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"I'll take care of you," said the robot

Reflecting upon the legal and ethical aspects of the use and development of social robots for therapy

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Abstract: The insertion of robotic and artificial intelligent (AI) systems in therapeutic settings is accelerating. In this paper, we investigate the legal and ethical challenges of the growing inclusion of social robots in therapy. Typical examples of such systems are Kaspar, Hookie, Pleo, Tito, Robota, Nao, Leka or Keepon. Although recent studies support the adoption of robotic technologies for therapy and education, these technological developments interact socially with children, elderly or disabled, and may raise concerns that range from physical to cognitive safety, including data protection. Research in other fields also suggests that technology has a profound and alerting impact on us and our human nature. This article brings all these findings into the debate on whether the adoption of therapeutic AI and robot technologies are adequate, not only to raise awareness of the possible impacts of this technology but also to help steer the development and use of AI and robot technologies in therapeutic settings in the appropriate direction. Our contribution seeks to provide a thoughtful analysis of some issues concerning the use and development of social robots in therapy, in the hope that this can inform the policy debate and set the scene for further research.

Keywords: social robots, therapy, legal aspects, ethical legal and societal issues (ELSI), socially assistive robots, personalized care, rights, privacy, procrustean design, safety, autism, long-term consequences

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1 Introduction

The insertion of social robots in therapeutic settings is accelerating. Robots help doctors diagnose, can elicit certain behaviors, and can be social mediators in peer-to-peer therapies [1]. A review of the literature reveals an emphasis on the benefits of robots for cognitive therapies. It seems robots are an excellent therapeutic tool because they modularly adapt to the user's needs, and tackle the specific needs of a particular disorder, either at a physical level, via the use of lower or upper limb exoskeleton technology, or at a cognitive level with social robots [1]. Robot's behavior is also predictive and repetitive, and less complex or intimidating than humans, something that has a positive impact in the development of specific therapies, including therapies that focus on the autism spectrum disorder (ASD).

Although these results are qualitatively rich, there are not many quantitative studies concerning the effectiveness of such methods [2]. What's more, despite these benefits, available research suggests that robot technology may cause moral and legal implications, [3, 4] including (but not restricted to) acceptability, trust, sociability, or attachment issues [5]. The European Parliament (EP) has warned against the dehumanization of health practices the incremental use of care robots could entail in the future. Moreover, research in other fields also suggests that technology has a profound and alerting impact on us, including the way we think [6].

While therapists currently use the majority of robots as a tool, as an extension of the therapist, little is known about the impacts of current, and future therapeutic robots may have on users. This lack of knowledge may be due to the novelty of practices, the lack of interdisciplinary and longitudinal research, or the fact that research tends to be benefit-centered. The fact that there are still no general and accepted quantitative methods and guidelines to evaluate such therapies, and that robot therapies are not yet mainstream in the healthcare sector, do not make the discernment of these concerns clearer either [7].

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There are currently legal and regulatory initiatives aiming at governing the impacts of robot technology. These include private standards concerning robot technologies such as the ISO 13482:2014 Personal Care Robots, BS 8611:2016 Guide to the ethical design and application of robots and robotic systems, and IEEE Ethically Aligned Design 2017 from the IEEE Global Initiative and Standard Association. It also includes public policymaking, including European regulatory initiatives (Resolution 2015/2103 (INL) 2017 and its response from the European Commission) and international public policies on drones, self-driving cars and delivery robot regulations (mainly in the United States). In parallel, some disorders have their legal framework, like the Charter for Persons with Autism [8]. Although these initiatives or in-force laws set guiding principles, these are often too general and abstract to give an adequate response to roboticists working on particular robots: what safeguards should be put in place to assure that robots interacting socially with humans for therapeutic or educational purposes follow the privacy-by-design principle?

This article initiates a multidisciplinary conversation on what challenges the adoption of therapeutic artificial intelligence and robot technologies face and cause, and what we can do about it. We aim to help steer the development and use of AI and robot technologies in therapeutic settings in a direction that innovation and user rights are compatible. After introducing what robotic therapies are, we compile legal and ethical challenges for therapeutic robots in section three. In section four, we propose some solutions that could help address the described challenges. Our contribution seeks to provide a thoughtful analysis of some issues about the use and development of social robots in therapy, in the hope that this can inform the policy debate and set the scene for further research.

2 Robotic therapies

A therapeutic setting should address the dominant core characteristics of the disorder to be effective, and be individualized to meet the needs of each participant [9]. Robots have been found to be remarkable at this regard, either in physical – i.e., exoskeleton – or in cognitive rehabilitation therapies [10]. Robots can adapt quickly to each other's needs, they are predictive and repetitive, and also very engaging [11, 12]. The very act of building a robot, actually, encourages social and cooperative skills, something very beneficial for children with neurodevelopmental disorders [13]. Moreover, this is why therapists increasingly use robots in therapy.

Therapy is a learning process referred and connected to education [14]. Depending on the educational goals, therapists model robotic therapies one way or another. Therapists are trained very similar to educators, being able to handle the children's dynamic behavior in a particular setting. Trust and intimacy, respect, and empathy drive the social relationship between the children and the therapist. Therapists take into consideration these aspects when they design and plan robot therapies, usually to stimulate a fruitful relationship between the child and the robot [2]. We could divide therapies according to their purpose: for cognitive rehabilitation purposes or as social assistants. If the robot is a social assistant, the robot can play the role of a companion or be a tool that helps the therapist achieve specific goals. Depending on the role the robot has there are multiple types of robotic therapies, including [15]:

- Social robotic companion therapies: the robot has the role of a companion, and has to create a definite emotional link between the robot and the child (Figure 1.a);
- Social robotic playful tools: a robot is a smart tool that entertains the user, increases user immersion into the activity and allows the action of the therapist (Figure 1.b) ;
- Social robot coaches: the robot is meant to induce a specific behavior to improve the user's skills (Figure 1.c) .

