologies, Friedman and Kahn propose a list of twelve human values with ethical dimensions that are fundamental to human-computer interaction, including autonomy, informed consent, human welfare, privacy, and freedom from bias (Friedman & Kahn, 2002). VSD is developed as a tool depending on the specific values that would be embedded in the design process. The impacts of certain technologies on the users thereof are gradually shaped by the specific design and the context in which it is situated (van den Hoven et al., 2015). As described by Friedman and Kahn, people value their autonomy in making decisions and taking actions in ways that they believe will help them to achieve their goals. For this reason, autonomous decision-making should be a key value in VSD (Friedman & Kahn, 2002).

KOMPAÏ, a care robot produced by a European robot company, is an example of the implementation of autonomy in VSD. It is designed to enhance the autonomy and independence of both caregivers and fragile or dependent care receivers at residential homes or other care settings, such as hospitals and nursing homes (KOMPAÏ Robotics, 2017).

Equipped with a monitoring function, KOMPAÏ collects, aggregates, and stores elderly care receivers' medical data from certain devices and sends it to medical professionals. Based on the data from KOMPAÏ, an individual caregiver can create an entire picture of care receivers' health information without checking in on them in person multiple times a day. In doing so, the elderly care receiver will not need to meet caregivers at the nurse station to

report their medical data, nor would they need to undergo daily physical checks. As a result, they can have more time and energy to decide what kinds of activities they want to dedicate their time to and when to execute them, which helps boost their autonomy.

In addition, KOMPAÏ helps elderly care receivers recall useful information and it offers interactive entertainment via the equipped screen. Owing to the high elderly care receiver-caregiver ratio in healthcare, it is likely that caregivers do not have sufficient time and energy to entertain elderly care receivers or provide necessary information promptly. KOMPAÏ's assistance makes it easier for elderly care receivers to be aware of time and place so that they can freely arrange the time and location of their entertainment, which promotes their autonomy.

KOMPAÏ is also designed to maintain social connectivity between elderly care receivers and their family and friends. When they are feeling lonely, elderly care receivers can easily contact their loved ones via video calls. By enabling elderly care receivers to talk to their family whenever they want, the care robot empowers them with the ability to make decisions and act immediately. This function promotes certain online social interactions, but elderly care receivers are still in need of interpersonal relationships that cannot be met by robots.

Another important feature of KOMPAÏ is its ability to provide physical assistance to elderly care receivers, thereby allowing them to move freely. Deteriorating health conditions are inevitable in aging. Getting up when seated without a caregiver's help can be difficult, sometimes even impossible, for some elderly care receivers. KOMPAÏ can play a significant role in these scenarios, such as when the caregiver is not nearby, as it supports people with mobility issues to maintain balance and stability when they walk or move between their bed and a chair. When holding onto the top of the walking frame and following KOMPAÏ's movement, elderly care receivers with muscle weakness or joint pain can walk without relying on a human caregiver, thereby regaining their autonomy.

While embracing the instrumental functions of KOMPAÏ that enhance the elderly care receivers' autonomy in various ways, it is noticeable that the implicit concept of autonomy embedded in KOMPAÏ tends to be individualistic. As an implementation of autonomy in VSD, KOMPAÏ enables self-determination and self-sufficiency for elderly care receivers. Although the manufacturer clarifies that the robot aims to provide support without replacing the unique presence of human assistance, the interactions between KOMPAÏ and an elderly care receiver are intended to replace a certain number of interpersonal interactions. For example, when KOMPAÏ facilitates walking rehabilitation in elderly people who have difficulty walking alone, it decreases their already limited opportunity to talk to other people by replacing human caregivers in rehabilitation training. Focusing on an individualistic interpretation of autonomy, robot design tends to neglect the social environment of elderly users and leaves them isolated in decision-making. Such neglect should no longer be overlooked.

5.4 Critiques of an individualistic interpretation of autonomy and its implementation in value sensitive design

Prior to the pivotal role of individual autonomy in bioethics since the 1970s, the centrality of an individualistic interpretation of autonomy goes back to longstanding philosophical traditions. Kant's doctrine of respect for persons and Mill's view on individualism, which focus on self-determination and individual liberty, have had a profound influence on discussions on autonomy (Campbell, 2017; Ho, 2008b). Such philosophical traditions precipitated three main critiques of an individualistic understanding of autonomy in the literature, which I explore below. Furthermore, they led to the implementation of individualistic autonomy in VSD. This includes the introduction of KOMPAÏ in elderly care, which results in challenging ethical issues. For these reasons, these three aspects of the individualistic implementation of VSD require scrutiny.

5.4.1 An inadequate conception of the self

One of the strongest critiques of traditional individualistic autonomy concerns the inadequate conception of the self (Ells et al., 2011; Grignoli et al.,

2018; Ho, 2008a; Sherwin & Winsby, 2011; Verkerk, 2001). The liberal ideal of the self is frequently criticized for being atomistic. Liberalism assumes that the individual is conceptually and ontologically prior to the social context in which the self is situated. The self is the ultimate unit of society and is not intrinsically dependent on, nor constituted by, the social relationships in which individuals happen to live (Parekh, 1992). From a liberal perspective, one of the main goals societies should provide individuals with is the opportunity to become or remain autonomous. Although liberals accept the idea that we need to live peacefully with others in society in order to fulfil our interests, they suggest that individuals should liberate themselves from being socially conditioned beings to become ontologically transparent and autonomous (Parekh, 1992). According to Parekh, one of the main issues with the liberal conception of the self is that the individualistic interpretation of autonomy is built on the unrealizable scenario without incorporating social context (Parekh, 1992). The individualistic conception of the self neglects the significant fact that, ontologically, we are all in various types of human relationships. A person cannot separate themself from personal attachment with other individuals or groups (Lee, 2007). By the same principle, an elderly care receiver in a nursing home is a member of that home, their family, and their ethnic, cultural, and societal group. As social creatures, each individual is in their connection to others to survive and thrive. Elderly people who lack meaningful and productive activities with others may survive, but they would have difficulty thriving due to the health risks posed by social isolation and loneliness (Cacioppo & Cacioppo, 2014).

This criticism of the individualistic self suggests the limitation of individualistic autonomy designs in care robots. Despite various conveniences and the enhanced autonomy that care robots offer, the human need for care, especially in the context of elderly care, cannot be completely satisfied by the functions that robots provide. The COVID-19 pandemic shows the necessity of interpersonal interaction even though we have various digital devices to entertain ourselves and virtually maintain social ties. Interpersonal interactions cannot be replaced by virtual interaction, due to the irreplaceable human dimensions such as emotions and support in human dynamics. As KOMPAÏ can easily provide a digital connection between an

elderly care receiver and others, there is a genuine chance that the face-to-face visits and interactions with their family and caregivers would decrease and, in some cases, be entirely eliminated. When elderly people lack social relationships over the long term, they face higher risks of various physical and mental conditions, such as heart disease, obesity, depression, dementia, and even death (Cacioppo & Cacioppo, 2014).

