Development of Robot-enhanced Therapy for Children with Autism Spectrum Disorders

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DREAM

Development of Robot-enhanced Therapy for Children with Autism Spectrum Disorders

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D7.2.1 Ethics white book for child-robot interaction for children with ASD

Preliminary Discussion Document

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I Executive Summary

Deliverable D7.2.1 An Ethics White Book for Child-Robot Interaction for Children with Autism Spectrum Disorders (ASD) is a preliminary deliverable version produced by M24 and serves mainly as a consortium-internal discussion document, and as such at this point reflects the current state of the discussion, as perceived and formulated by the principal contributors, rather than a consortium-wide consensus. The final version of this deliverable will be produced by M36.

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IV Ethical Issues in Child-Robot Interaction

Rationale for using robots for helping children with autism

Autism Spectrum Disorder (ASD) is characterized by widespread abnormalities in social interactions and communication, as well as severely restricted interests and highly repetitive behaviour (American Psychiatric Association 2013). The diagnostic criteria for ASD included in the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) (American Psychiatric Association, 2013), refer to ASD as a single diagnosis category that includes autistic disorder (autism), Asperger's disorder, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified (APA 2013). Autism is a very specific difference in the ability to read social cues, understand social interaction and respond appropriately. In general terms, the level of cognitive ability, intelligence, perception, use of language, degree of withdrawal, excitability, self-injury and physical appearance will vary greatly in autistic persons (Trevarthen et al., 1996 p. 3).

According to the Centers for Disease Control and Prevention (CDC), ASD occur 1 in 68 children and is almost five times more common among boys than girls: 1 in 42 boys versus 1 in 189 girls. While autism affects more males than females new research has begun to look at the gender bias in the testing procedures for autism, such as the Autism Diagnostic Observation Schedule (ADOS) and highlight different ways that autism can become ignored in females, for instance through 'camouflaging' techniques. Females with autism for instance use gestures more frequently than males with autism (Rynkiewicz et al., 2016). ASD behaviours include, compulsions, echolalia and motor mannerisms such as hand flapping and body rocking (Matson and Rivet 2008). There is some debate on the 'primary impairment' in ASD. Kanner's original paper (1943) cited 'affective disturbance' as the primary impairment but today, the primary impairment is recognised to be cognitive, specifically in the social domain described as "theory of mind" or "mentalizing" (Leekam 2016).

Children (and adults) with ASD tend to prefer and gravitate towards things over and above other persons (Kanner 1943; Baron-Cohen 2002; Baron-Cohen and Wheelwright 1999; Baron-Cohen et al., 2002; Overskeid 2016). Baron-Cohen has termed these interests to be characteristic of *systemitising,* a drive to know and build systems (2002) The drive to systemize is assumed to explain central aspects of autistic behaviour (Overskeid 2016 p. 18). Moreover, autism researchers has proposed that autism is linked to biological markers, such as high levels of testosterone, and it is a sex based disorder of the Extreme Male Brain (EMB) (Auyeung et al., 2009). Roboticists have creatively used this understanding of autism from psychiatry and developed robots as autism therapies. Robots retain their objectlike status (something children with ASD prefer), with social like qualities (which the children find difficult to understand) and research has shown this is an effective way to engage children with ASD. The challenge and unique position of DREAM is to conduct the first major study, driven by clinical researchers at Babeş-Bolyai University (UBB), to explore the effectiveness of using robots for helping children with ASD develop social skills.

The robot NAO and children

Research shows the positive effects of using robots as educational and therapeutic tools (Peca et al., 2014; Scassellati 2007; Dautenhahn and Billard 2002; Pop et al., 2014). In DREAM, the robot platform NAO is used in the clinical experiments and these experiments are carried out in Cluj, Romania with the help of Asociația Autism Transilvania – Cluj. NAO is 58-cm tall, has 5-kg in weight and 25 degrees of freedom for movements. It is equipped with a rich array of sensors: 2 cameras, 4 microphones, sonar rangefinder, 2 IR emitters and receivers, 1 inertial board, 9 tactile sensors, and 8 pressure sensors. NAO has various communication devices including LED lights, two loud-speakers, a voice synthesizer with language-specific intonation and pronunciation. However, the Romanian voice is not yet available on the NAO platform so that a pre-recorded human voice with sound processing effects was used in these experiments (D2.1.1 p. 9). The robot has a simplified face (no nose, no ears, a small square shaped mouth), and two eyes that use LEDs. Though NAO acts in a very sophisticated manner through speaking and moving, the robot also retains its object-like properties. It is mechanical, and 'cute', like a small astronaut. Robots are very effective tools for working with young children, typically developing and children with ASD.

