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ORIGINAL PAPER

A Survey of Expectations About the Role of Robots in Robot-Assisted Therapy for Children with ASD: Ethical Acceptability, Trust, Sociability, Appearance, and Attachment

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Abstract The use of robots in therapy for children with autism spectrum disorder (ASD) raises issues concerning the ethical and social acceptability of this technology and, more generally, about human–robot interaction. However, usually philosophical papers on the ethics of human–robot-interaction do not take into account stakeholders' views; yet it is important to involve stakeholders in order to render the research responsive to concerns within the autism and autism therapy community. To support responsible research and innovation in this field, this paper identifies a range of ethical, social and therapeutic concerns, and presents and discusses the results of an exploratory survey that investigated these issues and explored stakeholders' expectations about this kind of therapy. We conclude that although in general stakeholders approve of using robots in therapy for children with ASD, it is wise to avoid replacing therapists by robots and to develop and use robots that have what we call supervised autonomy. This is likely to create more trust among stakeholders and improve the quality of the therapy. Moreover, our research suggests that issues concerning the appearance of the robot need to be adequately dealt with by the researchers and therapists. For instance, our survey suggests that zoomorphic robots may be less problematic than robots that look too much like humans.

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Introduction

Children with autism spectrum disorders (ASD) have impairments in social-emotional reciprocity, non-verbal communicative behaviours, and developing and maintaining relationships. They find it difficult to recognize body language, to make eye contact, to talk about personal feelings, and to understand other people's emotions (American Psychiatric Association 2013; see also Scassellati et al. 2012). Children with ASD prefer stable social situations. The diagnostic and statistical manual of mental disorders (DSM-5) lists the following criteria for the diagnosis of ASD (our summary):

1. persistent deficits in social communication and interaction across multiple contexts;
2. restricted, repetitive patterns of behaviour, e.g. stereotyped or repetitive motor movements or adherence to routines;
3. symptoms must be present in early childhood; and
4. symptoms cause clinically significant impairment in social, occupational, or other important areas of functioning (American Psychiatric Association 2013).

Since there is no cure, treatment of children with ASD is aimed at improving their quality of life. What matters is improving functioning. Various forms of therapy are being used, including animal-assisted therapy (AAT) and robot-assisted therapy (RAT) (see for instance Costescu et al. 2014). RAT has the advantage that, compared to animals, robots are easier to control. It also creates a predictable environment for the children, and avoids diseases or allergies (Wada et al. 2008; Vanderborght et al. 2012).

Robots can be used for diagnosis (Scassellati 2005a) and for therapy. The development of these robots is part of what is sometimes referred to as "socially assistive robotics" (SAR): the aim is to develop robots that (1) engage in social interaction with humans and that (2) assist people. (Scassellati et al. 2012). Bartneck and Forlizzi define a social robot as an autonomous or semi-autonomous robot that interacts and communicates with humans by following the behavioral norms expected by the people with whom the robot is intended to interact (Bartneck and Forlizzi 2004). Fong et al. 2003 introduce the term socially interactive robots to describe robots that exhibit the following "social" characteristics: the ability to express and perceive human emotions, communicate by means of a high-level dialogue, learn/recognize models of other agents, establish/maintain social relationships, use natural cues (gaze, gestures, etc.), exhibit distinctive personality and character, and learn/develop social competences (Fong et al. 2003). And Libin and Libin (2004) define the following features for an artificial creature to be an interesting and engaging communicating, gaming, educational, or even therapeutic partner for people of all ages, cultures and life experiences:

- It imitates human (or animal-like) behavior.
- It models motor, emotional, and cognitive behaviors normally experienced by animals or humans.
- It communicates with a person on various levels: tactile-kinesthetic, sensory, emotional, cognitive, and social. These communications can be verbal and nonverbal (Libin and Libin 2004).

Using social robots for RAT seems promising: it seems to increase the social engagement of the children. For example, a recent case study suggests that social robots can improve the ability of children to identify situation-based emotions in others (Pop et al. 2013). Other examples include research on how humanoid robots can help to increase bodily awareness of children with autism (e.g. Costa et al. 2015) and on the impact of the physical design of social robots on the perceptions and references of children (Peca et al. 2014).

However, robot developers and therapists are concerned about the ethical and societal acceptability of their tools and methods. As a recent Eurobarometer study of public attitudes towards robots shows, many people in Europe resist this idea of using robots in care. 60 % of EU citizens saying that robots should be banned from the care of children, elderly people and people with disabilities. There is also still considerable opposition to using robots in other 'human' areas: 34 % of respondents say robots should be banned in education, 27 % are against the use of robots in healthcare and 20 % oppose their use for leisure purposes (European Commission 2012: 11). Robot engineers and technologists are also sometimes confronted with negative responses to their work. Also, often robots are linked to science-fiction and are presented as dangerous to mankind. Some sound an 'apocalyptic alarm' (Veruggio 2005). Therefore, we want to know what stakeholders—children, but also parents, therapists, members of autism organizations, autism researchers and students—think about RAT. Do they think it is ethically acceptable to use robots for this purpose? Do they think it is helpful? Would parents trust their children to a robot? And if more autonomous robots were to be developed, would they trust a situation in which there is no adult supervision? Moreover, how do they perceive the robot? For example, should zoomorphic robots be used, for example, which tend to appear nonthreatening? Or is it fine to use humanoid robots, as long as it does not look too similar to (adult) humans? Unless these questions are addressed, engineers, therapists, and others cannot begin to develop, program, and use robots for RAT in an ethically responsible way, and policy makers have too little information about how robots are perceived by people and cannot deal with the ethical, social, and legal issues related to that perception.[1]