5.4.2 An insufficient depiction of decision-making

The idealized portrayal of decision-making within the individualistic interpretation of autonomy is often criticized as being abstract, empty, and unrealistic. Scholars caution that individual autonomy is often interpreted as an all-or-nothing notion, as care receivers are expected to take full control of decision-making with full competence (Gómez-Vírseda et al., 2019; Verkerk, 2001). Following this binary notion of autonomy from the individualistic perspective, there are two scenarios in decision-making in elderly care. If the care receiver is competent to make their own decisions, other stakeholders including healthcare professionals should respect their decisions. When the patient cannot make decisions on their own, then the decision-making will be delegated to a proxy to work in their best interest. However, when adopting a one-sided view of autonomy from an individualistic perspective, we may fail to take the physical and mental conditions of elderly care receivers into consideration when advocating for their autonomy and the quality of care. At the later stage of life, elderly care receivers often struggle with being competent and well informed to make decisions freely. Elderly care receivers, especially those who suffer from serious disease, often face physical and cognitive deterioration, which inevitably undermines their ability to make decisions as well as the degree of autonomy they can enjoy. The all-or-nothing notion of autonomy in decision-making fails to consider those who are not fully competent to make all of their decisions, but who might still be able to make some decisions and execute certain decisions freely. It is cautioned that there will be potential exclusivity raised by the physical and/or cognitive impairment of individuals in the context of elderly care (Głos, 2016). Some elderly care receivers may lose part of their autonomy due to certain health conditions, but they should not be excluded from the discussion.

This inadequate portrayal of autonomy also neglects the social reality that, in elderly care, many decisions are based on relational interests, often in consultation with others. This occurs especially when elderly care receivers are not fully competent to make their own decisions. However, even if they are, they may prefer to make such decisions in collaboration with others, rather than act according to the models of self-sufficiency and independence (Wright, 2017). Empirical research shows that some patients choose to live in hospitals for hospice care primarily because they want to reduce the burden on their family members and shield them from witnessing the distressing disease progression, regardless of their own preference (Broom & Kirby, 2013). Such patients may have different opinions to their family members on certain medical decisions, but they demonstrate their willingness to prioritize their family's preference over exercising their autonomy in an individualistic way.

Following the individualistic interpretation of autonomy, the robot designed to enhance the user's autonomy will be deficient for elderly care receivers in decision-making. In some circumstances, the robot plays the role of a proxy for decision-making for elderly care receivers. Due to its technological limitations in receiving, processing, and conveying information, the robot cannot capture all the contextual details of a care setting. The loss of contextual details may lead to imprecise information and inappropriate advice on care, which may diminish elderly care receivers' decision-making ability (van Wynsberghe & Li, 2019). When cared for by robots, elderly care receivers are likely to have less interaction with caregivers, family, friends, and fellow residents in care facilities, and they may become excessively dependent on robots. This lack of proper human interaction will impede the medical consultation and decision-making that occurs in their relationships with family, friends, and medical professionals. As a result, elderly care receivers' shared decision-making is compromised, which diminishes their wellbeing and the quality of their care.

5.4.3 Cultural bias against alternative value systems

The attraction of individualistic autonomy also leads to cultural bias against alternative value systems that are fundamental in other societies. As feminist

scholars Sherwin and Winsby point out, respect for patient autonomy, a central value in bioethics, is deeply linked to Western values and readily accepted in Western democracies (Sherwin & Winsby, 2011). The dominant culture in these countries supports the notion that independent, rational, and self-governing agents make uncoerced decisions and live lives of their choosing.

However, several scholars have questioned the view that self-sufficiency and independence are the leading values for human beings (Ho, 2008a; Tan Kiak Min, 2017). While emphasis is placed on individualistic autonomy in Western society, alternative social values, such as interdependence, family harmony, and filial piety, appear to be more essential in other societies (Ho, 2008a, 2008b; Lee, 2007; Tan Kiak Min, 2017; Turoldo, 2010). For example, it has been noted that individualistic autonomy does not play a central role in East Asian cultures, such as Japan and China. According to an empirical study conducted in Japan, physicians are reluctant to disclose patients' medical information, such as the diagnosis of certain disease and consequent treatment plans, to them alone, even though the concept of informed consent is promoted in healthcare in Japan. Instead, the active involvement of the patient's family is strongly preferred (Hattori et al., 1991). The different value system of informed consent in healthcare in Japan demonstrates the complexity of autonomy. Such involvement of family members in the decision-making, especially when the patient refuses to undergo certain treatment, can be considered interference in the patient's decision-making from an individualistic perspective.

When it comes to elderly care in Chinese culture, interdependence and social relationship between the elderly care receiver, family, and the doctors are crucial in decision-making. Normally, elderly care receivers do not make decisions on treatment options alone but ask family members and doctors for advice. Medical decision-making in such societies does not only constitute individual choice, but includes consultation with family members to consider the interests of the entire family and minimize the potential burden on them (Lee, 2007).

Given these cultural differences, it is important to inspect the notion of autonomy more closely to incorporate additional insights for greater understanding of autonomy in care settings. This can shed light not only on autonomy and care in non-Western cultures, but also on some universal features of the complex questions of the role of autonomy and care, which can, in turn, inform a more responsible design of care robots.

5.5 The significance of social relationships in an exploratory case study

For decades, the value of autonomy has been privileged as the core principle in Western bioethics and an essential component in the quality of care (Johnstone, 2009; Steinhauser et al., 2000). To examine important factors for elderly care receivers to receive high-quality care in non-Western cultures, I conducted a pilot study in a nursing home in 2019 in Suzhou, China. In the qualitative study, I interviewed five elderly care receivers and eight caregivers, including doctors, nurses, and care workers, to understand what elderly care receivers consider important in high-quality care in their daily lives. The data collected from the interviews corroborates the hypothesis that there are other ways of conceiving autonomy and high-quality care than the individualistic perspective. It reveals a divergent view with more attention to social relationships than individualistic autonomy. The interviewees emphasized the importance of relational aspects, rather than the individual assumptions. This does not mean that they do not value autonomy, but rather that, from their perspective, the quality of their care primarily depends on the quality of their interpersonal interactions with others, caregivers in particular.

According to the empirical data, good interpersonal interaction between elderly care receivers and caregivers is the most important factor. The following data consists of quotations from interviewees, featured from some of the most frequently discussed factors of receiving high-quality care, which have been anonymized by means of numeric codes (CG1=caregiver 1; CR1=elderly care receiver 1).

(1) Human bonding

The interviews reveal that human bonding, the process of forming a close interpersonal relationship, is a fundamental factor in receiving high-quality care. How people talk to elderly care receivers has an impact on human bonding and the quality of care. One caregiver indicated that good relationships with family members and caregivers are significant to elderly care receivers: "The emotional support from their family also plays a key role. The elderly care receivers can be disappointed and may have a feeling of being left out. In addition, caregivers' support and encouragement are helpful as well" (CG6).

According to the interviewees, communication plays an important role in elderly care receivers' daily lives, as it is in essential means to interpersonal bonding: "Sometimes, the caregivers (care workers) talk in an inappropriate way. They are too direct and sometimes talk in an impolite tone" (CG2). "A few of the elderly people who can take care of themselves in daily life mentioned that they are unable to interact with their paralyzed roommates" (CG6). Here, the caregiver emphasizes elderly care receivers' deep desire for social relationships. When an elderly care receiver has a roommate who is not able to talk due to severe disease, such as paralysis, they may miss out on communicating with fellow residents, which impedes their development of social relationships and reduces their already limited interpersonal interactions.