Three tasks have been identified as crucial to social interaction, communication and learning: turn-taking, joint attention, and imitation. Turn-taking involves reciprocal interaction with others and is necessary for collaborative learning (Ikegami and Iizuka 2007). Imitation is a vital human skill for social cognition, and helps support interactions with others, speech and language and cognitive development (Ingersoll 2008; Tapus 2012). Joint attention is the ability to attend to objects in the same space and is enacted through pointing or gaze gestures (Charman 2003).

The turn-taking task is a game and the child interacts with NAO via a Sandtray platform developed by Plymouth University (D2.1.1 p 9). The sandtray platform is drawn from the 'sandbox' and is used to help encourage collaborative playing and storytelling (Baxter, Wood and Belpaeme 2012). Robot and child can play a game by selecting the relevant objects on screen and assigning it to a relevant category. During the turn-taking task on the screen appears an emotional expression (either sad or happy) and the child has to match this facial expression with one of the categories from the left or right of the screen (the sadness category or the happiness category) (D2.1.2 p. 7)

The *JA task* consisted in the interactional partner using one of the following methods: gazing; gazing and pointing; gazing, pointing and vocalizing at different objects in order to induce JA responses. Two different objects are placed on the table that sits in front of the child (D2.1.2 p. 7).

The *imitation task* consists of four different parts. The first part is represented by functional imitation with objects, and there are 4 different movements and sounds that the child has to imitate: moving a car, drinking from a cup, moving a plane and smelling a flower. The second part of the imitation task is the symbolic imitation with objects, which has the same four movements as the functional imitation task, only that this time instead of the real objects the child and his interactional partner use a wood cylinder pretending that it is a real object. The third part of this task is imitation without objects and it consists in four types of arms movements that are accompanied by sounds. The last part of the imitation task consisted in imitating four basic emotions: happiness, sadness, fear and anger. The emotions were illustrated by using hand gestures, head movements and sounds (D2.1.2 p8).

Methodology

This document is a preliminary discussion document and was primarily prepared as a library based conceptual document, supported by participant observation of the robot therapy research and informal interviews with DREAM researchers in 2015. This document does not reflect a consensus among consortium members and is prepared primarily by the principal contributors in the ethics team. The full version of D7.2 will be submitted in Month 36.

As the ethics WP we start from the well documented position that the introduction of a new technology *will* impact on its users and communities in ways that are predictable, and ways that are unpredictable. Ethical technologies must comply with relevant national, EU and international legislation and must also ensure a richer understanding of sciences' impacts on society, the user and other relevant stakeholders (Horizon2020). The role of this ethics WP is to meet the requirements laid down in the Description of Work on the one hand, but also to *present* new ethical issues to the DREAM consortium, exploring the legal, economic, social and human level effects of using robots in therapeutic practices.

There are some ***methodological difficulties*** in producing an ethics document for a project that includes clinical practice and psychiatry on the one hand, and robotics, engineering and computer science on the other. The ethics WP has to incorporate multiple perspectives and raise different kinds of questions. These questions sometimes invite the researchers to examine their normative assumptions, what they believe to be inherently true, or to join up the technological, clinical and cultural in new ways. This is also an issue for ethics researchers on EU projects, as we come from backgrounds in philosophy, anthropology or sociology, research fields that rely on different epistemological practices that are not based on the same experimental or data collection processes as engineering or psychiatry. The ethics of technology draws on fields in the social studies of science and technology and the philosophy and anthropology of technology (Turkle 1984, 2007, 2011; Coeckelberg 2010, 2012; Lin, Abey and Bekey 2011, Richardson 2015). Moreover, in the last decade a specialised field entirely dedicated to ethics in machines and robots has grown out of philosophy (Anderson and Anderson 2011; Wallach and 2010; Lin, Abney and Bekey 2011; Malle 2015; Coeckelbergh 2010).

As ethics in WP7 is an iterative and dialogical process that runs parallel to the clinical specialists and engineers, we are learning the differences between our respective fields. We are also involved in collaborative learning practices. DREAM consortium engineers would like ethics WP7 to have a clearer practical input in the development of the development of the robot, and to translate *conceptual ideas* into practical support. One of the criticisms of ethics was:

> 'When I read ethics related papers they mostly only come with questions, but seldom answer how we can improve the technology so it is implemented or behaves more ethically'.