[1] Note that there can be at least two kinds of arguments for taking into account people's perceptions. One is a pragmatic one and is mainly the point of view of the robotics researcher: in order to ensure social acceptance of technology, one needs to take into account people's perceptions, even if "we", researchers, know what is objective and real. There is little point in developing robots for therapy if the end user (patient) has no subjective feeling of comfort when interacting with the robot. Another argument requests attention to perceptions based on the philosophical position that questions the very distinction between "objective" versus "subjective" knowledge (even scientific knowledge is a kind of perception, a way of seeing, a perspective) and that sees the exclusion of the view of lay people on the grounds that it could be based on "ignorance" or "error" as problematic. The authors of this paper sympathize with the latter

There has been work done on ethical challenges in socially assistive robotics (SAR), including ethical issues raised by working with children with ASD (see for example Feil-Seifer 2011; Feil-Seifer and Mataric 2011; Sharkey and Sharkey 2011), but so far, stakeholder involvement has been limited in this research area. Moreover, there have been surveys about using robots in care, but many of them are about physical therapy (e.g. Lee et al. 2005; Lu et al. 2011; Broadbent et al. 2010) and do not specifically investigate ethical issues.

Therefore, we conducted a survey: we wanted to know how parents and therapists think about social robots and if they believe robots can and should be used for ASD therapy for children, in order to inform robot developers, therapists, and policy makers about the ethical and social issues involved in RAT. We investigated a range of factors that have to do with ethical acceptability, trust, sociability, and utility of the child–robot interaction in RAT. We asked both people that had a direct interest in ASD (therapists, teachers and parents of a child with autism) and people with a degree in psychology and as such a professional education of autism, but no practical experience of dealing with children with ASD. In the beginning of the questionnaire, we asked about gender, age, nationality, education, occupation, role (parent, therapist, or none of these), and—importantly—about the experience people had with robots. Some of the people had previous experience in using robots (e.g. because their child was involved in experiments involving robots or because they conducted such experiments): 22 % of our participants were parents of children with ASD and 16 % therapists or teachers of children with ASD (Fig. 1). Others were for instance students of ASD and people involved in autism organizations.

The Survey: Ethical and Therapeutical Concerns, Questions, Method

In our study, we focused on the following groups of questions, which by no means exhaust the possible range of relevant ethical questions discussed in the previous section and elsewhere, but which helped us to start involving stakeholder's opinions in research in this area:

Ethical Acceptability, Replacement, and Autonomy

Given the general attitude towards robotics in health care mentioned previously, we want to know if this is also the case for therapists and parents of children with ASD. More specifically, do parents and therapists think it is **ethically acceptable** to use robots in therapy for children with autism? Do they have problems with accepting that robots may *replace* therapists or if it is more acceptable that robots help, without replacing the human therapist(s)? **Replacement** is not only an issue in autism therapy but in the ethics of health care robotics in general: there is a growing

Footnote 1 continued
argument and position, that is, assume that scientific views should not *necessarily* have epistemic, moral, and political priority but should be part of a broader discussion in which other voices should also be heard and valued.