In 1a), the robot is a social agent with a high level of autonomy that needs to be regulated. In 1b) the robot is a cyber-physical interface without an autonomous control system. In 1c), it is critical how the therapists present the system to the children.

Our research has focused on creating and developing different robots for neurorehabilitation therapies, including children under the autistic spectrum disorder (ASD) and with traumatic brain injury (TBI) (see Figure 2). In the following subsections, we introduce our projects to illustrate a typical robotic therapy.

2.1 Traumatic brain injury therapies

There is substantial evidence to support cognitive rehabilitation for people with TBI [16]. Under normal conditions, people with TBI maintain all the cognitive functions they have acquired and consolidated before the injury. During

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Figure 1: From left to right, a) the robot can have the function of social agent, b) robot as a playful tool, and c) robot as a coach.

Figure 2: Different robots built in-house for cognitive therapies, including TBI and autism.

and after the injury, however, TBI sufferers encounter the need to develop and the acquire new cognitive functions, which is crucial in young populations [17].

Robotic technology offers the possibility to adapt to the children's learning rhythm, and offers multiple and different activities that have been found useful and engaging in TBI populations [18]. Moreover, the robot can monitor the children on and off therapy, working as a sort of extension of the therapist. Because robots bring about a lot of benefits, we used a social robot with children that suffered TBI in several projects [19, 20]. In one of the projects, we created a social robot that children could bring home to do some exercises. The study aimed to compare a rehabilitation program that included a personal robot as a therapist, and a control group with children with a moderate or severe brain injury that did not include such a robot. The idea was to evaluate the effectiveness of a robot neuropsychological rehabilitation treatment.

2.2 Autistic spectrum disorder therapies

Children and adolescents within autistic spectrum disorder (ASD) have persistent deficits in social communication and social interaction across multiple contexts [21]. Helping these children to manage simultaneous sensory inputs through peer-mediated approaches and social play interventions have been proven to be effective [22]. Because engagement drives learning [23], ASD therapies are normally configured in a way that children are motivated and engaged. LEGO® robotics creates a context where social and problem-solving skills meet, and this motivates many people. That is why there are studies that show that the creation of such a context is exceedingly positive for children with neurodevelopmental disorders [24–26], including children with ASD [27, 28].

Our studies concerning children with ASD were based on these grounds. We created a context were children with ASD could participate in robot-based activities: in some activities, the children had to create a LEGO® robot and program it to move [26, 29, 30]; in others, the children had to program a mobile robot to complete a circuit on a game board [31]. We used LEGO® robotics to foster and facilitate social skills, but also as a social robot that interacted with the children. The project aimed at eliciting social behavior among children, and between the children and therapists. The researchers assessed all the behaviors and analyzed the effectiveness of the therapy, and used that knowledge to improve the design of robot-based interventions for future applications.

We also run the project "Data Analysis and Collection through Robotic Companions and LEGO® Engineering with Children on the Autism Spectrum" at the Center for Engineering Education and Outreach (CEEO) at Tufts University [32]. This project measured the effect of LEGO® engineering and its collaborative nature on the development of social skills in children and adolescents with ASD. The particularity of this project is that the robots in this project were not standalone robots. Instead, they were part of a cloud robotics ecosystem (see Figure 3.). Cloud

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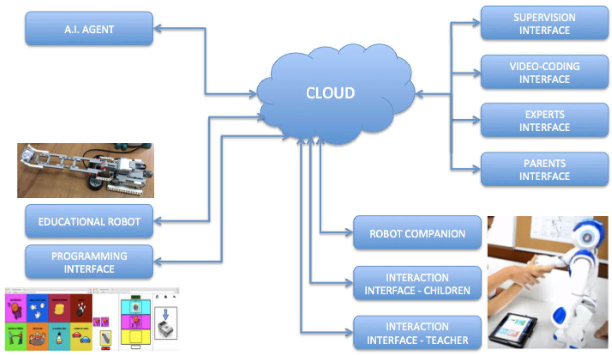

Figure 3: Cloud robotics ecosystem for the "Data Analysis and Collection through Robotic Companions and LEGO® Engineering with Children on the Autism Spectrum" project.

robotics are those cloud services providing computation, data, and storage to support the operation of a robot [33]. The cloud allows access to ubiquitous digital information and enhances sharing information. In this type of systems, the high-level computational system is located remotely in the cloud instead of in every single physical artifact, which, in turn, lightens the weight of the robot and helps reduce its costs.

In this project, the cloud robotics ecosystem comprised the robot, the cloud, traditional recording, and coding systems to allow data collection, and different participants' interfaces (see Figure 3). The cloud system helped control the behavior of the robots, which participated actively in the classroom playing the role of master helping students work together and achieve classroom goals. This cloud-robotic ecosystem created the basis for an enhanced educational context where exploration and discovery, social interaction, play, collaboration and cooperation (i.e., joint attention, sharing material, negotiating plans) where possible [34].

3 Legal and ethical challenges

In the following subsections, we compile some legal and ethical challenges concerning social robot technologies for therapy. We give reasons to believe that the insertion of robots in therapeutic contexts is not straightforward. This investigation has been mainly based on literature research, and it is not a systematic review. Our contribution reinforces the idea that robot technology poses multidisciplinary problems that should be addressed from a multidisciplinary perspective.

3.1 Gaps in governance framework for therapeutic robots

Therapeutic robots are considered healthcare robots because they are within the "domain of systems able to perform coordinated mechatronic actions (force or movement exertions) on the basis of processing of information acquired through sensor technology, with the aim to support the functioning of impaired individuals, medical interventions, care and rehabilitation of patients and also to support individuals in prevention programs [35]." There can be physio-therapeutic robots, those that help in physical therapies or cognitive therapeutic robots, which are robots that interact with patients socially for therapeutic purposes. In these therapies, called robotherapies, the interactions and communications between a subject and an artificial complex interactive system are used for evaluation, diagnosis, prognosis or treatment [2, 36, 37].