In WP7 we take this request seriously and will engage more directly with DREAM engineers for Deliverable D7.3 (Implementation of ethical constraints in the cognitive controller of the robot), and develop a self-monitoring subsystem (Task 6.5). How do we as ethicists help to create an ethical robot rather than continually taking a reflexive and conceptual stance in relation to robotics? We believe it is necessary to develop the conceptual work in addition to the practical support we can provide to the researchers in developing an ethical robot. At the end of this deliverable we begin to present some ways that we can do this more concretely.

The preliminary deliverable is intended to encourage discussion about two interlocking issues:

1. *The child perceives the robot as autonomous, though it is not* (it is controlled by Wizard of Oz).

The Wizard of Oz (hereafter WoZ) involves a hidden robot controller and is a study design used extensively in autism and robotic experiments (Hoysniemi and Read 2005).

2. *What is the experience of the child with autism to the robot as an anthropomorphic object*?

We address these issues through the following headings:

-Social context of ethical acceptability of robots in autism therapy
- Ethical issues associated with child-robot interaction
- "Autonomy" in DREAM
- Will the robot's increased autonomy impact on the attachment behaviours of the child with ASD to the robot?
- If a robot has some degree of autonomy is this still an ethically neutral issue?
- Do children with ASD experience the uncanny valley?
- Is the child 'deceived' in the Wizard of Oz scenario?
- Do children with ASD anthropomorphise the 'anthropomorphic' robot?
- Ethical systems for a robot

Social context of ethical acceptability of robots in autism therapy

While robots in autism therapy hold out promising results for clinical service provision of autism, Europeans hold complex and divergent views on the use of robots for helping care or support the elderly or children with special needs. A European barometer of 2012 reported the following findings "Robots should not be used to care for people – EU citizens also have well-defined views about the areas where robots should be banned. Views are most emphatic when it comes to the care of children, elderly people and people with disabilities, 60% of EU citizens saying that this is an area where robots should be banned" (2012 p. 11). European citizens make a distinction between robots that are developed for impersonalised forms of work, and "care" work, activities that require an affective component. A barometer published in 2015 found European attitudes to robots had softened significantly on the 2012 survey. Important findings were:

> Eight in ten Europeans (82%) who use robots think well of them, while nine in ten (90%) among them would purchase one.

> 74% of young Europeans have a positive view of robots and 72% of all Europeans (77% of young people) believe robots are good for society because they help people.
> A fifth of respondents (20%) say that they would consider having a robot at home. One in ten (10%) could get one within the next five years (EU Barometer, 2015).

Robots are perhaps more controversial than other technologies in healthcare (telecare, ICT, social networking, not to say these technologies are free of controversy) because of their prior and parallel status in popular culture. Robots are not merely objects of the laboratory, but of screen fictions and literary tales (Richardson 2015; Reilly 2011; Reichardt 1978; Breazeal 2002). For Europeans and North Americans, robots are not neutral cultural objects but are presented in popular culture as threatening and disturbing (Richardson 2015). These disturbing perceptions of robots are not helped by recent surveys that suggest robots and automation could put half of the world's population out of work (Yuhas 2016). Moreover, commercial robots are developed and sold with minimal, if any, ethical considerations (Reik and Howard 2014). There are also issues with therapy and the introduction of mechanical agents to replace aspects of trained psychotherapeutic practices These concerns were raised by Josef Weizenbaum, an MIT computer scientist who created the program DOCTOR, a script based on a simulation of a Rogerian psychotherapist (1976). Ethical principles are central to the philosophical design and technical production of robots (Lin, Abney and Bekey 2011: Wallach and Allen 2010).

The growth of robotics and the widespread importance attributed to creating 'ethical robots' has lead researchers in Human Robot Interaction (HRI) to develop codes of ethics more widely. One such example is provided by Riek and Howard (2014) who took up the challenge to design a code of ethics for the human-robot interaction profession and these include:

> **Human Dignity Considerations** (e.g., the emotional needs of humans are always respected), **Design Considerations** (e.g., maximal, reasonable transparency in the programming of robotic systems is required. Or Obvious opt-out mechanisms (kill switches) are required to the greatest extent consistent with reasonable design objectives) and **Legal Considerations** (e.g., all relevant laws and regulations concerning individuals' rights and protections).