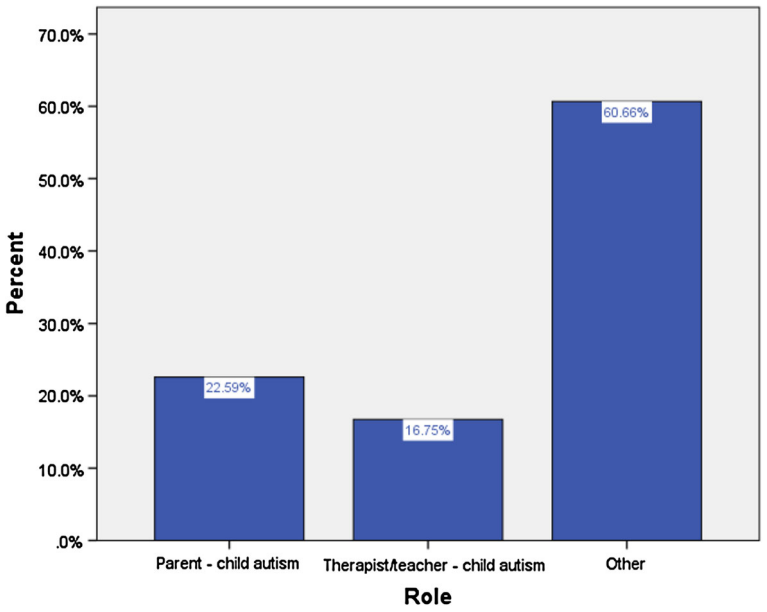

Fig. 1 Role distribution of participants

body of literature in this field (see for instance Sparrow and Sparrow 2006; Sharkey and Sharkey 2010a; Coeckelbergh 2011a, 2012b, 2013, 2015; Whitby 2015). What are the implications for human labour, and is the quality of the care process improved when robots are introduced? For instance, are robots introduced in health care and therapy only to save money, or also and mainly to improve the quality of care? And does the use of robots in care contribute to "cold", mechanistic aspects of modern health care, or are there other possibilities? What do we mean by good care, and does good care necessarily exclude the use of advanced technologies such as robots and (other) information and communication technologies (ICTs)? (Coeckelbergh 2013, 2015) In this case questions are included regarding the following issues: What would the use of robots in autism therapy mean for the quality of therapy? Does it mean that humans are replaced by robots? How exactly would the therapy change? These questions also relate to the issue of **autonomy**: does the use of autonomous robots necessarily mean replacement of human carers and therapists, or not? How, exactly, do autonomous robots change the practice of care? For ASD therapy this means: how, exactly, do (more) autonomous robots change the way therapy is done, and what is the (remaining) role of the therapist?

In our survey we asked:

- Is it ethically acceptable that social robots are used in healthcare?
- Is it ethically acceptable that social robots are used in therapy for children with autism?
- Is it ethically acceptable to use social robots that replace therapists for teaching skills to children with autism (e.g. imitation, social skills).?

- Is it ethically acceptable that social robots are used in therapy to support the interaction between the therapist and the child with autism?

Safety and Trust

Related to acceptability is the issue of safety and trust. Clearly robots should not harm people and be **safe** to work with. As Feil-Seifer and Mataric (2011) state, the most obvious risk of any assistive technology is the potential of physical harm. This is especially important in health care and therapy, since it involves vulnerable humans such as ill people, elderly people, and children. In this case children are involved. Child–robot interaction should be safe and social robots are often explicitly designed for safety (see for instance Goris et al. 2011). However, to address the issue of safety it is not sufficient for robotics researchers to say that, on the basis of literature and experimental tests, their robot is safe. There may be a difference between "objective" safety based on experimental evidence (if this exists at all) and perceived, "subjective" safety. The importance of the latter is also acknowledged by many robotics researchers. For instance, the Japan Robot Association includes psychological safety as a criterion for service robots (Kamide et al. 2012). It is important to find out about perception and opinions of end-users of robots and other stakeholders.

In our survey, we asked if people think that it is safe for children with autism to interact with social robots (with or without therapist supervision), if children can get physically hurt by the robots (for instance if it fell on a child), if it is safe for them to touch and hug the robots, and if they would feel comfortable in the presence of the robots. We asked for instance:

- It is safe for children with autism to interact with social robots under the supervision of a therapist?
- Is it safe for children with autism to interact with social robots without therapist supervision?

The use of robots in this kind of therapy also raises the issue of **trust**. Are parents prepared to leave their children under the care of the robot? Can the children be left without any adult supervision? Do parents trust robots that move, or that are bigger and stronger than the child? Do therapists think it is safe for children to interact with a robot? There has been philosophical reflection on trust and robots in general (Coeckelbergh 2012c) and Feil-Seifer et al. mention trust as part of their discussion of benchmarks for evaluating socially assistive robotics: 'Can a user and caregiver put the necessary trust in a robot system for that robot to be able to perform effectively?' (Feil-Seifer et al. 2007: 428). But so far no work has been done on trust in robots used for autism therapy; again it is important to know what stakeholders think about this. Therefore, in our survey we also asked questions about trust: would people trust a robot (mobile or not mobile)? Should social robots respond autonomously to the child's behaviour's, without an operator?

Social Interaction

Since children with ASD have problems with **social interaction**—it is a defining feature of autism (Scattone 2007) and the most challenging for treatment (Weiss and Harris 2001)—we want to know if parents and therapists think that the robot can act in "social" ways, enabling and stimulating communication, becoming a play partner, help the children develop social behaviours, etc. It is important that parents and therapists are convinced that the robot has sufficient social capabilities; otherwise they are not likely to accept and use the robot and it is highly questionable if it makes sense to design a robot which is "social" according to the researchers but is not perceived as such by those who are going to use it. What do key stakeholders think about the social-interactive capacities of the robot? Note that this issue also relates back again to the question regarding the quality of care and the quality of therapy: clearly the robot should contribute to the goals of the therapy, and this is only possible if the robot has sufficient "social" qualities and capacities.

In our survey, we asked about what people think about the capacity of the robot to stimulate social interaction. Can social robots and children with autism communicate with one another? Can the robot become a play partner? Is it possible for the children to consider the robot as their friend? Can these robots encourage children with autism to better enjoy a conversation with humans? We also asked questions regarding the perception of the robot in relation to the interaction. Would the children think that the robot has thoughts and intentions, feelings and preferences, and/or memory? Can robots help the children to learn social behaviours?