(2) Attentiveness

Attentiveness is considered a crucial feature of caregivers' work in care delivery. The caregiver-elderly care receiver ratio makes it difficult for caregivers to be highly emotionally attentive: "The most important element for me to receive good care here is the doctors' and nurses' attentiveness. I can receive good care if they do their work seriously and thoughtfully" (CR2). Elderly care receivers' needs cannot be met if the caregivers provide care that is akin to simply ticking off a checklist, as opposed to in a responsive and considerate manner that helps develop interpersonal relationships and improve the quality of care.

(3) Respect

The value of respect is mentioned by caregivers, especially when it comes to those who are in poor health. Although some elderly care receivers partly lose control of decision-making and execution, they still have the dignity that is inherent to every human being and deserve respect from others: "It (the most important factor for elderly care receivers to receive good care) should be respect (from others). They (elderly care receivers) should be cared for nicely and genuinely. The paralyzed people still have dignity and deserve to be respected. Our careful and genuine care contributes to the elderly people's health, which may reduce our workload in turn" (CG1). "They have barriers here, especially the people with dementia and a poor mental situation. For the people who are conscious, we should respect their thoughts in their treatment (whether they agree on the medical professionals' suggestions on the treatment or they have different opinions)" (CG5).

(4) Timeliness of care

Timeliness of care is another significant factor that elderly care receivers expect in the nursing home. The lack of timeliness inevitably jeopardizes the quality of care. "To be frank, I don't think I get proper care in this nursing home because they are so short-handed now. It didn't work when I rang the bell due to an emergency. It took at least 10 minutes to have a caregiver (care worker) in my room after I rang the bell, which makes these bells useless decorations" (CR4). "The timeliness of our responses to their needs I mentioned previously (is the most important factor). After ringing the bell, some elderly people can wait a bit if they do not have urgent issues, but others may have emergencies waiting for us to deal with. Their needs such as using the toilet cannot wait" (CG7). Going to the toilet in time is a basic need. However, in the elderly care context, some elderly care receivers are not able to fulfil this need independently due to physical weakness. Thus, they need help from caregivers, which is crucial to their experience of good care and regaining their autonomy.

These empirical insights highlight a concern about individual decision-making, such as receiving prompt help for ordinary but pressing daily tasks.

This aligns with the individualistic conception of autonomy. However, the interviewees also emphasized elderly care receivers' need for social relationships. The necessity of communicating with roommates and receiving emotional support from family and caregivers regarding potential treatment serve as evidence of the first two critiques of individualistic autonomy, namely an inadequate conception of the self and insufficient decision-making, because the individualistic conception disregards the significance of social relations, as highlighted by several interviewees.

This alternative view presents elderly care receivers' need for both individual and relational aspects in an elderly care facility in China. It illustrates that the dominant Western conception of autonomy is not always paramount in other cultures, which indicates a potential cultural bias against alternative value systems. Furthermore, the observations from this Chinese study may be universal and highlight important shortcomings of the individualistic conception of autonomy in care settings in general. More attention to social relationships calls for an alternative interpretation of autonomy to overcome the shortcomings of the individualistic perspective.

5.6 Complementary insights from a relational perspective of autonomy

As discussed above, the individualistic interpretation of autonomy is challenged from three main angles: inadequate conception of the self, insufficient depiction of decision-making, and cultural bias against alternative value systems. Relational autonomy is often proposed as an alternative perspective to address the shortcomings of the individualistic conception of autonomy, as discussed in previous sections (Nedelsky, 2011; Verkerk, 2001). However, until now, there has been no consensus on the definition of relational autonomy. The term refers to conceptions of autonomy based on the social character of our lives (Mackenzie & Natalie, 2000). Thus, relational autonomy can be defined as the ability to make one's own decisions and take actions with consideration of one's social contexts, including economics, politics, culture, and so on. While maintaining the fundamental aspect of autonomy, namely taking control of decision-making,

relational autonomy offers a richer and more contextualized understanding of autonomy with an emphasis on particular social relations. The following section presents the alternative relational account of autonomy as a response to the three critiques of individualistic autonomy.

5.6.1 A comprehensive conception of the self

In contrast to the individualistic perspective, the relational conception of the self acknowledges the important fact that ontologically we are all in a social net with others. In the specific context of elderly care, it is unwise to separate an elderly care receiver from social relations with medical professionals and family members. If an elderly care receiver lives in a healthcare facility, such as a hospital or a nursing home, there is the added social relation with roommates and/or other residents in the care facility.

From an individualistic perspective, patients in clinical settings are at risk of paternalism when medical professionals override their judgment and make decisions that they believe are in their best interests (Agich, 1990). There are also cases where medical professionals leave the burden of decision-making to the patient in order to maintain their individualistic autonomy (Fan, 1997). However, in such a relationship in elderly care, doctors and other medical professionals should keep patients well informed of all available treatment plans and their potential advantages and risks, rather than solely emphasizing their individual autonomy. Hence, the aim should be to achieve a meaningful balance between the individual and their social relations.

In the context of elderly care through care robots, these robots are introduced to enhance patients' autonomy and minimize the interaction between elderly care receivers and medical professionals. However, even if the monitoring robot can easily deliver elderly care receivers' medical data to healthcare professionals, there is still a possibility of imprecise and unsatisfactory care due to the loss of contextual details that can only be gathered through interpersonal interaction (van Wynsberghe & Li, 2019). Thus, it remains necessary for elderly care receivers and medical staff to establish and nurture human relationships, even when enlisting the help of care robots.

5.6.2 A versatile portrayal of decision-making

The relational perspective on autonomy embodies the dynamic and interactive characteristics of autonomy in a rich and contextualized care setting rather than a minimalistic, isolationist account of individual autonomy that is without context. As Nedelsky points out, "The functioning of the capacity for autonomy is highly fluid: it varies across time and spheres of our lives. Autonomy exists on a continuum. As we act (usually partially) autonomously, we are always in interaction with the relationships (intimate and social-structural) that enable our autonomy" (Nedelsky, 2011). Owing to the dynamic nature of autonomy, when we evaluate the autonomy of elderly care receivers, it is advisable to follow a case-by-case approach, so that their autonomy is evaluated at different stages. When elderly care receivers lack sufficient decision-making skills to manage their daily lives and care treatment, shared decision-making is a favorable approach to care practice. This means placing elderly care receivers at the center of care by asking medical professionals for their input, as well as family and friends, as they have a close, personal connection to the patient.

In the current robot era, shared decision-making is not executed in human-human interaction, or human–robot interaction, but within the triadic human-robot-system interaction (HRSI) model, which consists of an elderly care receiver, a care robot, and a healthcare system of human caregivers, including medical professionals and family and friends (van Wynsberghe & Li, 2019). Shared decision-making develops into a comprehensive process that combines opinions from all human participants directly engaged in elderly care and suggestions from care robots with their powerful functions of data collection and analysis. For the design of robots to facilitate optimal decision-making on care, the function of synthesizing different opinions in the care context is required. Thus, shared decision-making provides valuable resources for patients who cannot make decisions on their own for various reasons, such as lack of medical knowledge or need of moral support from family, which helps enhance the autonomy and wellbeing of elderly care receivers.