Riek and Howard also propose social issues to consider in the ethics of HRI these: '**Social Considerations** [are]…Wizard-of-Oz should be employed as judiciously and carefully as possible, and should aim to avoid Turing deceptions…The tendency for humans to form attachments to and anthropomorphize robots should be carefully considered during design…Humanoid morphology and functionality is permitted only to the extent necessary for the achievement of reasonable design objectives….Avoid racist, sexist, and ableist morphologies and behaviors in robot design' (2014 p. 6).

We presented similar recommendations at the end of Deliverable D7.1 Robot Ethics Manual. For DREAM, (physical) Design Considerations, are relevant to the project for two reasons, while NAO is the physical platform, in WP4 (Task 6.1 Reactive subsystem) will develop eye blinking for the robot, we can inform the design by inviting WP4 researchers to reflect on the way they will develop the new features of the robot. Moreover, as stated in the

DoW, Probo is also used to conduct experiments. Probo's morphological features are developing. Probo is popular robot with children with autism, and in a study by Peca et al., (2014), Probo was the most preferred robot for children with ASD. DREAM can build on these design insights for developing effective robots for children with ASD. Legal Considerations have been discussed in the Robot Ethics Manual, but we reiterate the most important ones here about child's information to be secured at all times and to consider privacy and data protection as an integral research objective. We believe the Human Dignity Considerations are embedded in the DoW, and in the experimental process guided by expert clinical professionals (UBB) who draw on the National Institute for Clinical Excellence (NICE) guidelines and the American Psychiatry Association (APA) guidelines on ethics. The Social Considerations are relevant to DREAM research and are in parity with results of a DREAM survey of stakeholder attitudes towards robots as therapeutic agents for children with autism (Cockelbergh, et al., 2015). One important finding in DREAM's survey was the positive acceptability of robots for helping children with autism compared with the negative feedback given in the EU Barometer (2012).

The DREAM survey included responses from parents of children with ASD (22%), and therapists or teachers of children with ASD (16%), the rest of the cohort was made up of students of ASD or people involved in organisations. Questions presented to the stakeholders were wide ranging and included the following

'Is it ethically acceptable that social robots are used in therapy for children with autism?' Of which the majority of interview respondents agree (48%) and strongly agree (37%).

'Is it ethically acceptable to use social robots that replace therapists for teaching skills to children with autism?'
With only 18% (agree) and 08% (strongly agree).

The DREAM survey indicated the importance of stakeholder involvement in the process, focused around specific healthcare issues. Moreover the findings indicated three ethical themes of high importance for the survey participants, these are 'replacement, appearance and attachment' (p. 12). We examine these issues through specific problems raised by the ethics of child-robot interaction.

Ethical issues associated with child-robot interaction

Research exploring the therapeutic benefits of robots (humanoid and nonhumanoid) for helping children with autism develop social skills has increased significantly over the last fifteen years (Dautenhahn 2000; Dautenhahn and Billard 2002; Dautenhahn et al., 2003; Dautenhahn and Werry 2004; Diehl et al., 2012; Hoysniemi and Read 2005; Thill et al., 2012; Vanderborght et al., 2012; Tapus et al., 2012; Pop et al., 2013; Coeckelbergh et al., 2015; Costescu et al., 2014; Pop, Pintea, Vanderborght & David 2014). The use of robots as therapeutic tools for children with autism is inspired by a number of factors summarized here:

> The clinical use of interactive robots is a promising development in light of research showing that individuals with ASD: (a) exhibit strengths in understanding the physical (object-related) world and relative weaknesses in understanding the social world… (b)

> are more responsive to feedback, even social feedback, when administered via technology rather than a human,…and (c) are more intrinsically interested in treatment when it involves electronic or robotic components (cited in Diehl, Schmitt, and Crowell 2011, p. 2).

Robots have been shown to be beneficial in the following areas, from acting as tools for helping children with autism learn social skills through the use of social stories (Vanderborght et al., 2012), helping children to recognise emotions (Pop et al., 2013), enhancing play skills using social robots (Pop, Pintea, Vanderborght & David 2014) and social imitation skills (Tapus, Peca, Aly, Pop, Jisa, Pintea, Rusu, and David 2012). If robots are singled out as special case objects, we have to consider what underlies the process of increasing children's with ASD performances and engagement when interacting with humanoid robots? Researchers in the US give the following as an explanation:

> Perhaps the simplified social cues that robots present result in less overstimulation of the children; perhaps robots offer more predictable and reliable responses than those from a human partner with ever-changing social needs; perhaps robots trigger social responses without the learned negative associations that some children have with human-human interactions; and perhaps the exaggerated social prompts that robots provide are better triggers for social behavior than the nuanced and subtle social prompts from a human partner (2012, p. 292).