At the moment, there is no concrete and specific law for robot technology, although "a mosaic of general and more specific measures (...) that facilitate both the development of robot applications and protect the values that are dear to us" can be pieced together from existing regulations [38]. Yet, the novelty of the technology, its applications and the uncertainty of its potential impacts raises uncertainties and doubts with regards to the application of the current legal framework to a new robot technology in general, and to therapeutic robots in particular: how do traffic laws apply to autonomous cars if these laws did not foresee driverless cars? [39] The following paragraphs compile dissonances and ambiguities concerning the current framework and how this applies to therapeutic robot technology.

3.1.1 Unclear applicability of medical device regulation

An often alluded framework for therapeutic robots is the medical device framework. However, it is unclear whether therapeutic robots are toys or medical devices: is it a toy used in therapies or is it a therapeutic robot [40]? It may well be that engineers try to avoid complying with the medical device regulation because 1) they do not consider they have created a medical device, or 2) because they want to market their robot faster. It could also be that engineers seek the inclusion of a robot under the medical device scope to get the chance of being financed by the social security system or an insurance company.

However, categorizing a product as a medical device does not only lie on the creator's intention but the intended purpose of the device. If a robot has an intended

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medical device purpose, then the medical device framework applies. In this respect, it is a current practice to see companies developing one robot that has two intended purposes: one medical, and the other one not medical. For instance, the company Cyberdine has two exoskeletons HAL, one is a medical device, and another one is for activities of the daily living. However, "devices with both a medical and a non-medical intended purpose shall fulfill the requirements applicable to devices cumulatively with an intended medical purpose and those applicable to devices without an intended medical purpose" (Article 1.3 of the European Regulation 2017/745 on medical devices). Therefore, creators of therapeutic robots have to pay close attention to whether the medical regulation applies to them and if so, follow it at risk to be incompliant otherwise.

3.1.2 Nursing standards do not recognize therapeutic robots as a nursing intervention

Healthcare settings use standardized clinical reasoning terms, evidence-based assessment criteria for selecting appropriate diagnoses, and activities for interventions and indicators for different outcomes to deliver adequate care. The North American Nursing Diagnosis Association (NANDA) recognizes animal-assisted therapy as a nursing intervention. However, (pet) robot (assisted) therapies still do not enjoy the same category [41]. Although some common metrics for human-robot interaction studies were released time ago [42], there are no practical guidelines that frame the use and development of robots and AI technologies in therapeutic contexts [7]. The lack of agreed standardized procedures and guidelines for therapeutic robots impedes the establishment of a safeguard baseline to be respected by anyone working in this area, and this leaves users unprotected [43].

3.1.3 Lack of regulation for robots as hybrid product-service

Robots differ from personal computers because they combine the processing of a vast amount of information with the capacity to do actual physical harm [44]. The capacity for doing actual physical harm is the reason why much research focuses on how to make robots safe to use. In the legal domain, every product that enters into the market needs to be safe, i.e., "protected from or not exposed to danger or risk; not likely to be harmed or lost [45]." Safety is usually ensured via ex-ante mechanisms that ensure the product is safe to enter the market, and via ex-post mechanisms, that is, through mechanisms that ensure damage is compensated. In the European Union, these mechanisms are secured by the Directive 2001/95/EC on general product safety and the Directive 85/374/EEC on liability for defective products.

However, according to the European Commission, "complex and sophisticated interdependencies both within products (based on hardware and software) and across interconnected devices" challenge the legal certainty as regards to the application of such legal framework [46]. Robots are part of a cloud robotics ecosystem that is "an inseparable mixture of hardware, software, and service." This intertwinement challenges the very concepts of product, producer, and defect [47], and brings about difficulties in understanding what legal requirements need to be followed to comply with the law when creating complex cyber-physical systems. Today, the current legal framework does not yet recognize hybrid categories yet.

3.1.4 Inadequacy of product safety rules for artificial social beings

Compared to other high-tech products in the market, moreover, social robots enjoy the category of technological product and the attribute of social being. Indeed, social robots are constructed in a way that they provoke an emotional attachment from the user's side that mainly differs from the attachment that users have on other smart devices [48]. This dual nature would suggest that, if social robots are consumer products and social beings at the same time, then product-safety rules may fall short in safeguarding the interaction between the users and the product.

3.2 Cognitive aspects can challenge the safety of the user, but available safety standards currently disregard them

Traditional robot safety standards cover industrial robots. They ensure safety by separating the human operator from the robot. Service robot technology, however, aims at performing useful tasks for humans in direct contact with them. In consequence, service robot safety standards should address issues arising from the interaction between the human and the robot [49]. The only available standard for service robots is the ISO 13482:2014 standard, which establishes safety requirements for personal care robots. The standard aims at mitigating physical HRI haz-

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ards by stipulating safety requirements on various design factors, including the robot shape, robot motion, energy supply, and storage, or incorrect autonomous decisions [50–52]. While this standard is unique in addressing service robot related physical safety issues [53], robots used in therapeutic settings interact with the user mostly socially [54, 55]. Social robots express and perceive emotions, communicate in high-level dialogue, learn/recognize models of other agents, establish and maintain social relationships, use natural cues such as gaze or gestures, exhibit distinctive personality and character, and might learn or even develop social competencies [56]. Those social robots that assist users through social interaction have been called socially assistive robots (SAR) [57]. Socially-interactive robots raise the question of whether available service robot safety standards suffice to mitigate hazards that mostly relate to cognitive aspects. Since the European Parliament (EP) on its latest resolution concerning the legal aspects of robot technology mentions, "human dignity and autonomy – both physical and psychological – is always to be respected," in this subsection we address some points that challenge this cognitive side.