5.6.3 An emphasis on cultural diversity and inclusivity

Beyond interactions with direct stakeholders in elderly care at both the individual and group levels, there is always a broad social and cultural context to consider when analyzing elderly care receivers' autonomy within social relationships.

My exploratory empirical research in elderly care discussed in the previous section calls for cultural diversity, as the significance of social relationships in elderly care is highlighted in the specific microcosmic context influenced by Confucianism. These observations are highly relevant and representative of the specific social and cultural background in China, which indicates that the individualistic perspective on autonomy with a sole focus on self-efficiency and independence needs to be adjusted to include the alternative views held in other cultures. This is echoed by Turoldo, who highlights the necessity of a relational account of autonomy that includes cultural diversity from a global bioethical perspective (Turoldo, 2010). In contrast to the exclusively individualistic interpretation of autonomy as self-determination and independence, relational autonomy offers a complementary reflection from other cultures, whereby values such as family determination and interdependence are neglected in the individualistic understanding of autonomy due to cultural bias are now given appropriate consideration.

In addition to cultural diversity, the relational perspective also brings inclusivity into the discussion on autonomy. The main factors of high-quality care, such as social bonding, attentiveness, respect, and timeliness of care, revealed from my pilot study in a nursing home in China, are not only important in Chinese society but, indeed, shared by multiple cultures. Societies such as China with deep roots in Confucianism prioritize family harmony and community, which is distinct from the mainstream values of autonomy and independence in traditional bioethics (Fetters, 1998; Turoldo, 2010). However, as discussed, without exception, each individual functions within social relations, which greatly impact their autonomy. Thus, emphasizing social relationships does not exclusively fit into the social reality of non-Western cultures, but it also sheds light on the general discussion on autonomy in various socio-cultural contexts. Relational autonomy offers a

complementary approach to the interpretation of the value of autonomy. The emphasis on social relationships as a universal human need serves to complement the limited individualistic interpretation of autonomy.

When investigating the central role that social relationships play in elderly care, the fundamental values of Confucianism are valuable as an alternative perspective on autonomy. As a comprehensive system of social and ethical philosophy, Confucianism is deeply rooted in Chinese culture and still profoundly influential in contemporary Chinese society after two millennia (Guo, 1995; Lee, 2007). Social relationships are the most central feature in Confucianism. Every person is part of a society, and their relationships make them who they are (Hu, 2002). Social relationships not only have a descriptive value by describing a relationship between two people, but more importantly, they are also significant in the normative sense (Herr, 2003). The need for social relationships is the natural endowment with which we are born, and this usually reveals itself when we are confronted by others' calamities. For example, when we see a child fall into the ditch crying, we are triggered by our moral consciousness to take action to comfort or rescue them as soon as possible to relieve their pain (see Mencius 2A: 6). Filial piety is another core value in Confucian ethics, which refers to the duty of the adult child to take care of their elderly parents. This could be influenced by the introduction of robots to child-parent relationships. Fulfilling the filial duty to care for elderly parents is a significant way to achieve self-cultivation. At the minimum, it requires younger generations to take care of their elderly family members (Mooney & Williams, 2016).

Investigating the role of autonomy in elderly care from a Confucian perspective uncovers the potential failure of self-cultivation of both elderly care receivers and caregivers. In Confucianism, people achieve self-cultivation through different relationships and continue practicing it to maintain harmonious relationships. If care robots merely take over a large number of tasks from human caregivers, the elderly care receivers and caregivers who are supposed to be intertwined in social relationship will no longer have these interactions, which diminishes the social context within which self-cultivation occurs.

5.7 Embedding relational autonomy in the value sensitive design of care robots

Let us now consider how these insights from a relational view can offer a new perspective on the VSD of care robots. Through interaction with robots, our needs and responses are reshaped and reconstructed by these machines. In light of the growth of long-distance communication and the emergence of care robots, there is a genuine chance that the amount of time and energy that people spend interacting with others via digital devices, which may have previously been done through interpersonal interaction, will increase. If care robots are tasked with more duties besides mundane activities in daily care, it is likely that elderly care receivers and caregivers will have less access to the contexts for moral practice to harmonize the relationship, and thus face the potential failure of self-cultivation. In the design, development, and deployment process of care robots, all stakeholders should be informed that care robots are not used to replace human interactions in care settings, but rather to strengthen the connection and relationships between elderly care receivers, family and friends, and to assist caregivers with certain tasks. During the lockdowns of the COVID-19 pandemic, most people could still communicate with others via digital devices, including robots. However, the desire to see and hug loved ones in person has not diminished. On the contrary, such desire is actually growing stronger.

Introducing care robots to senior family members has a profound impact on both children and parents. The instrumental functions of robots to provide care and companionship are valuable when younger generations are too busy with their careers and lives to attend to parents' needs. In some cases, care robots create conflict between two generations. Imagine, for example, if an elderly care receiver refuses to rely on a care robot for assistance in their daily lives but demands that their children sacrifice their careers to take care of them. The younger generations may not be willing to comply with this, and the conflict between the preferences of both parties is exactly an illustration of the complexity of autonomy, which should consider both personal preference and social context. If we embrace the help of care robots for elderly people in parent-child relationships too quickly, or even accept them as

substitutes for the children, the younger generation may lose opportunities to take on care tasks as these are delegated to care robots. In China, the relationship between elderly parents and the child has a normative connotation. Filial piety requires children to take care of their elderly family members. Not doing so will mean failure to fulfill filial responsibility, as the younger generation's roles are challenged and their responsibility to their parents become questionable in the robot era.

5.8 Conclusion

Building on the critiques of individualistic autonomy, this chapter uncovers the shortcomings of the individualistic understanding of autonomy that currently governs the implementation of VSD in care robots. My pilot study reveals that participants value social relationships more than individualistic autonomy, which should start a broader conversation about which type of autonomy VSD should incorporate in elderly care. To deal with the critiques of individualistic autonomy and address the shortcomings of its implementation in care robots, this chapter employs the relational concept of autonomy to critically challenge the dominant individualistic approach. With an emphasis on social relationships, relational autonomy offers a comprehensive conception of the self, presents a more versatile portrayal of decision-making, and emphasizes cultural diversity and inclusivity in the discussion of autonomy. I recommend that embedding such a relational interpretation of autonomy in robot design is necessary to broaden the discussion on autonomy and thereby enhance the autonomy of elderly care receivers.

6 Conclusion

This thesis aimed to further identify and refine robot ethics by reconceptualizing autonomy in elderly care in the robot era from a relational perspective. It begins with an examination of how care robots impact the autonomy of care receivers and caregivers in elderly care. A human-robot-system interaction (HRSI) model is developed to strengthen the normative foundation of the ethical assessment of care robots. I propose a relational understanding of the value of autonomy to reconceptualize the autonomy of elderly care receivers. High-quality care can only be achieved when the value of autonomy is embedded in robot design in the elderly care context.