Emotions and Attachment

Emotions are very important in social interaction and studies showed that the motivation of the children is very important. Moreover, play is an important learning tool for children. This creates great expectations about using robots as a 'social crutch' (Scassellati 2005b) that teaches ASD children social skills. But is this also perceived by parents and therapists? We want to know if parents and therapists think that robots could be perceived by the children as having emotions and elicit enjoyment and fun in play settings. There is also the issue of emotional **attachment** on the part of the child, and this is again an ethically relevant issue: is it acceptable that children with autism get attached to the robot?

Attachment seems at the same time good and problematic. It can be seen as good in so far as attachment supports the process and goals of the therapy: without any kind of attachment, it might be difficult to teach children social skills. Robotics and human robot interaction (HRI) researchers therefore actively try to stimulate attachment by for instance designing the robot in specific ways (e.g. a huggable robot such as Probo, see for instance Goris et al. 2011). On the other hand, attachment to a *robot* may also be seen as problematic: when the robot is taken away, this may cause distress to the user (Sharkey and Sharkey 2010b, see also Feil-Seifer and Mataric 2011), for example to the child in this case. Is this problem different from attachment to soft toy animals and dolls? And is it ethically

acceptable that children become attached to a machine, rather than a human being? Or is the issue less problematic than it may seem at first sight? This problem is also related to what is often discussed as the issue of deception: is it acceptable to deceive children, elderly people, etc.? Robots may be constructed to physically resemble for instance a pet, or there may be unintended effects related to the way the robot looks, for example how it is dressed (Feil-Seifer and Mataric 2011). What matters here is how the robot is perceived and whether this then counts as "perception" and may invite attachment problems. (For a discussion of the deception issues see for example Coeckelbergh 2012a; for a philosophical discussion about appearance and its implications for ethics of robotics see Coeckelbergh 2009, 2010.) In the case of RAT for children with ASD ethical questions include: is attachment to a robot in ASD therapy a case of deception at all, and if so, is it acceptable?

In our survey, we asked about the ethical acceptability of children with ASD perceiving social robots as friends, of children with ASD becoming attached to social robots, and of making social robots that look like humans, like animals, like imaginary creatures, or like objects. Questions included:

- Is it ethically acceptable that, as a result of their therapy, children with autism perceive social robots as friends?
- Is it ethically acceptable to make social robots that look like humans?
- Is it ethically acceptable to make social robots that look like animals? Imaginary creatures maybe also, since the existing robots called nao and probo are like this.

We also asked about enjoyment and (other) emotions. Do parents and therapist think social robots can provide children with enjoyment, that the robots can act as conversational partners, that children are willing to touch the robot (e.g. hug, touch hands, head, etc.), and that the robot can be a favourite toy? Do people think that social robots can trigger positive emotions (e.g. happiness) and negative emotions (e.g. fear)? Can children with ASD become attached to a social robot?

Quality of the Therapy

An important issue related to, and emerging from, the previously discussed issues, concerns the quality of the therapy. It is important that the therapeutic goal is reached (Feil-Seifer and Mataric 2011) and that specific therapeutic actions can be carried out by or with the robot. We want to know if therapists and parents think the robot is helpful and effective in the therapy, and if they think that specific skills can be learned (e.g. play, shared attention, turn-taking, etc.). As said, there are encouraging results, but not all individuals with ASD showed an increase in social communication when interacting with the robots, and as Scassellati et al. (2012) remark in their recent review of the literature, so far there are 'no large-scale longitudinal studies with many participants that provide quantitative measures about how people with autism interact with social robots' (Scassellati et al. 2012). Thus, the field is still being developed and there is still some controversy about the

benefits of the therapy; we want to know how therapists and parents respond to experiments with RAT.[2]

In our survey, we asked many questions about how helpful social robots can be in therapy for children with autism. Can they be helpful at all, can they improve the outcomes? Is it plausible that these robots will become usual components in the therapy? Do people believe that they reduce the workload of the therapists? Can the robots even be used to assess the abilities of children with autism? We asked about how useful the robots might be for various tasks: play, imitation, attention, turn taking, conversation, and autonomy (e.g. dressing, washing). We also asked what characteristics a social robot needs to have in order to be useful in this kind of therapy. How machine-like, human-like, animal-like, life-like, and verbal should it be? Should it be perceived as male or female, or something in between? Should it be young or old, mobile or not mobile, apathetic or responsive, non-intelligent or intelligent, inert or interactive, non-emotional or emotional? Should the robots express thoughts and feelings about themselves during therapy? Should they express thoughts and feelings about the child? Should they make jokes or be self-ironic with typically developed children? Should they refuse the child requirements? Should the robots make *mistakes* like human conversation partners? Should they *lie* sometimes during the interaction? This is a selection of questions we offered to the respondents:

- Social robots should respond autonomously to the child's behaviors (so the robot controls its own behaviours without an operator).
- Social robots can help children with autism to learn social behaviours.
- Social robots can be helpful as tools in therapy for children with autism.
- Social robots should sometimes lie during the interaction.