Put simply, the robot provides a tool to deliver social cues via an object-like form and these can be organised into three categories of robot-inspired therapy: Robotherapist, Robomediator, and Roboassistant. In the three conditions, the robot takes on different roles in conjunction with specific therapeutic practices (David, Matu and David 2014). The authors propose Robotherapy as a useful way to extend and build on previous autism-robotics research. Robotherapy allows the robot to take on more therapeutic roles, recording data and carrying out therapy for temporary periods (ibid p. 194). Developing robot-enhanced therapy is the DREAM goal. Researchers in the interface of autism and robotics, take something the child prefers, namely objects, and uses these objects as a way to impart social information to the child with the expectation of generalized social learning. Results have demonstrated that social information can be imparted to a child via robots that are imaginative constructions (Keepon or Probo), or zoomorphic (AIBO, Pleo) or a mixture of the two (Probo which resembles something in between an elephant and a phantasmagorical creature) and humanoid (NAO, KASPAR). Anthropomorphic and anthropomorphism are two interrelated terms. *Anthropomorphic* refers the morphological resemblance as well as other forms of behavioural resemblance to a human. Anthropomorphic morphology provides a visible and direct means of deciding if an object is physically 'humanlike' or not. Anthropomorphic also refers to humanlike behaviours, speech and language or emotional or cognitive signalling, that are similar to humans, but may not present in a humanoid form. For example, in cartoons, train engines can have human faces that express emotions and speak (Baron-Cohen et al., 2007). *Anthropomorphism*, by contrast is the *attribution* of humanlike characteristics to nonhuman animals and things regardless if they are human or not. As NAO's appearance and behaviours are humanlike it is not merely a question of *attribution*, the object behaves as though it was humanlike. Ziemke, Thill and Vernon (2015) have written about this as a 'double-edged sword' because intentionality is connected to the embodied form. NAO is mimicking human behaviour (though it is controlled via WoZ), it is not merely attributed to it by a child with ASD or other naïve spectator. This is why robots have the capacity to make us reflect on the ontological (the nature of being and existence) status of what it means to be human. If robots become more autonomous, do they open up new ways of understanding what is animate? As robots acquire more autonomy, so these questions become more important. This is perhaps why studies have suggested:

> robots occupy a special niche between inanimate toys (which do not elicit novel social behaviours) and animate social beings (which can be a source of confusion and distress to children with autism) (Scassellati, Admoni, and Mataric 2012 p. 276).

Robots are liminal objects and are of fiction as well as technology (Breazeal 2002, Levy 2009, Richardson 2015, Turkle 2011). Robots such as NAO, take on the appearance and roles of a human, in this case the therapeutic activities of the therapist (David, Matu and David 2014). Moreover will increased robot therapy displace human therapists? How will psychiatry and psychotherapy change as a result of increased automation? The introduction of robots in therapeutic contexts changes the role of the therapist, the treatment offered and the effects of that treatment on children directly, and their family. On the plus side, the robots can add enjoyment to the child-focused therapy session, and also record important information, that has to be collected and analysed later, often via video-taped recordings, or notes. A robot with sensing and interpreting capabilities could support therapeutic goals. On the downside, a robot that has the capacity to record information could be hacked and personal data stolen. In the DREAM survey, 78% of interview respondents think it is ethically acceptable that a robot records and stores information when it interacts with a child (Coeckelbergh et al., 2015, p. 51). Interview respondents in the DREAM study (Coeckelbergh, et al., 2015, p. 51) preferred to support the use of robots in autism therapy if the robot was supervised in a therapeutic encounter. Full autonomy of the robot was not considered desirable by the interview respondents, preferring instead a 'human is in the loop'. This is a theme that has been incorporated into the goals of the DREAM team who are developing *supervised autonomy* (Thill et al. 2013).

The humanoid robot in the therapeutic context provides a means through which object-like properties can be fused with social-like properties (speech, language, imitation, turn-taking, joint attention) in a humanoid robot. Do we need to consider the reverse possibility? Is it possible that objects with humanlike properties become uncomfortable for the children? Here we are not addressing the issue of whether children spontaneously enjoy interacting with robots, but more their unintended effects. Children with autism display deficits in ToM, imaginative thinking, speech and language and reflective thought and communication (Craig and Baron-Cohen 1999). What will be the long term effects of interacting with these objects?