A looming demographic change is emerging worldwide due to global population aging. Considering the disparity between the growing demands for elderly care and the acute shortage of caregivers, care robots have been introduced in various care settings as a technological solution to the elderly care crisis. Care robots have a significant influence on the caregiver-care receiver relationship. Thus, a comprehensive evaluation of the ethical values in elderly care, such as the value of autonomy, now becomes urgent.

As laid out in the introduction chapter, there are four major shortcomings in the current research on elderly care through care robots. First, the human-robot interaction (HRI) model commonly used in ethical analysis in healthcare does not account for the complexity of the interaction between care receivers, care robots, and caregivers. Second, an in-depth study on elderly care receivers' autonomy in robot care is absent. Third, caregivers' autonomy has not gained adequate research interest, despite their central role in robot care. Fourth, the mainstream individualistic understanding of autonomy embedded in robot design has difficulty encompassing elderly care receivers' actual needs in care relationships. Motivated by the need to close these research gaps, this PhD research has answered the research question "How should we reconceptualize the value of autonomy with regards to the relational aspects of elderly care in the context of care robots?" This central

research question was addressed by examining four sub-questions: RQ1 "How should we understand the complex relational aspects of elderly care through care robots?" (Chapter 2), RQ2 "How should the autonomy of elderly care receivers be considered in robot care?" (Chapter 3), RQ3 "How to conceptualize caregivers' autonomy in elderly care in the robot era?" (Chapter 4), and RQ4 "Which conception of autonomy should be embedded in the design of care robots?" (Chapter 5).

6.1 Key findings of the study

The development of the HRSI model is one key finding. While the commonly used HRI paradigm only captures the dyadic interaction between robots and human users, the HRSI model articulates three levels of interaction scenarios between a care receiver, a care robot, and a healthcare system. It provides a comprehensive understanding of the relational aspects of elderly care through care robots. The HRSI model also contributes to robot ethics by revealing new ethical issues associated with trust, responsibility, accountability, and conflicting preferences in the complex relationships in elderly care through robots. For example, care robots may have difficulty processing the contextual details of care receivers' health data due to technological limits, which would lead to the generation of imprecise and unsatisfactory suggestions.

The second key finding uncovers the value of autonomy in the robot context, which exerts a considerable influence on elderly care receivers. This thesis develops a taxonomy of autonomy, which has been extended from human care settings to robot care to capture the complexity of autonomy in elderly care and illustrate how robots could influence the autonomy of elderly care receivers. Through a thorough autonomy-centered analysis in Chapter 3, the taxonomy was used as a tool to evaluate care robots retrospectively. In addition, it can also be used prospectively to provide robot designers with an enriched understanding of the value of autonomy in elderly care.

In line with the scrutiny of care receivers' autonomy in robot care, I conducted an in-depth philosophical study on caregivers' autonomy to conceptualize their autonomy on both the individual and collective levels.

The third key finding emerged from the study in Chapter 4, which illustrates that, in the robot era, nurses' decisions are not made merely through their interactions with elderly care receivers; decisions are also influenced by care robots in their work environment. The HRI model was employed to elaborate how the involvement of care robots in the nursing process could enhance and/or diminish the professional autonomy of individual nurses. Importantly, the HRSI model uncovers the significant influence of care robots on the nursing profession at large and how they restructure the healthcare system in various ways. It was found that nurses' professional autonomy is undoubtedly influenced by a new division of labor in nursing, the necessity of additional robotic training in professional education, and reallocation of resources when care robots are introduced in healthcare. These findings call for new regulations to define and distribute roles and responsibilities in elderly care through robots. Organizational efforts need to be strengthened to empower nurses to fulfill their professional autonomy and enhance care quality.

Considering the impacts of care robots on the autonomy of elderly care receivers and caregivers, a care robot-centered analysis and an exploratory empirical study were conducted in a nursing home to illustrate that the implementation of the individualistic autonomy in care robots fails to meet elderly care receivers' need for interpersonal relationships. The fourth key finding advocates that a relational concept of autonomy, which is derived from Confucian ethics and emphasizes social relationships, provides a complementary perspective on autonomy that should be embedded in the value sensitive design (VSD) of robots. With a comprehensive concept of the self, a versatile depiction of decision-making, and cultural diversity and inclusivity, a relational understanding of autonomy compensates for the shortcomings of the individualistic perspective and offers a richer and more contextualized understanding of autonomy. The application of the relational interpretation of autonomy is not limited to non-Western cultures but can shed light on broader social and cultural contexts. The significance of the relational perspective is also supported by the discussions in care ethics, especially the research on care-centered value sensitive design in the healthcare context (van Wynsberghe, 2013b). Such a relational account, in

light of Confucian values such as filial piety and self-cultivation through human relationships, can broaden the discussion on autonomy, eliminate cultural biases, and provide a new perspective on embedding the value of autonomy in robot design.

6.2 Implications of the thesis beyond the robot care context

Even though this thesis specifically focuses on autonomy in the context of elderly care through care robots, the significance and necessity of both the HRSI model and a relational understanding of autonomy are not and should not be limited merely to the specific research scope of this thesis. The findings may have an impact beyond the robot care context to the broader relationship between humans and technology.

As defined in previous chapters, the system in HRSI stands for a healthcare system consisting of human caregivers. Looking beyond such specific circumstance, the HRSI model can highlight the impacts of robots on humans that are explored in the relationships between humans and robots introduced in other sectors (van Wynsberghe et al., 2021). When the application of HRSI is extended to the industrial work setting of a warehouse, the model is equally effective for evaluating the impact of robots on workers. Similar to the trends in the healthcare sector, the roles and responsibilities of individual workers in a warehouse will be altered as robots take on tasks such as loading, unloading, packing, and labeling etc. The vocational education and training of warehouse workers as a profession will thus also have to include the technical knowledge and skills of working with robots.

Furthermore, the contributions of the relational perspective on the value of autonomy can shed light on the limitations of the individualistic understanding of autonomy in other pressing issues the world is facing, such as climate change and the ongoing COVID-19 pandemic. Based on an individualistic understanding of autonomy, some people may object to the strict measures that have been implemented to reduce the spread of the coronavirus, such as quarantine and social distancing, in the name of individual freedom and independence. However, this demonstrates the shortcomings of an individualistic perspective on autonomy, as we are all

dependent on others to stay safe. To protect individuals from the contagious virus and reduce the burden on healthcare systems, a relational understanding of autonomy, with emphasis on the social context rather than the individual, should be highlighted in the pandemic. If everyone can consider the rules recommended by public health authorities and medical professionals, and take vulnerable groups in our social relationships into consideration, it will be much more effective in managing the public health emergency in an ethical and responsible way.

6.3 Research limitations and recommendations for future work

One limitation of this PhD research is the small sample size of the exploratory case study discussed in Chapter 5 to investigate the main factors of high-quality care for elderly care receivers in non-Western societies. Due to limited time and the ongoing COVID-19 pandemic, I interviewed five elderly care receivers and eight caregivers in a nursing home in Suzhou, China. The results of the empirical study highlight the shortcomings of the individualistic perspective on autonomy by emphasizing the importance of social relationships. Larger sample size in multiple care facilities is needed to be fully representative for generalization in other regions or cultures.