Privacy and Data Protection

On the one hand, there is a need for researchers, therapists, and parents to retrieve information about the progress of the child and monitor the quality of the therapy. On the other hand, there are issues concerning the recording and storage of information: who has access to this information, are the data securely stored, to whom are the data passed on, etc. Again these issues are not confined to RAT but are relevant to all uses of robotic technology and ICTS in health care. In our survey, we asked participant to respond to the following claims:

- It is ethically acceptable that information is recorded and stored by a robot when it interacts with a child with autism.
- It is ethically acceptable that social robots are used to monitor the progress and help in the diagnosis process of a child with autism.[3]

[2] Note also that this discussion raises the philosophical question what sociality is, and invites critical reflection on how we (therapists, society) define and deal with autism spectrum disorders, also in different therapeutical situations and at different times and places.

[3] Note that it may have been better to ask about "children with ASD" and "children suspected to have ASD", rather than "children with autism".

Other Issues

Note that this is not meant as an exhaustive list of issues. For instance there are more issues related to the human–robot interaction, including those issues that have to do with problems in the caregiver–child relationship (Borenstein and Pearson 2013), and the problem of what kind of autonomy and authority can and should the child have in the therapeutic process. Note also that next to these issues related to robots in RAT and robots in health care, there are also general principles for ethics in health care, such as those outlined by Beauchamp and Childress (2001), which are also relevant to socially assistive robotics (Feil-Seifer and Mataric 2011). In addition, there are political–philosophical principles and questions relevant to this discussion, for instance the question who should decide or have a say in the development and use of new technologies.[4] However, we will not further examine these issues in this article.

Practical Aspects of the Methodology

The questionnaire was mainly offered on-line by the free and open source online survey application LimeSurvey installed at the Free University Brussels webserver and was available in three languages English, Romanian and Dutch. This software enables the researchers to develop and publish surveys, and collect responses, without doing any programming. Robots exists in different shapes, sizes and capabilities for wide range of applications; we introduced the social robots to be used by means of a 1 min video in Layman's terms in the three languages. The video contained short clips of a selection of currently most used social robots (NAO,[5] Keepon,[6] Probo,[7] Kaspar,[8] Iromec platform,[9] Pleo[10]). Robots were shown that look like machines, (imaginary) animals, humanoids and androids. Moreover, the video had a neutral voice, was kept short to keep interest, and did not show children in it. This is the link to the video: http://www.youtube.com/watch?v=DSklqn49gD8. (We received permission from the owners to use this material.)

The questionnaire was developed in a multidisciplinary team consisting of psychologists, therapists, engineers and ethicists and was based on guidelines and essential elements of questionnaire design and development in order to obtain a reliable and valid questionnaire (Rattray and Jones 2005).

[4] In this paper we assume that all stakeholders should have a say. This may mean various things and invites larger questions and discussions about technology and democracy, but in this article we limit ourselves to using the very concrete tool of the survey to give stakeholders a chance to give their opinion on the use and development of the new technology under consideration.

[5] https://www.aldebaran.com/en/humanoid-robot/nao-robot.

[6] http://www.mykeepon.com/.

[7] http://probo.vub.ac.be/Probo/.

[8] http://www.herts.ac.uk/kaspar/the-social-robot.

[9] http://www.iromec.org/8.0.html.

[10] http://www.pleoworld.com/pleo_rb/eng/index.php.

Our target population was parents and therapists in Romania, Belgium, the Netherlands, and England. Participants were recruited based on databases of persons involved in our past research and messages were posted on relevant blogs, Facebook, newsletters and websites of autism organizations. A total of 416 subjects participated in the study. Data from 22 participants were excluded from the analysis since their responses were incomplete. As mentioned before 23 % of the participants were parents of children with ASD and 17 % of the participants were therapists or teachers of children with ASD.

Data Analysis and Results

In this paper we only present a selection of the results derived from answers to the questionnaire: those results that we think are most relevant for some of the key ethical and therapeutic issues identified in the previous pages.

The analysis of the distribution of responses to the first two questions, ''It is ethically acceptable that social robots are used in therapy for children with autism'' (85 % agree—see Fig. 2) and ''It is ethically acceptable that social robots are used in healthcare'' (85 % agree) indicate that a great majority of the respondents agree with using robots in the health care system, including in robot assisted therapy for ASD children. This is somewhat surprising, given that according to the Eurobarometer study many people in Europe do not accept the use of robots in health care. Note the difference with the Eurobarometer results about care mentioned above; apparently the autism community is far more positive about using robots in healthcare, including autism therapy.

However, in line with our discussion of ethical issues, it turned out that a significant number of participants (44 %) were opposed to the idea of the robot replacing therapists (Fig. 3): instead many respondents preferred that the interaction is supervised by the therapist and that the robot is tele-operated rather than fully automated.