3.2.1 Robot personality may challenge safety in some therapeutic contexts

To establish relationships and lasting attachment between humans and social robots, these latter require being more real and alive than mere machines. That is why some social robots incorporate personality, which is created through unique, imperfect behaviors from different types of data, collected from different types of sensors, and via cloud computing [58]. The personality of robots provokes a powerful unidirectional emotional bond from the child to the robot [59, 60]. Robots achieve uniqueness and imperfection through the disobedience of their internal rules [61]. This imperfect and unique robot personality may compromise its behavior predictability. Not obeying the rules may, in turn, challenge the safety of those therapies that rely upon such predictability to work with users with special needs, e.g., children under the autistic spectrum disease [13].

3.2.2 Perceived safety may have to be addressed

In the "license for users," the EP asserts that users should make use of a robot without risk or fear of physical or psychological harm [62]. Also called perceived safety, this refers to "the user's perception of the level of danger when interacting with a robot, and the user's level of comfort during the interaction [63]." In physical rehabilitation robots, this is very clear: the fear of falling constraints the performance of a lower-limb exoskeleton. Still, although it is acknowledged in the literature [64], current safety standards have not devised safeguards to mitigate such cognitive hazards yet [65]. Because of this, it could well be that an agency correctly certifies a robot under a safety standard (certified safety), but it could still be perceived as dangerous (perceived safety) [3]. This problem also concerns robots interacting socially with humans: a robot could be safe, but its human resemblance could make it fall under the uncanny valley. What safeguards policymakers need to devise to ensure both certified and perceived safety?

Connected to this, Salem et al. sustain that robots should be trustworthy, i.e., that users should be able to trust not only the robot's physical safety but also the reliability of robot's behavior and intentions [66]. However, a high degree of trust can lead to the ascription of ontological significance to the robot, which could result in a possible obfuscation of its technological activities, maybe because the user would no longer perceive the robot as a lifeless machine, but as a social agent [48].

3.3 Social robots challenge various dimensions of privacy

Technical standards are more intelligible and applicable than public policymaking principles and rules, which tend to be very abstract. Technical standards usually cover one single impact, for instance, safety. However, when service robots are inserted in sensitive contexts such as healthcare facilities, robots perform delicate tasks and interact with the elderly, children or infirm people. In such contexts, other aspects rather than mere safety - privacy, dignity or autonomy - could be compromised [67, 68]. Indeed, it could well be that the robot challenges other users' rights without causing them actual physical harm. For instance, "an interference with data protection rights does not depend on whether there has been any harm or inconvenience to an individual [69]."

Roboticists often claim the importance of meeting "human privacy rules [5, 55]." However, roboticists often fail to understand that data protection and privacy are not little ethical issues to be addressed in the design of their creation, but an actual legally binding obligation. In the EU, the General Data Protection Regulation entered into force in May 2018 and applies to the "processing of personal data in the context of the activities of an establishment of a controller or a processor in the Union, regardless

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of whether the processing takes place in the Union or not (...) of data subjects who are in the Union by a controller or processor not established in the Union, where the processing activities are related to (a) the offering of goods or services, irrespective of whether a payment of the data subject is required, to such data subjects in the Union; or (b) the monitoring of their behavior as far as their behavior takes place within the Union (...) processing of personal data by a controller not established in the Union, but in a place where Member State law applies by virtue of public international law [70]." Therefore, ensuring privacy-by-design, right to be forgotten, data portability, transparency and all the rest of rights enshrined in the regulation need to be respected at risk of otherwise facing criminal charges or fines up to 4% of the total worldwide annual turnover of the company.

3.3.1 User awareness of collected data

Humans tend to project and attribute human-like features to simple objects. This propensity is called anthropomorphization. We do project human traits to robots too [71–73], e.g., by thinking that robots have eyes instead of cameras that process information [74]. Unlike other robots expressly designed for surveillance, it might not be very obvious to a user that a social robot is a data-processing device. A user may fail to acknowledge that the robot is not the only relevant unit in the robotics system, but significant aspects of its functioning are based somewhere else [33]. Indeed, robots are constructed systems with different components, including hardware, software, and cloud services that may be from different companies, even open source. This complex ecosystem where multiple parties are involved in challenges the awareness of data collection, and processing.

Let's see an example. Barbie created Hello Barbie, a Barbie that talks back to children. Barbie hired a speech-recognition company to collect information from the doll that interacts with a child for improvement purposes. Barbie shares the data with this company. Children interacting with this doll may not know that they are openly disclosing information that may be used by this third company for "improvement purposes."

Users (children, parents) may not even be aware that their privacy is not adequately protected. When reading the terms of service of Barbie, one realizes that Barbie clearly states that is not responsible for the data protection legal compliance of the speech-recognition company [75]. This should not be allowed, as Article 28.1 of the GDPR states "where processing is to be carried out on behalf of a controller, the controller shall use only processors providing sufficient guarantees to implement appropriate technical and organizational measures in such a manner that processing will meet the requirements of this Regulation and ensure the protection of the rights of the data subject."

Therapeutic environments may add additional burdens, especially if children treat robot technology as their friends [76]. Children may freely disclose personal information thinking they are sharing it with a friend, not with a robot that is collecting information. As long as these robots are in a research project, researchers might take care of the compliance with the personal data regulations. However, what is going to happen when the industry releases therapeutic robots that can be bought directly by parents? The more these technologies mingle with the user's everyday activities, and everyday surroundings, the more difficult it is going to be for the user's to distinguish whether these are separate entities or part of their lives [77].