Another limitation is that this thesis does not provide guidance on how to translate the relational understanding of the value of autonomy into robot design requirements. In design practice, it will be conducive if there are specific guiding principles for robot designers to include and enhance the autonomy of both elderly care receivers and caregivers in their design.

Despite the limitations, the findings in this thesis can be used to identify future research areas and new directions in policymaking. First, the scope of research on the ethical issues regarding the complex interactions between elderly care receivers, care robots, and caregivers can be expanded to other ethical values such as privacy and dignity. This thesis provides a more comprehensive approach to examining these relationships, with an emphasis on the value of autonomy in elderly care through care robots. In future research on other ethical values in the context of robot care, both HRI and HRSI models can be employed to investigate care robots' direct impacts on

other values, such as the privacy and dignity of individuals in care settings and the impacts on the healthcare system at a collective level.

The second suggestion that emerges from the findings pertains to the significant role of caregivers, nurses in particular, and their professional autonomy in the robot era. The potential negative impact of care robots on the autonomy of caregivers can threaten their wellbeing in the work environment and diminish the quality of care they provide. This calls for policies that correspond to the robotic development in healthcare to help caregivers adapt to working with care robots. Policymakers should collaborate with caregivers, such as doctors, nurses, and managers in care facilities, and educators in medical/nursing schools. Joint efforts are required to amend the existing or propose new legislation to categorize caregivers' roles and responsibilities and provide organizational support to enhance their autonomy, help them fulfil their profession, and improve the quality of care they provide.

Third, a relational account of autonomy grounded in care leads a direction of future robot design, development, and implementation. A key design priority should therefore be to embed relational autonomy in robot design for its invaluable ethical insights and guidance. With a specific focus on social contexts, the relational perspective calls for participative design to embed relational autonomy in value sensitive design of care robots. Considering that care robots are used in care practice and have a significant influence on the relationships between care receivers and caregivers, it is paramount to involve care receivers and caregivers, such as medical professionals and informal care workers, in the robot design process, so that their experience and expectations can be considered to better meet their actual needs in care practice. Detailed design guidelines should be developed for decision-making in care robot design as well as inclusion of relational autonomy in robot design in order to promote the value of autonomy in care.

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Summary

In response to the pressing demand for elderly care, care robots, the robots used by care receivers and/or caregivers for care purposes in various settings, such as hospitals, nursing homes, and personal residences were introduced and have been gaining traction as a technological solution to improve care quality and to enhance the value of autonomy. Despite all the benefits offered by robotic innovations, the consequent ethical issues in human-robot relationships in elderly care warrant sustained scrutiny. Due to the technological breakthroughs in robotics and its impacts on relationships in elderly care, the conventional dyadic human-robot interaction (HRI) model which focuses on one human and one robot, and the dominant Western individualistic understanding of autonomy are insufficient for the ethical evaluation of robots in elderly care.

The interactions in robot care are not limited to a relationship just between care robots and a single human user but go beyond the individual level to a more complex inter-relationships consisting of single or multiple care receivers, care robots, and a healthcare system of various caregivers. The HRI model captures the dyadic interaction but fails to account for the multifaceted interactions in the healthcare context. Such a gap raises concerns on how the complex relational aspects of elderly care should be dissected and understood in the robot era.

The discussion on the value of autonomy in such relationships prompts several questions. For example, how should the autonomy of elderly care receivers be taken into consideration when care robots enter their nursing homes or inpatient wards? How to conceptualize the autonomy of caregivers in the robot era due to the significant roles robots play in care practice? Analyses of the implementations of autonomy in robot design point out that the mainstream individualistic understanding of autonomy that can be traced back to the dominant Western philosophical tradition becomes inadequate to meet the fundamental needs of elderly care receivers in the context of care that involves robots. Hence it leads to the question: which conception of

autonomy should be embedded in robot design to enhance the autonomy in the relationships in elderly care through robots?

To address these questions, this thesis critically examines the interactions between humans and care robots impacted by robotic development in elderly care with an emphasis on the impacts on autonomy of both care receivers and caregivers. It is argued that to consider relational aspects of elderly care in the context of care robots is an integral part of reconceptualizing the value of autonomy.

To gain an improved understanding of the complex relational aspects of elderly care through robots, Chapter 2 "A paradigm shift for robot ethics: From HRI to Human-Robot-System Interaction (HRSI)" proposes a triadic HRSI model allowing for a more comprehensive ethical assessment of robots between an elderly care receiver and a healthcare system. The paradigm shift from HRI to HRSI uncovers how care robots restructure the healthcare system by redefining the roles and responsibilities of caregivers, redesigning healthcare professionals' vocational education and training, and redistributing financial resources in medical institutions.

Chapter 3 "The complexity of autonomy: a consideration of the impacts of care robots on the autonomy of elderly care receivers" deciphers the complexity of the autonomy of elderly care receivers in the robot era by extending the application of a taxonomy of autonomy from traditional human-human interaction in healthcare to the robot context. A systematic autonomy-centered analysis shows that retrospective use of the taxonomy serves as a critical tool for assessing the impacts of care robots on the autonomy of elderly care receivers in diverse ways. On the other hand, prospective use of the taxonomy offers an invaluable means for translating the comprehensive understanding of autonomy in elderly care to promote the value of autonomy in the design, development, and implementation of care robots.

Chapter 4 "Reconceptualizing nurses' professional autonomy in robot care" advocates that nurses, as an often underpaid and underrepresented group of caregivers, deserve adequate attention because of their fundamental roles in

the healthcare system and increasing risks posed to their jobs with the introduction of care robots. Their professional autonomy requires reconceptualization, as it is deeply impacted and critically challenged in the robot context. An individual perspective views nurses as single medical professionals, while a collective perspective construes nurses as an occupational group and a profession in a relational and systematic manner. Both perspectives are applied for reconceptualizing the professional autonomy of nurses and exploring the impacts of care robots on the professional autonomy of nurses through the HRI and HRSI models. Such exercise points out that to maintain and enhance their professional autonomy in the robot era can only be achieved through constructing a friendly working environment in healthcare for nurses.

Using the care robot KOMPAÏ, Chapter 5 "Individualistic perspective vs. relational perspective: How to improve autonomy in value sensitive design in care robots" identifies that the mainstream interpretation of autonomy in VSD and philosophical traditions with emphasis on individualism and self-determination as two major determining influences on why the current implementations of autonomy in value sensitive design (VSD) are often individualistic. Such individualistic understanding of autonomy no longer suffices to meet the essential needs of elderly care receivers. The shortcoming is echoed by an exploratory empirical study conducted in a nursing home in Suzhou, China, revealing more stress on interpersonal interactions. A relational interpretation of autonomy, such as can be found in the Chinese philosophical tradition of Confucianism, is proposed in robot design to complement the individualistic approach, remove cultural bias, enrich the discussion of autonomy, as well as uncover additional ethical concerns on robots in elderly care.