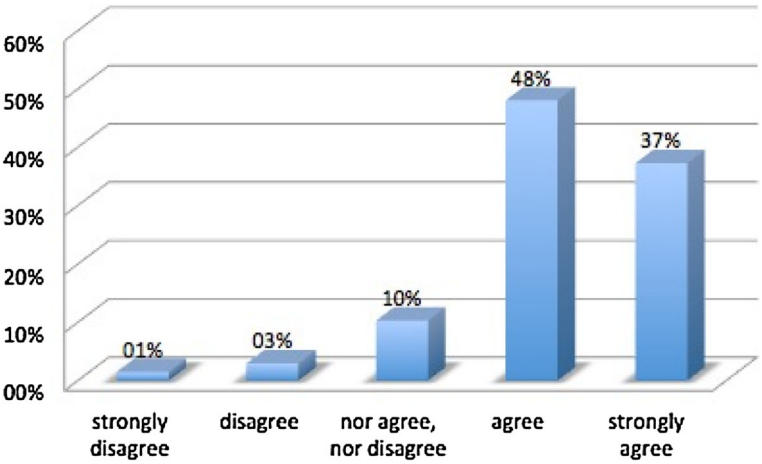

Fig. 2 It is ethically acceptable that social robots are used in therapy for children with autism

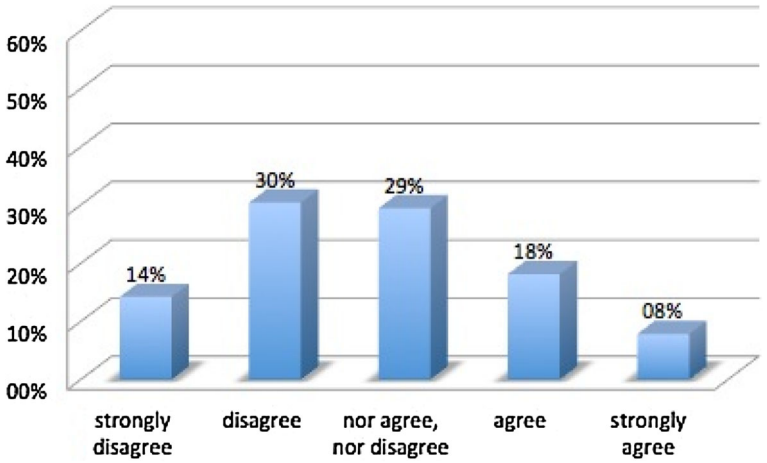

Fig. 3 It is ethically acceptable to use social robots that replace therapists for teaching skills to children with autism (e.g. imitation, social skills)

A large majority of respondents—84 %—rather agree with the robot supporting the interaction between therapist and child, instead of replacing the therapist. Most respondents (84 %) also think that it is ethically acceptable that social robots are used to monitor the progress of the child and help in the diagnosis. But what is the most acceptable appearance of the robot for these purposes? We asked about robots that look like humans, animals, objects, and imaginary creatures. Most respondents (74 %) think it is ethically acceptable to make social robots that look like animals (Fig. 4).

Using social robots that look like objects (66 %) and imaginary objects (63 %) seems slightly less accepted, but still a large majority does not have a particular ethical problem with it. A human shape, by contrast, is perceived as more ethically problematic: in this case only 55 % thinks they are ethically acceptable; 16 % disagrees and 5 % strongly disagrees.

Furthermore, our respondents seemed to worry that children will see the robot as a friend (only 43 % thinks it is ethically acceptable) (Fig. 5) and that children will become attached to the robot (only 40 % thinks this is ethically acceptable).

Finally, for most respondents data protection was not a big issue. For example, about 78 % think it is ethically acceptable that the robot records and stores information when it interacts with the child. Only 6 % think it is a problem—they disagree and think it is not acceptable.

Discussion and Limitations

Discussion

In general, it turns out that key stakeholders find it acceptable to use social robots in healthcare and for therapy for children with autism. Perhaps part of the difference