3.3.2 Emotional Data

Social robots may respond in real-time to the reactions of a child to maintain and support long-term interactions. These reactions can be, for instance, a response to their speech (the child says something), or to their emotions (the child cries). It seems that if a robot exhibits personality, the engagement with the user accelerates[78]. The public opinion is divided between those that believe that robots should exhibit, express and understand emotions for specific applications and those who disagree [79]. An old quote from Picard illustrates this dilemma: without emotion, computers are not likely to attain creative and intelligent behavior, but with too much emotion, we, the maker, may be eliminated by our creation [80].

Unlike ordinary toys or other tools used in therapies, social robots are capable of recording and processing every aspect of the therapy with a child, including emotions. In 2003, Fong et al. already highlighted that detailed user modeling could involve privacy concerns and might not be acceptable in the long term [56]. There is currently no significant research on this topic [81]. Available legal research on emotions has typically focused on how emotions can bias legal reasoning [82], on how they influence criminal behavior [83], or on the legal and regulatory implications of emotion detection technologies used for advertising and marketing [84]. Questions concerning the boundaries of the embedment of emotions in a robot, or the safeguards implemented to ensure a safe emotional human-robot interaction have yet to be adequately addressed in the HRI literature [81, 85].

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The latest findings actually point out to two opposite directions: while some researchers argue that by allowing the robot to show attention, care and concern for the user as well as to being able to engage in genuine, meaningful interactions [86], socially assistive robots can be useful as therapeutic tools [87]; other studies suggest that, actually, the emotional sharing from the robot to the user does not necessarily imply feeling closer to the robot [88].

The lack of longitudinal studies concerning the consequences of the use of emotions in HRI prevents us from asserting that this practice could challenge the rights of the user in the near or the long run [89]. Whether the law should appropriately address this probably by establishing a purpose limitation or by applying the precautionary principle may depend on the level of uncertainty surrounding a legal intervention. For example, in particular use of emotions in an HRI context, would some guidelines or legal actions increase or reduce certainty as to the respect of the protection of user's rights?

3.3.3 The cyber-physical nature of social robots challenges security

A review of the literature reveals an emphasis on reciprocal risk transfer between the physical and the digital, and the potential for compounding risks. The dual cyber-physical nature of social robots may obscure the origin of a particular problem, the scope of its consequences, and its subsequent impacts in both worlds [90]. This duality complicates legal relationships and liabilities among various actors, such as users, manufacturers, and cloud service providers [33].

Cloud computing includes various deployment models and may involve multiple service layers and service providers [91]. These relationships may be complex, and dynamic because there might be many persons involved: hardware manufacturers, robot service providers, cloud service providers, and users. Such complexity can give rise to significant challenges concerning control, security, and risk management [92]. New techniques based on blockchain are emerging and may be able to secure both things, the remote operation of the robot [93], and the sensible data processed in applications like the previously mentioned therapies[94]. These techniques would somehow ease the compliance process with the data protection regulation. However, can data security ensure a physical safe HRI? How does the cyber-physical nature of robots affect the relationship between privacy and safety?

3.4 Long-term consequences of technology cannot be overlooked in the case of therapeutic robots

While the current legislative framework has ex-ante and ex-post mechanisms to ensure product safety, these mechanisms refer to the immediate product and their immediate consequences. There are few, if any, mechanisms that protect users from broader and long-term consequences of a particular technology. Indeed, designers may correctly specify an objective function, their system may perform a task in the environment, but they may ignore the fact that their technology may have broader consequences in the long run. Machine learning techniques in medicine, for instance, can improve diagnoses made by humans [95], but it may reduce physicians' skills, have an over-focus on data and dismiss the context, dismiss the value of ambiguity in observed phenomena or create even more opaque models to the eyes of the physician [96, 97].

Robot technology can have moral implications. It can contribute to the loss of human contact, reinforce existing socio-economic inequalities or fail in delivering good care [3]. In light of potential long-term consequences of robot technology, the European Parliament has recently stated that robotic engineers should remain accountable for the social, environmental and human health impacts that their creations may pose to present and future generations [98]. However, what these future impacts are? In this section, we bring to the fore possible long-term consequences of different types of technology. We compile relevant findings in related disciplines that, although dissonant to human-robot interaction studies (HRI), may be relevant when given a closer glance.

Before that, mention that while the EP resolution raises awareness of the need to address long-term consequences of robot development, robot professionals may be ill prepared to manage such claim, as they lack formation in other than mere technical aspects. The more roboticists build robots that are meant to interact with humans, the more the necessity to include In legal and ethical aspects (value-sensitive design, multidisciplinary collaboration in the design and implementation process) is going to become evident [99].

3.4.1 Technology limits and conditions the way we behave, see and understand the world

In Greek mythology, Procrustes was the son of Poseidon. He invited all the people who were passing by his house to spend the night in his place. Upon their arrival, he offered

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them an iron bed to sleep. If the guest were too tall, Procrustes would cut off the excess length to fit into the bed; if they were too short, they would be stretched [100]. Thanks to this myth, today the word procrustean refers to the enforcement of uniformity or conformity without regard to natural variation or individuality.

In robotics, the physical embodiment limits robot behavior. This further shapes the consequent interaction with the human. In other words, just like when we buy a t-shirt, and we adapt to its size, and not the other way around, humans have to adapt to robots. The use of patterns of recognition is modeled on a daily basis in robotics labs to improve efficiency and real-time responses. Disregarding individual differences in the design of robot technology in favor of standardized patterns may entail, however, the standardization of HRIs, something already happening in the field of emotions and HRI [80].