Chapter 6 "Conclusion" reiterates the key findings of this thesis and points out possible directions of future research. The normative analysis of reconceptualizing the autonomy of elderly care receivers and caregivers through the lens of HRSI and embedding the relational perspective of autonomy in robot design are the two key elements that enable preserving and enhancing autonomy in elderly care in the context of care robots. The

implications of the findings in this thesis could reach well beyond the robot care context. Future work should focus on exploring broad applications of the normative HRSI model for ethical evaluation in robot care and other public health contexts. The insights of this thesis on the importance of relational autonomy can shed light on future legislation and elaboration of new policies in healthcare and other sectors, where solidarity is needed to complement individual autonomy. Additionally, this thesis provides recommendations for participative design with emphasis on social relationships in the future robot design to promote the value of autonomy in care.

Taken together, this thesis provides a constructive solution to a crucial challenge in understanding the relationships in elderly care in the robot era. The HRSI model and the relational understanding of autonomy offer a normative foundation for reconceptualizing the value of autonomy and practical pathways for embedding autonomy in robot design with consideration of relational aspects of elderly care.

Samenvatting

Als antwoord op de nijpende vraag naar ouderenzorg zijn zorgrobots geïntroduceerd, de robots die door zorgontvangers en/of zorgverleners worden gebruikt voor zorgdoeleinden in verschillende omgevingen, zoals ziekenhuizen, verpleeghuizen en persoonlijke woningen, die aan populariteit winnen als een technologische oplossing om de kwaliteit van de zorg te verbeteren en de waarde van autonomie te vergroten. Ondanks alle voordelen die robotinnovaties bieden, rechtvaardigen de daaruit voortvloeiende ethische kwesties in mens-robotrelaties in de ouderenzorg langdurig onderzoek. Vanwege de technologische doorbraken in robotica en de impact ervan op relaties in de ouderenzorg, zijn het conventionele dyadische mens-robotinteractie (HRI) model dat zich richt op één mens en één robot, en het dominante westerse individualistische begrip van autonomie onvoldoende voor de ethische evaluatie van robots in de ouderenzorg.

De interacties in robotzorg zijn niet beperkt tot een relatie alleen tussen zorgrobots en een enkele menselijke gebruiker, maar gaan verder dan het individuele niveau naar een meer complexe onderlinge relatie bestaande uit enkele of meerdere zorgontvangers, zorgrobots en een zorgsysteem van verschillende zorgverleners. Het HRI-model legt de dyadische interactie vast, maar houdt geen rekening met de veelzijdige interacties in de zorgcontext. Een dergelijke kloof roept vragen op over hoe de complexe relationele aspecten van ouderenzorg moeten worden ontleed en begrepen in het robottijdperk.

De discussie over de waarde van autonomie in dergelijke relaties roept een aantal vragen op. Hoe moet bijvoorbeeld rekening worden gehouden met de autonomie van ontvangers van ouderenzorg als zorgrobots hun verpleeghuis of ziekenhuisafdeling binnenstappen? Hoe de autonomie van zorgverleners in het robottijdperk te conceptualiseren vanwege de belangrijke rollen die robots spelen in de zorgpraktijk? Analyses van de implementaties van autonomie in robotontwerp wijzen uit dat het mainstream individualistische begrip van autonomie dat terug te voeren is op de dominante westerse

filosofische traditie, ontoereikend wordt om te voldoen aan de fundamentele behoeften van ontvangers van ouderenzorg in de context van zorg waarbij robots betrokken zijn. Het leidt dan ook tot de vraag: welke opvatting van autonomie moet worden opgenomen in het robotontwerp om de autonomie in de relaties in de ouderenzorg door robots te vergroten?

Om deze vragen te beantwoorden, onderzoekt dit proefschrift kritisch de interacties tussen mensen en zorgrobots die worden beïnvloed door robotontwikkeling in de ouderenzorg, met de nadruk op de effecten op de autonomie van zowel zorgontvangers als verzorgers. Er wordt betoogd dat het beschouwen van relationele aspecten van ouderenzorg in de context van zorgrobots een integraal onderdeel is van het herconceptualiseren van de waarde van autonomie.

Om een beter begrip te krijgen van de complexe relationele aspecten van ouderenzorg door middel van robots, wordt in hoofdstuk 2 "Een paradigmaverschuiving voor robot ethiek: Van HRI naar Human-Robot-System Interaction (HRSI)" een triadisch HRSI (lett. Mens-Robot-Systeem Interactie) -model voorgesteld dat een meer omvattende ethische beoordeling van robots tussen een ontvanger van de ouderenzorg en een zorgsysteem. De paradigmaverschuiving van HRI naar HRSI onthult hoe zorgrobots het gezondheidszorgsysteem herstructureren door de rollen en verantwoordelijkheden van zorgverleners te herdefiniëren, het beroepsonderwijs en de opleiding van zorgprofessionals te herontwerpen en financiële middelen in medische instellingen te herverdelen.

Hoofdstuk 3 "De complexiteit van autonomie: een beschouwing van de effecten van zorgrobots op de autonomie van ontvangers van ouderenzorg" ontcijfert de complexiteit van de autonomie van ontvangers van ouderenzorg in het robottijdperk door de toepassing van een taxonomie van autonomie uit te breiden van traditionele mens-mens interactie in de zorg naar de robotcontext. Een systematische, op autonomie gerichte analyse laat zien dat retrospectief gebruik van de taxonomie een cruciaal instrument is om de effecten van zorgrobots op de autonomie van ontvangers van ouderenzorg op verschillende manieren te beoordelen. Aan de andere kant biedt

prospectief gebruik van de taxonomie een waardevolle manier om het uitgebreide begrip van autonomie in de ouderenzorg te vertalen om de waarde van autonomie bij het ontwerp, de ontwikkeling en de implementatie van zorgrobots te promoten.

Hoofdstuk 4 "Herconceptualisering van de professionele autonomie van verpleegkundigen in robotzorg" pleit ervoor dat verpleegkundigen, als een vaak onderbetaalde en ondervertegenwoordigde groep zorgverleners, voldoende aandacht verdienen vanwege hun fundamentele rol in de gezondheidszorg en toenemende risico's voor hun werk met de introductie van zorg robotten. Hun professionele autonomie vereist een herconceptualisatie, omdat deze diep wordt beïnvloed en kritisch wordt uitgedaagd in de robotcontext. Een individueel perspectief beschouwt verpleegkundigen als individuele medische professionals, terwijl een collectief perspectief verpleegkundigen op een relationele en systematische manier construeert als een beroepsgroep en een beroep. Beide perspectieven worden toegepast voor het herconceptualiseren van de professionele autonomie van verpleegkundigen en het onderzoeken van de impact van zorgrobots op de professionele autonomie van verpleegkundigen via de HRI- en HRSI-modellen. Een dergelijke oefening wijst erop dat het behouden en verbeteren van hun professionele autonomie in het robottijdperk alleen kan worden bereikt door het creëren van een vriendelijke werkomgeving in de gezondheidszorg voor verpleegkundigen.