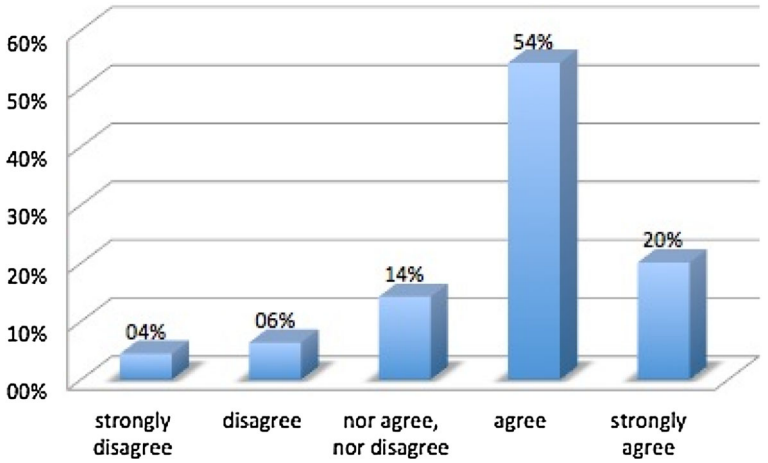

Fig. 4 It is ethically acceptable to make social robots that look like animals

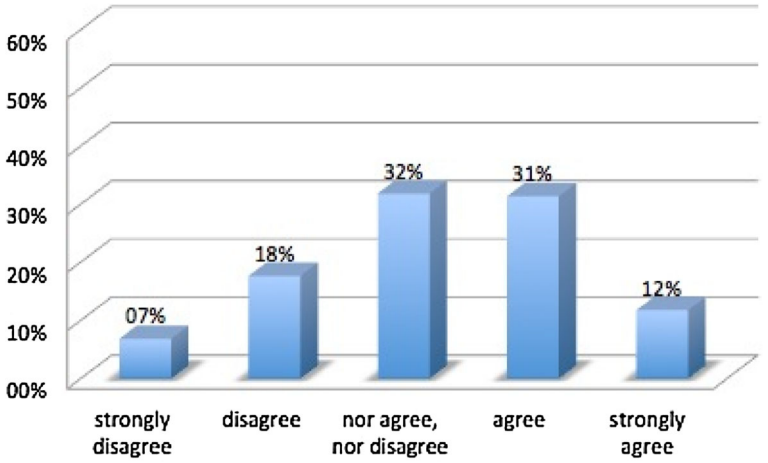

Fig. 5 It is ethically acceptable that, as a result of their therapy, children with autism perceive social robots as friends

with the Eurobarometer results is due to our choice to explain in a video the concept of a social robot. But in general the likely reasoning for this acceptance, if any, is that people agree to the design and use of these robots if they are beneficial to a therapy. There is a relatively high demand in the autism community for trying new therapies, including therapies that involve robots. Moreover, ASD therapy is costly and time consuming (Roberts 2003), so therapists may want assistance from a robot.

However, our respondents are far more hesitant about the idea that these robots would replace therapists; most participants seem to rather think that if they are used at all, robots should support the interaction between therapist and child and monitor

the progress of the therapy, *without replacing the therapist.* Based on our ethical discussion, we speculate that the reason for this could be that therapy, like health care in general, is seen as a "human" activity and practice in which humans should retain the role of the therapist. Robots could be part of the therapeutic process, but not *as therapists.*

This is an important message for the ethical discussion about robot-assisted therapy and for therapist and researchers using and designing social robots. These results suggest that therapists should conduct their therapy and research in such a way that (perceived) replacement or displacement of the therapist is avoided and support the idea of giving the robot—at most—what we in the FP7 project DREAM[11] call *supervised* autonomy (Thill et al. 2012). The robot is then capable of some autonomous behaviours and interaction, but the therapist remains in the room and supervises and—if necessary—intervenes in the child–robot interaction.

Some respondents are also worried about the possibility that the robot is perceived by the child as a friend, or that the robot looks too human-like; they are generally more positive about robots that look like animals. They even seem to prefer the animal-shaped ones over object-shaped ones or imaginary creatures, expressing perhaps the hope that animal-shaped robots will be better at performing a social, interactive function in the therapeutic process. Maybe parents and therapists do not want children to see the robot as a human or a friend because they worry that the robot would replace human–human relationships (see also again the replacement issue). Animals may then be a "safe" choice since generally we do not seem to worry too much about human–pet relationships replacing human–human relationships. Our respondents also worry that the child might become attached to the robot and see the robot as a friend. The additional reason for this worry may be that people think that if the child becomes too attached to the robot, this then causes distress when the robot is no longer present. This result presents a challenge to those roboticists who develop robots that look like humans in ASD therapy.

In general, however, the responses to the other questions suggest that most stakeholders approve of using social robots in autism therapy, for example to learn social behaviours, and therefore (we may suppose) they approve of developing this kind of robot.

Finally, privacy and data protection was not seen as major ethical issue, or at least most respondents agreed with the robot collecting and storing data during the therapy. This does not mean that this privacy and data protection do not deserve our attention in this context and the 6 % minority should not be ignored. Privacy is an important ethical issue in robot ethics in general (see for instance Calo 2010) and as we said in our discussion RAT raises ethical issues concerning access to information, storage of data, etc. Moreover, this result may also be due to the fact that many people are not aware that this kind of research and therapy raises privacy issues at all; they may not know that this information can also be used for other purposes. But the replacement issue and the question regarding the appearance of the robot seemed to elicit more ethical concern. The reason for this may be that

[11] More information is available at http://dream2020.eu/.

generally people do not associate robots with privacy problems (in contrast to computers, for instance).

These results are important for at least the following target groups of this article: designers of robots for RAT and therapists who use RAT. While our data do not suggest in any way that research and use of robots in ASD therapy is unethical, both groups need to take into account the ethical issues indicated by the ethical analysis and the survey. Specifically, our results suggest that particular attention needs to be given to the issues of replacement, appearance, and attachment, since these are key issues that emerged from the research: key issues that emerged from the ethical analysis and key issues that seemed problematic in the opinion of stakeholders. Furthermore, we hope that ethicists working in other fields of human–robot interaction may find these results helpful. It is clear that there are many similarities and convergences when it comes to ethical issues; the challenge is now to better understand them conceptually (the deception issue for instance is rather complex) and to draw implications for design and use in practice.