Technology shapes the way humans experience reality and operate within it [101, 102]. According to the theory of technological mediation, the types of relations, the points of contact, and the mutual influence between humans and technologies impact on how humans interpret and even construct reality [103]. Technology becomes a filter and, at the same time, an agent that determines how individuals see the world [104]. These effects may undoubtedly gain importance in domains of application particularly sensitive such as healthcare, mainly if the robot interacts socially with the human. If not addressed adequately, this may suggest that the one-size-fits-all approach may directly clash with user-centered approaches such as personalized medicine [105]. In respect to understanding how therapeutic robot technology shapes the behavior of users, and whether this brings about negative impacts in the long-term, we need more longitudinal research.

3.4.2 Technology may cause the problem it tries to solve

Many cities are constructed nowadays with walls, with physical barriers [106]. Closed and guarded condominiums offer a safer alternative to the quality of life deteriorated in shared public spaces. The purpose is to create interdictory spaces and avoid building bridges, easy passages and meeting places to bring the city residents together and facilitate communication [107]. However, as Bauman explains, "the solutions on offer create, so to speak, the problems they claim to resolve." According to him, builders and architects of such guarded spaces may create, reproduce, and intensify the need and the demand they claim to satisfy.

A similar thing happens with technology: technology can be the solution to and the source of our problems. An overexposure to screens has, among others, two worrying consequences. First, it activates a system of rewards in the brain that releases dopamine, which leads to a pathological addiction involving irritability, anger, aggressivity, and violence called digital heroin [108]. Second, it promotes the alteration and shrinking of the frontal cortex, something typically related to disorders such as the ASD or bipolarity [109, 110]. There is much research that focuses on the consequences the Internet has in our brains [6]. All this research may suggest that the solution some robots claim to propose, may be the cause of the problem they try to solve. Therapeutic robots for autism may isolate users [2, 26], and intensify even more their disorder – especially if they have screens. More longitudinal studies are needed to understand until what extent this technology affects the brain, and whether this is helping in therapies, or may backfire.

3.4.3 Critical need for ethics training as part of STEM education

Science, Technology, Engineering, and Mathematics (STEM) approaches separate humans from being humans. Branches of study such as engineering have almost lost all connection with human spoken language. In a recent and very famous book, Harari explains that the mathematical language is not natural, that humans never communicated in binary code, not even in 0-9 numbers. Harari argues that if there is the need to teach humans to communicate in these artificial languages, it is because machines do not understand how we talk, feel and dream [111].

Coding literacy may be necessary for STEM curricula and may provide students employability in the future [113]. Still, this may entail a greater disconnection from what constitutes to be human in the future. As Bauman highlights, the more we are in the virtual type of proximity, the less time we spend in learning and acquiring the skills needed in the non-virtual type of reality [107].

Not including ethics, philosophy, and history in school curricula may probably prevent future generations from not only solving ethical questions arisen from technology (problem-solving) but what it is more worrying, from identifying such problems and issues in the very first place (problem-finding).

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4 Proposed solutions

In the previous sections, we have identified and reflected upon some of the legal and ethical challenges that therapeutic robot technologies pose, including safety, privacy, and long-term consequences. In this section, we make policymaking proposals to steer the use and development of therapeutic robots in the appropriate direction. Our goal is to inform the policy debate and set the basis for a future policy framework for robots in therapy that can both guide roboticists in their innovation process without giving up the protection of users' rights.

4.1 Robot impact assessment

The use and development of robot technology have several impacts that can potentially raise various questions in the ethical and legal domains [3, 65]. These issues typically relate to the robot characteristics, i.e., the embodiment, robot capabilities and cloud services used; in conjunction with contextual and purposive factors such as the context of use, among others, industry, surveillance, transport, care, or entertainment; inasmuch as relevant to legal, ethical and societal standards and concerns [39]. Because roboticists usually lack legal and ethical knowledge, there is the need to create an instrument that could accompany roboticists in their legal compliance process.

The robot impact assessment is a methodology used to identify, analyze, mitigate and eliminate the risks posed by the insertion of robot technology [65]. This methodology is gradual and modular, and can be applied in various forms during the various stages of the robot lifecycle: during the concept stage in a simulator [113], in a test bed or living lab when the concept has been materialized in a prototype [114], or after being launched in a real environment, as the EP proposes. The underlying idea of this methodology is to collect and address in a single instrument all the possible impacts arising from the use and development of this technology. The methodology consists of establishing the context, defining the robot type, identifying and classifying threats and risks, and analyzing and treating them [115].

The methodology is based on the assumption that a robot challenges different legal and ethical aspects. In other words, single-impact assessments relating to data protection [116] and surveillance [117] may fall short in providing comprehensive protection to users because a robot may challenge other aspects. Still, the only binding requirement is to conduct a data protection impact assessment, an obligation laid down in the General Data Protection Regulation (Art. 35 of the GDPR). ISO/IEC 29134:2017 is one of the only documents that establish some guidelines for conducting a privacy impact assessment. However, we need to wait until guidelines on how to carry a Robot Impact Assessment are released soon [65].

4.2 Shared repository for policymaking purposes

Overlooked in the latest review of "the grand challenges of science robotics [119]," what lacks in robot governance is a back-step mechanism that can coordinate and align robot and regulatory development [39]. In other words, there is the need to create a process on how to produce applicable robot guidelines and policies; guidelines and policies that can translate general legal principles and rules into concrete technical requirements for those working on robots that are meant to interact directly with humans.

In our understanding, this process needs to start from the collection of empirical data from several research projects. The Robot Impact Assessment methodology uniform the way data is compiled. Second, there is the need to connect these empirical data with policymaking (evidence-based policies). Nowadays, however, the mere fulfillment of an accountability requirement, i.e., impact assessment in data protection (art. 35 GDPR), does not feedback the legal system per se. In this sense, there is not any data collection mechanism that could be used to develop guidelines and policies for roboticists. In other words, the information generated through the accountability compliance mechanisms does not update the law, they are just a simple standalone and static instrument.