Met behulp van de zorgrobot KOMPAÏ, hoofdstuk 5 "Individualistisch perspectief versus relationeel perspectief: hoe de autonomie in value sensitive design (lett. waarde gevoelig ontwerp) in zorgrobots te verbeteren" identificeert de algemene interpretatie van autonomie in value sensitive design (VSD) en filosofische tradities met de nadruk op individualisme en zelfbeschikking als twee belangrijke bepalende invloeden op waarom de huidige implementaties van autonomie in VSD vaak individualistisch zijn. Een dergelijk individualistisch begrip van autonomie is niet langer voldoende om te voorzien in de essentiële behoeften van ontvangers van ouderenzorg. De tekortkoming wordt bevestigd door een verkennend empirisch onderzoek uitgevoerd in een verpleeghuis in Suzhou, China, dat

meer druk op interpersoonlijke interacties blootgelegd. Een relationele interpretatie van autonomie, zoals die kan worden gevonden in de Chinese filosofische traditie van het confucianisme, wordt voorgesteld in het ontwerpen van robots om de individualistische benadering aan te vullen, culturele vooroordelen weg te nemen, de discussie over autonomie te verrijken en ook bijkomende ethische bezwaren tegen robots aan het licht te brengen.

Hoofdstuk 6 "Conclusie" herhaalt de belangrijkste bevindingen van dit proefschrift en wijst op mogelijke richtingen voor toekomstig onderzoek. De normatieve analyse van het herconceptualiseren van de autonomie van ontvangers en zorgverleners in de ouderenzorg door de lens van HRSI en het opnemen van het relationele perspectief van autonomie in robotontwerp zijn de twee belangrijkste elementen die het mogelijk maken om de autonomie in de ouderenzorg in de context van zorgrobots te behouden en te vergroten. De implicaties van de bevindingen in dit proefschrift zouden veel verder kunnen reiken dan de robotzorgcontext. Toekomstig werk zou zich moeten richten op de brede toepassingen van het normatieve HRSI-model voor ethische evaluatie in robotzorg en andere volksgezondheidscontexten te verkennen. De inzichten van dit proefschrift over het belang van relationele autonomie kunnen licht werpen op toekomstige wetgeving en uitwerking van nieuw beleid in de gezondheidszorg en andere sectoren, waar solidariteit nodig is als aanvulling op individuele autonomie. Daarnaast geeft dit proefschrift aanbevelingen voor participatief ontwerp met de nadruk op sociale relaties in het toekomstige robotontwerp om de waarde van autonomie in de zorg te bevorderen.

Alles bij elkaar genomen biedt dit proefschrift een constructieve oplossing voor een cruciale uitdaging om de relaties in de ouderenzorg in het robottijdperk te begrijpen. Het HRSI-model en het relationele begrip van autonomie bieden een normatieve basis voor het herconceptualiseren van de waarde van autonomie en praktische paden voor het opnemen van autonomie in robotontwerp, rekening houdend met relationele aspecten van ouderenzorg.

Appendices

Appendix 1: Topic guide for interviews with elderly care receivers

1. Could you please let me know your age, gender, education level?

2. How long have you been staying in this nursing home?

3. Could you please describe your daily activities in the nursing home?

4. What is important to receive good care and preserve your dignity in daily life here? (autonomy, privacy, respect, communication, identity, emotional support, fair treatment, etc.) Could you rank them by order of importance? Why?

5. What is important to preserve care givers' dignity in their daily work? (autonomy, privacy, respect, communication, identity, emotional support, etc.)

6. Have you heard about care robots? (I will explain a bit about care robots' definition and basic function. Some short videos of care robots will be played so that the interviewees can have an intuitive sense of care robots.)

7. Do you believe care robots can help with your daily life in order to improve the aspects you mentioned in question 4? Why?

8. Do you believe care robots can help with care givers' daily work in order to improve the aspects you mentioned in question 5? Why?

9. If the care suggestions made by a well programmed robot conflict with your will, how would you handle that? Why?

10. If the care suggestions made by a well programmed robot conflict with your care giver's, how would you handle that? Why?

11. To what degree should a robot get involved in care practice? What should be its role? A tool, an intelligent assistant, or even an independent care giver in the future? Why?

12. Did you use any care robots? (If yes, go to question 13. If no, skip question 13 and go to question 14.)

13. What was your main reason for using it? Could you share your experience? Were you satisfied with that experience? Why?

14. If you have a chance to use a care robot, would you like to have a try? Why?

15. If you can design a care robot to meet your actual needs in care, how would you design it? (expected appearance, functions, etc.)

Appendix 2: Topic guide for interviews with caregivers

1. Could you please let me know your age, gender, education level?

2. How long have you been working in this nursing home?

3. Could you please describe your daily work in the nursing home?

4. How many patients do you have to take care of every day? Are you satisfied with the current workload?

5. Do you have difficulties in your daily work? Which actual need is the most significant to be met?

6. What is important to preserve your dignity in daily work? (autonomy, privacy, respect, communication, identity, emotional support, etc.) Could you rank them by order of importance? Why?

7. What is important for elderly care receivers to receive good care and preserve dignity here? (autonomy, privacy, respect, communication, identity, emotional support, fair treatment, etc.)? Could you rank them by order of importance? Why?

8. Have you heard about care robots? (I will explain a bit about care robots' definition and basic function. Some short videos of care robots will be played so that the interviewees can have an intuitive sense of care robots.)

9. Do you believe care robots can help with your daily work in order to improve the aspects you mentioned in question 6? Why?

10. Do you believe care robots can help with elderly care receivers' daily life in order to improve the aspects you mentioned in question 7? Why?

11. If the care suggestions made by a well programmed robot conflict with an elderly care receiver' will, how would you handle that? Why?

12. If the care suggestions made by a well programmed robot conflict with yours, how would you handle that? Why?

13. To what degree should a robot get involved in care practice? What should be its role? A tool, an intelligent assistant, or even an independent care giver in the future? Why?

14. Did you use any care robots at work? (If yes, go to question 15. If no, skip question 15 and go to question 16.)

15. What was your main reason for your choice? Could you share your experience with the care robot you used? Were you satisfied with that experience? Why?

16. If you have a chance to use a care robot, would you like to have a try? Why?

17. If you can design a care robot to meet your actual needs, how would you design it? (expected appearance, functions, etc.)

Appendix 3: Participant informed consent form

Preliminary field study about care robot designers', care givers' and elderly care receivers' perception of care robots and dignity

Researcher: Shuhong Li

In this project, I will investigate care robot designers', care givers' and elderly care receivers' perception of care robots and the value of dignity in care robot companies, hospitals, and nursing homes.

I will mainly use observation to better understand daily care practice in hospitals and nursing homes. The semi-structured interviews will be used in care robot companies, hospitals, and nursing homes to encourage the interviewees to explore and describe their experiences and expectations of care robots. The observation on single participant will take 2 hours (maximum) and each interview will take 30 minutes. The interviews will be in small groups or one-to-one meetings between the interviewee and me. The interviewees consist of designers/engineers in care robot companies, elderly care receivers and care givers.

Participation is voluntary. The interviews can be stopped immediately if a participant indicates he/she does not want to continue. The interviewees can ask questions and withdraw from the research at any time without any consequences. Personal data will not be retained or send/sold to a third party for future research. I will take notes in the observation and audio-record the interviews. The data will be stored on protected hardware that can only be accessed by the researcher. The collected data will be handled anonymously.

The results of the research will be published in international journals/conference proceedings using anonymous presentation or initials. I will thank the anonymous interviewees in the publication.

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Please sign if you understand this information and if you consent to participation:

Name: Signature: Date:

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About the author

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List of Publications

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