Limitations and Further Remarks

Note, finally, that there are some limitations of this study. For instance, as this paper indicates there are many ethical questions, but we had to limit our scope: we have offered only a brief and preliminary overview of these questions and in our survey we have limited our survey to a selection of questions and rather general questions about RAT. More research is needed to expand the ethical analysis and to ask stakeholders more and more precise questions.

Furthermore, all surveys have their limitations as a research method and this particular survey has also specific issues which we need to make explicit. For instance, although we have shown a video to the participants in the survey, it is difficult to know their interpretation and imagination: while some respondents did have experience with this kind of therapy, most of them did not actually see how robot assisted therapy is conducted. Moreover, this survey was exploratory and selective with regard to stakeholders; it does not, and cannot, make a claim that it fully represents what stakeholders in Europe think about RAT. Furthermore, we did not yet analyse how specific types of stakeholders think about RAT (e.g. parents, caregivers, students, others), we did not specifically ask people with ASD (e.g. adults and younger people with ASD, high functioning and other people with ASD), and we do not have details about the participants' experience with robots.

The latter is an important limitation of our study, which has only general information about experience of participants: almost 40 % of our participants had previous experience with robots. More detailed information would require a new study and other research methods such as in-depth interviews. However, we can say something more about the relation between experience and acceptance since we calculated correlations between experience with robots and ethical acceptability. For the acceptability of use of the therapeutic robots, the analysis of variance revealed a significant difference between groups with different levels of experience with robots, $F(2, 198) = 8.85$, at $p < .01$ Posthoc analysis using the Sheffe posthoc criterion for significance indicated that the group with specific experience with

robots manifested a higher level of acceptability for use (M = 4.40, Sd = .50) compared to the group with no experience with robots (M = 3.81, Sd = .76) and the mean difference MD = 2.93 was significant, $p = .00$, with a high effect size (d = .905) This suggests that giving people more information about RAT and increasing exposure to robots may increase acceptance.

More research is needed to explore (co)relations between experience and opinion of participants, and to ask further questions: what kind of information needs to be provided to the participants to give them better knowledge of what these kinds of robots and this kind of therapy is, given that much of their knowledge may come from what is provided by the video and by the mass media? Our video was only to inform participants in the survey what we meant by a "social robot". But it is worth exploring how to better inform participants about what this kind of therapy is and does. Yet to give answers to the above questions, a questionnaire is not sufficient. As said, other methods are needed, such as in-depth interviews. In the present study we have chosen to conduct a broad survey covering different stakeholders related to autism and comparing these results with those of the Eurobarometer.

In addition, we acknowledge that it is a limitation of this study that we did not ask *children* with ASD about their experiences, perceptions, and preferences. However, this issue is more complex than one may think. On the one hand, it is important to respect the child's own opinion and desires with regard to the therapy. It seems clear to us that, in general, patients should be considered the central stakeholders of therapy, and responsible innovation with regard to RAT which includes taking their view into account. On the other hand, there were practical limitations in asking the children themselves about RAT: ASD children with impairments in communication have difficulties in responding to questions from the researchers and this is barrier for studying how children perceive the robots and what they might say about this kind of therapy (Peca et al. 2014). Many children with ASD perceive the world very differently and about 50 % have insufficient language for effective communication (Goodrich et al. 2012). We believe future research should try to overcome these barriers: we should try to investigate children's perceptions and preferences and this should influence the design and use of this type of robot.

Note also that people who answered this questionnaire did so voluntarily, so these people were already interested in this topic. We do not know what other people think. Also, it is worth mentioning that 85 % of respondents were female, including many female psychology students. Care of children with ASD (and indeed psychology) seems still mostly a concern of women. Does this introduce bias into the survey? Finally, there are some issues to be mentioned which concern our questions and questionnaire. For instance, some respondents may have thought we asked too many questions—including questions that seem to measure the same thing—and for some people the questions might have been too difficult. Moreover, use of the word "it" or "he" when referring to robots may matter for the perception of robots and ethics of RAT (see also Coeckelbergh 2011b). Consider these questions: "It is ethically acceptable that information is recorded and stored by a robot when it interacts with a child with autism" versus "Social robots can provoke that children

with autism will touch the robot e.g.: hug the robot, touch his hands, head etc." Such limitations and problems need to be addressed in further research.

In spite of these limitations, however, we hope this identification of ethical issues and this exploratory survey has contributed to ongoing efforts to ensure that robot assisted therapy is conducted in an ethical manner and that technological innovation in this area is done in an ethically and socially responsible way, taking into account the views of key stakeholders in the autism and autism therapy community. Our ethical discussion together with our survey give some rather clear normative directions for RAT ASD therapy; of course it is then up to designers, researchers, therapists, and other RAT stakeholders to address the issues in their practices, and this is only one tool we offer.

We also hope that the results may stimulate further discussion about the ethics of human–robot interaction. Many of the issues discussed in this article are also relevant in other domains of technology and practice, and the knowledge gaps that need to be addressed are also similar. For instance, the present ethical discussions about RAT indicate that more work is needed on the ethical and practical implications of how humans perceive robots, and on how more autonomous technologies (may) influence human development and relationships.

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