In Japan, living labs generate data used later on for policymaking purposes [119]. We sustain the need to create "shared data repositories" to support evidence-based policies. Every stage of the robot development (concept, design, prototype, product) could produce valuable data that could be later on used to inform policies. In our opinion, this effort should be made gradually from local to international level, as the robotics market affects the market locally and globally. Today, there is no available formal written process on how to carry out such communication process between robot developers and policymakers.

If this mechanism and process could be formalized, then relevant knowledge from the development of the process could be generated, collected and used building evidence-based policies [39]. The collection and process of this data are going be cumbersome at the beginning because it may entail a rigorous case-by-case analysis.

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The system could perfect over time, and official guidelines could be released to help new uses and developments of (robot) technologies. What's more, this process could be automated. There are already examples of automation in legal impact assessments. For instance, the "Commission National de l'Informatique et des Libertés" (CNIL) released a tool to conduct privacy impact assessments automatically [120]. In the United States, 'Regulatory Robot' is a tool developed by the Consumer Product and Safety Commission that, although not specific for robot technology, helps producers comply with various legislations concerning products within the United States [121]. In the end, if research and practice in different disciplines start communicating to each other, and proceed in parallel, they may benefit each other with regards to legal certainty and reliance of the systems [122].

4.3 Development of new principles

The more new robot technologies pose new problems, the less prepared may be the law to accommodate such concerns. The development of new principles may help understand what boundaries in the development of a precise technology are, and may also guide roboticists mitigate compounding risks, and shape future robotic therapies framework. In the following subsection, we devise some principles that could help steer the development and use of robots in therapy to avoid compromising innovation and user rights. These refer to non-isolation (to promote human-human interaction), individualized-care (to foster personalization of care), value integration (implementing value sensitive and user-centric design), policy learning (evidence-based), and accessibility (low-cost and minimal design).

4.3.1 Principle of non-isolation

Human contact is considered one of the fundamental aspects of human care. In 2017, the EP openly feared that the inclusion of care robots could substitute human workers at some point and that this could entail the dehumanization of caring practices. The principle of non-isolation, therefore, refers to the idea that technology as an end on itself could lead to the isolation of users, either from others or from themselves. In this respect, technology should be conceived as a means, either of communication or information, not an end on itself, to serve their purpose and create a bridge between humans. This principle is in line with the Art. 19 b) of the UN Convention on the Rights of Persons with Disabilities, which reminds the general duty to promote dignity among care-receivers while minimizing exclusion contexts, enhancing social connectedness and encouraging care and human touch.

Social robots used as social mediators in autism-related therapies are a good example [26]. Instead of creating a robotic interface that interacts with the user, these therapies promote human-human interaction via the robot. In plain language, every time the users put a question to the robot, the robot answers "ask your teacher," "ask your classmate." In the end, the child understands that s/he better ask the human directly to get the necessary information.

The principle of non-isolation strictly links to the idea of non-replacement, at least from the care- giver's viewpoint. A robot is a tool for the therapist, not against the therapy. Although nurses usually work with machines that monitor the vital signs of patients, and other types of data and equipment, there is research that reports the feeling of replacement from caregivers after the introduction of a social robot [7]. It seems this fear relates to the attribution of agency to the robot. A transdisciplinary training before the robot could be used to educate caregivers on how to use the robot as a tool. Involving other departments in the information sessions could also be very beneficial to promote institutional cohesion, encourage interdisciplinary thinking and avoid exclusion and replacement contexts.

4.3.2 Principle of pan-centered inclusive care

Children under the ASD have deficits in social communication, social interaction, social-emotional reciprocity, and difficulties in developing, maintaining and understanding relationships [123]. Accordingly, ASD robotic therapeutic interventions have focused on social and cooperative skills training [26]. However, it remains in question 1) why these therapies are not equally spread among young and adult population [124]; 2) who decided that autistic children needed to be forcibly trained in social and cooperative skills; and 3) why society does not learn how to understand, respect, and integrate autistic children in the same way these children are learning how to adapt to neurotypically developed people.

While user-centered approaches can improve personalized care, these cannot disregard the milieu in which the user will be inserted. The principle of pan- centered inclusive care suggests that greater parallel efforts need to be done in order to allow society to understand, accept and integrate children with disabilities as they are. Mechanisms for a complete inclusion should be put in place. A

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good way to enforce this is to offer employability to persons with disabilities. The principle of inclusion aims at promoting the involvement of persons with disabilities into all the activities abled people enjoy. In June 2014, only 19.3% of people with disabilities in the U.S. were participating in the labor force – working or seeking work. Of those, 12.9% were unemployed, meaning only 6.4% of the population with disabilities was employed [125]. In contrast, 69.3% of people without disabilities were in the labor force, and 65% of the population without disabilities was employed. As per the Principle of pan-centered inclusive care, much more inclusive mechanisms should be put in place in order to provide everyone with the same opportunities, including the inclusion in the labor market.

4.3.3 Principle of organic accessibility

The employability data described in the previous subsection need to be integrated with some data in relation to what is the cost of supporting individuals with some sort of dependence. An individual with autism and intellectual disability costs around $2.4 million in the United States and £1.5 million in the United Kingdom during his/her lifespan. The cost of supporting an individual with an ASD without intellectual disability is around $1.4 million in the United States and £0.92 million in the United Kingdom [126].

To ensure global welfare, and to avoid widening the wealth gap and the digital divide, the principle of accessibility and affordability encourage robot developers to work with very low-cost technologies. By lowering the cost of robots, creating robots with cheaper components, for instance, could entail a greater accessibility rate of this technology. The principle also refers to the possibility to revisit traditional technology-free therapies that might work equally or better than robotic-based therapies. The healthcare system could offer these therapies as an alternative to the growing adoption of robotic and AI technologies in therapy. Offering this alternative could be a way to give the right to choose to users which kind of therapy they want, and an excellent way to keep humans in the loop.