"Autonomy" in DREAM

The ethics team requested clarification of the working definition of autonomy in the DREAM project. Experts in the field agree there is no commonly accepted definition of autonomy in the AI or cognitive sciences (Frose et al., 2007 p. 455; Vernon 2014). Autonomy of a robot implies some degree of freedom from its human controller (Frose et al., 2007). Autonomy may be set on a *continuum* with autonomy at one end, and heteronomy (its antinomy) on the other. Or as a *spectrum* that includes different kinds of self-determination of a system: autonomy, supervised autonomy, or behavioural autonomy operating in the same system.

One such definition of autonomy is given here:

> Autonomy can be defined as the degree of self-determination of a system, i.e. the degree to which a system's behaviour is not determined by the environment and, thus, the degree to which a system determines its own goals. Implicit in this definition is the notion that, in addition to selecting its goals, the agent can then choose how best to achieve them and that it can then act to do so. A system might have different degrees of autonomy with respect to the determination of goals and their achievement (Vernon 2016).

Behavioural autonomy represents a form of autonomy that is behaviour led. In DREAM behavioural autonomy and not constitutive autonomy (which addresses the organisational characteristics that allow it to maintain itself as an autonomous entity) is considered (Froese et al. 2007). Behavioural autonomy can be characterized by at least two distinct attributes: (a) the degree of autonomy (i.e. the extent to which a system is assisted by a human in the achievement of its goals and the execution of its behaviour), and (b) the strength of autonomy (i.e. the extent to which a system can deal with uncertainty or unpredictability in any aspect of achieving its goals). There is a continuous spectrum of both degree and strength. The type of autonomy DREAM is developing is *supervised autonomy*. The term supervised autonomy means 'that the therapist can take control at any time. This happens whenever (a) the therapy requires, i.e. after each episode in the therapeutic intervention, (b) the therapist requires, i.e. when she or he decides to take charge of the session, or (c) the robot requires, i.e. when it reaches some impasse or there is an (ethical) alarm. For this reason, supervised autonomy is sometimes referred to as episodic autonomy' (DREAM DOW p. 3).

The robot is envisioned to take on some therapeutic tasks of the therapists, Robot-enhanced therapy (RET), such as engaging the child in turn-taking, imitation or joint attention activities. In DREAM, effective child-robot social interactions in supervised autonomy RET requires the robot to be able to infer the psychological disposition of the child (DOW). NAO's functionalities do not extend to supervised autonomy. At present, the robot is controlled via WoZ and relies on a third party controller. Moving the robot to a supervised autonomous mode will take place in the future stages of the project and an important objective of DREAM is to replace the conventional WoZ set up to RET to reduce the burden on the therapist and reduce costs (David, Matu and David 2014). In developing a Cognitive Controller, the robot will be able to interpret situations or data. The controller will be *active* rather than *reactive* like Breazeal's Kismet robot system (Breazeal 2002).

Will the robot's increased autonomy impact on the attachment behaviours of the child with ASD to the robot?

We introduce the topic of *attachment* as it provides an important field to reflect on the development of robots for children with autism. Moreover, interview respondents in the DREAM survey (Coeckelbergh et al., 2015) were concerned about the child becoming too attached to the robot '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' (ibid, p. 50). When survey respondents were asked 'it is ethically acceptable that, as a result of their therapy, children with autism perceive social robots as friends? 12% of respondents strongly agree, 31% agree, but 32% neither agree nor disagree, making this an area that requires more investigation.

Moreover, is the term *attachment* an appropriate concept to apply to children with ASD? Or are other terms more appropriate? Attachment has two meanings that need to be described. The first is meaning is about the relationship between caregiver and child described through Attachment Theory (Bowlby 1978) and developmental psychology (Vygotsky 1986; Reis 2013; Dykas and Cassidy 2013; Liszkowski 2006). The second meaning of attachment is drawn from the verb 'attach' and includes the following: 1. Fasten, affix, join 2. Be very fond of or devoted to, 3. Attribute, assign (some function, quality or characteristic) 4. Include; cause to form part of a thing' (OED 1995, p. 79). Attachment theory is controversial in autism studies because for many years autism was blamed on parenting styles (Bettelheim 1967). Evidence now conclusively points to autism as a neurodevelopmental disorder (DSM-5), there is no substance to the idea that parents cause autism in their children. Some robotics researchers propose the former idea 'attachment' as necessary for developing social robots and explicitly draw on infant-caregiver relations (Canamero, Blanchard and Nadel 2006; Breazeal 2002; Richardson 2015). Belpaeme et al., (2012) take a positive stance on attachment by supporting the formation of child robot social bonds in specific contexts, such as when children are in hospital. We may then describe attachment as a developmental process between child and caregiver on the one hand, and attachment between human and inanimate objects (robots) on the other. Children routinely form all kinds of attachments to objects, such as dolls, cars, trains or blankets. Turkle (1984) included robots as the 'transitional objects' like the ones describes by Winnicott (1953). Winnicott saw the role of 'transitional objects' as playing a role in helping a child to develop a sense of agency over human relations via their objects. Turkle (1984), who has extensively studied children's interactions with technological objects writes about three stages in a child's relationship with computers:

> First there is a 'metaphysical' stage: when very young children meet computers they are concerned with whether the machines think, feel, are alive. Older children, from age seven or eight are less concerned with speculating about the nature of the world than with mastering it…In adolescence, experience is polarized around the question of identity, and the child's relation to the computer takes on a third character (1984, p. 9).

Turkle's study of children and adolescents explored typically developing children and demonstrates the child's complex engagements with video games. As children developed, so did their attitudes and beliefs about the technologies they interacted with. The meaning of the technological object also changed in line with the developing child's preoccupations and priorities. Conceptual development is part of typical childhood development (Carey 1985; Vygotsky 1986). What do we know about autism attachment patterns? Children with autism display a preference for interacting with objects in the physical world, particularly objects that are safe and predictable (Golan et al., 2010, Baron-Cohen et al., 2007), restrict their play to a limited set of objects, and show deficits in symbolic play (Naber et al., 2008; Honey 2007). This may mean children with ASD prefer to interact with objects than with other persons, but does it mean they form attachments to these objects? What is happening between robot and child is a central ethical issue. We decided to follow the ways the child interacts with the robots, and to keep the distinction between ascribed agency, and actual agency the child might attribute to the object. We may also, at times, make this distinction explicit. This is something we will continue to explore in the ethics WP engagements with parents and clinical specialists.

If a robot has some degree of autonomy is this still an ethically neutral issue?

Humans attribute anthropomorphic qualities to nonhuman objects, such as see faces in clouds (Guthrie 2015), or form emotional connections to technology (Turkle 2011). The propensity of humans to attribute social meanings to things is well documented in robotics (Scassellati 2002; Mori 2012; Levy 2009; Richardson 2015).

Mashiro Mori's well known 'uncanny valley' hypothesis refers to the term 'uncanny'. What is the uncanny? The uncanny, in part means 'resemblance' something that resembles something other, it also refers to an 'eerie' feeling. The 'uncanny valley' remains a controversial hypothesis in robotics. Mori drew two axes, one for appearance, and one for behaviour. He argued that if behaviour (for example a very lifelike robot) does not correspond with appearance, this would put the object in the valley (Mori, MacDorman and Kageki 2012). MacDorman (2006) studied how people responded to different robot forms. He found people did find human likeness to be strange or eerie, but this depended on what else the robot was doing (its motion) and by moderating the robot's motion, the 'uncanniness' of the robot impact on the viewer could be reduced. Humanlike robots can appear more capable than they are when operating autonomously or through 'deception' about the robot's agency (Kory-Westlund and Breazeal 2015) and this attribution of intentionality is supported by the particular embodied form (Ziemke, Thill and Vernon 2015). The WoZ set up can present the robot as very capable to a naïve onlooker and invites curiosity about how it works in the way it does. It may also present robotics to the public at a more advanced stage than it currently is technically. The ethics of WoZ is used widely in the robotics community, and current studies have begun to think it from the perspective and experience of the child (Kory-Westlund and Breazeal 2016, 2015, Kory-Westlund and Kleinberger 2014).