4.3.4 Principle of compliance by design and policy learning

The principle of compliance by design and policy learning refers to the integration of values and principles into the design of robot technology, which is binding for data protection under European law. The GDPR refers to privacy-by-design in article 25: “taking into account the state of the art, the cost of implementation and the nature, scope, context and purposes of processing as well as the risks of varying likelihood and severity for rights and freedoms of natural persons posed by the processing, the controller shall, both at the time of the determination of the means for processing and at the time of the processing itself, implement appropriate technical and organisational measures, such as pseudonymization, which are designed to implement data-protection principles, such as data minimisation, in an effective manner and to integrate the necessary safeguards into the processing in order to meet the requirements of this Regulation and protect the rights of data subjects.” The law pushes for the integration of legal principles from the very design phase of technology.

If a producer has done everything s/he could in or- der to ensure safety, then, in theory, there is an exemption for product liability. The article 7 (e) of the European directive 85/374/CE on the approximation of the laws, regulations and administrative provisions of the Member States concerning liability for defective products states, “the producer shall not be liable as a result of this Directive if he proves (...) that the state of scientific and technical knowledge at the time when he put the product into circulation was not such as to enable the existence of the defect to be discovered.” If developers need to apply some legal principles during the design phase of a particular technology, then not respecting that would not exempt a producer from being liable. Similarly, if available research suggests that the addiction to screens causes alienation and isolation problems, then, the producers should do something about it, e.g., a roboticist should work on screenless embodiment and prevent him/herself to be held responsible for such consequences.

4.4 Developing binding codes of conduct

A code of conduct is a set of rules outlining principles and values to be respected by a profession. The EP has recently affirmed that “clear, strict and efficient guiding ethical framework for the development, design, production, use and modification of robots is needed [127]. In 2010, some researchers outlined one code of ethics for robotics engineers [128]. These were built from available codes of conduct of IEEE, ASME and ACM, and included seven principles, here listed:

1. Recognize that I may be held responsible for the actions and uses of all creations in which I have a part.
2. Consider and respect not only people’s’ physical well-being, but their rights as well.

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3. Not knowingly misinform, and if misinformation is spread do my best to correct it.
4. Respect and follow local, national and international laws wherever applicable.
5. Recognize and disclose any conflicts of interest.
6. Accept and offer constructive criticism.
7. Help and assist colleagues in their professional development and in following this code.

The EP proposed framework consists of a code of conduct for robotics engineers, a code for research ethics committees when reviewing robotics protocols, and of two model licenses, one for designers and the other one for users. Some of the principles enshrined in such corpus are the Beauchamp and Childress' biomedical ethical framework (beneficence, non-maleficence, autonomy, and justice) [130]; the respect for fundamental rights, precaution, inclusiveness, accountability, safety, reversibility, privacy or the maximization of benefit and the minimization of harm. In our understanding, the principles of non-isolation, pan-centered inclusive care, accessibility and affordability, and compliance by design and policy learning should also be included within any code of conduct for robot engineers.

These codes are generally non-binding corpora — soft law, in legal terms. Failing to comply with codes of conduct does not imply any significant consequence. For instance, there are no fines for not disclosing any conflict of interest, for instance. One of the problems of soft-law is the lack of the capacity for enforcement, that is, allegations and defenses are not allowed to be tested under accepted standards and procedures when a violation occurs. In other words, these corpora do not fix any consequences for violations [130].

To indeed make roboticists "accountable for the social, environmental and human health impacts that robotics may impose on the present and future generations," as the EP mentions, we encourage central institutions to develop these codes establish consequences for violations, concerning fines and sanctions. The law could make them binding. Another way to make them binding would be to include them into a private contract, between a robot producer and a user – in this case a healthcare institution [131].

5 Conclusions

In this paper, we have identified some concrete legal and ethical aspects concerning the use and development of social robots in therapeutic settings. While there are some charters of rights for persons with disabilities, and regulatory initiatives governing robot technology are emerging, guidelines for social robots in therapy currently lack.

This has not impeded, however, advances in the understanding of how robot technology could help in the cognitive rehabilitation process of non-neurotypically developed persons. Indeed, there is much qualitative research promising a very engaging therapeutic setting, with great benefits and very low-risk for the users. Other research, however, states that technology has a profound impact in our nature and the way we perceive and understand the world and that they could potentially raise ethical and legal questions that have not yet been fully addressed. Many roboticists may be wondering why there are still no guidelines or laws in this respect. The truth is that regulation is complicated on many occasions, and does not happen at the same time as innovation [132].

Regulation usually entails the interplay between four main constraints: the architecture of what needs to be regulated, social norms, the rules of the market and the law [133]; but also with the time factor, i.e., at early stages of technology development hard law regulation may make little sense as impacts are unclear and the risk of overregulation abounds [39]. Moreover, regulation often entails a translational problem: abstractness is often the adjective that best describes the law.

Steps need to be taken to help speed the creation of guidelines that could frame the innovation happening in the therapeutic robotics field. In this article we have continued ongoing discussions on the implications of robot technology for therapy, we have highlighted some new issues not often found in the HRI literature, and we have proposed different solutions. Among other things, we propose the creation of a methodology that can help roboticists identify and mitigate multi-faceted risks. The knowledge generated through this mechanism could be collected in a shared data repository and be used to promote the configuration of evidence-based policies. Over time, these policies could adequately frame the innovation revolving around these technologies while ensuring comprehensive protection of the users. We also proposed different principles that we believe should be respected not only for this type of therapeutic robot settings but also in a lato sensu.

In the article, we acknowledge that technology is both a filter and an agent in determining how individuals see the world [104]. Because of that, we deem appropriate safeguards that can ensure both the physical and the psychological aspects of the human-robot interaction of utmost importance.

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