We might also consider another theme here and that is animism. *Animism* is the attribution of life to the non-living (Guthrie 2015). When an object moves in a certain way, it looks 'alive' even though we know it is not. Animistic language may be used in the tech community quite innocently. For example, roboticists may use animistic language in their manuals. Breathing is a term used in computer gaming to give characters the appearance of life. In Aldebaran robotics documentation on NAO, the term 'breathing' is used. Breathing refers to a biological process of intaking and exhaling of air and is connected to life. Here is an excerpt from Aldebaran documentation:

> Idle control modes

- **Breathing control:** in this mode, the robot plays a breathing animation in loop.
  Breath configuration
  Breathing animation can be activated on the following chains: “Body”, “Legs”, “Arms”, “LArm”, “RArm” and “Head”. The animation only works when the robot is standing.
  The breath task can be configured by setting two parameters:
- ‘Bpm’: The breathing frequency, in beats per minute, between 5 and 30.
- ‘Amplitude’: The animation amplitude, unit free value between 0 and 1. 0 corresponds to a minimal animation, where all joints move of at most 5 degrees.
  The default breathing configuration is: [['Bpm', 12], ['Amplitude', 0.5]]

The ‘breathing’ mode is to give the robot (or video game animation) a sense of ‘aliveness’ when it is not in operational mode. This can create a feeling in the observer that NAO is animate. Animate has two definitional meanings, one is ‘to give life to’, the other is to simulate life. It is the latter that Alderabaran’s robotics is trying to achieve. The lifelike features are further developed by WP6 (Robot Behaviour) that include blinking as micro-expressions to aid interactive social-communication between the child with ASD and the robot.

Humans look for explanations about how things work. As children with ASD have a preference for *systematizing* (finding out how systems work, and their logical organisation), this is all the more important in the ways children with ASD make sense of their lives (Baron-Cohen 2003). However, it is not easy at first sight to know how NAO or other robots using the WoZ system works. Such an issue become more complicated once increased autonomy is introduced into the system.

In the field of robot ethics, philosophers suggest increasing robotic autonomy will encourage us to rethink ‘personhood’ (autonomous decision making, social-communicative interaction, intelligence) and may well transform our ontological categories of what is an intelligent agent (Lin 2012). Though these issues may at first sight seem outside the scope of child-robot interaction, we have to reflect on the fact that the robot is introduced to a young child with ASD. Increased autonomy (behavioural, or supervised) in robotics presents new kinds of ethical issues, as “autonomous” robots will have more tasks delegated to them to carry out acts independently rather than being controlled by an operator (Lin 2012). Implied in the term autonomy is a sense of independent agency so that the robot can make decisions about how it acts without direct human intervention. Increased autonomy has led to a series of discussions about appropriate ethical guidelines for robots. These include, ‘humans, not robots, are responsible agents and should obey laws humans have made. Robots are products, they should be designed using processes with assure their safety and security. Robots are manufactured artefacts’ (see EPSRC Principles of Robotics guidelines). However, robots are not looked upon merely as ‘products’ or ‘manufactured artefacts’ and (Breazeal 2002) invites us to consider robots as more than products and appliances even changing our concept of what is a living agent extending this to robotics machines (Brezeal 2002). While Belpaeme et al., (2012) describes the benefits of child-robot social bonding.

While whether or not a robot has some degree of autonomy is an ethically-neutral issue: it is the impact of that autonomy in the robot's interaction with children that is ethically-loaded.

In DREAM we clarified some issues regarding this and these include:

A robot is an inanimate artefact, irrespective of the degree of autonomy it has.

Humans have a predisposition to anthropomorphize inanimate objects, i.e. to ascribe agency to inanimate objects that have no intrinsic agency.

Do children with autism experience the uncanny valley?

Do children with autism experience the uncanny valley? The responses to this question indicate something about how a child with autism is seen. As it is natural for humans to have uncomfortable feelings around lifelike objects, robots, statues, automata – why would children with autism not experience this? This is an important ethical question as it could imply some attitude towards children with autism that is not helpful. The uncanny has been the subject of many research papers exploring if it exists (Brenton et al., 2005), and others (Chaminade and Cheng 2009) suggesting as a hypothesis it is difficult to prove one way or the other. Mori's advice to robotics designers was to keep the robot's appearance mechanical and NAO is a mechanical looking robot.

According to Scassellati (2007) and Robins, Dautenhan and Dubowski (2006) the experience of the uncanny is minimal in children with autism because they lack a ToM, and are more drawn to mechanical objects in preference over other persons. In another study conducted with 210 participants with ASD found results did not support the view that autistic individuals do not experience the uncanny valley (Jaramillo 2015). Gray and Wegner (2012) found evidence of the uncanny was produced when subjects were expected to think of something without a mind 'a computer' as having one. It was an ontological conflict that produced expressions of the uncanny. They also suggest more research is necessary and autism could hold the key to important questions about the mind and cognition.

In a study by Peca et al., (2014) preference for robots was investigated among typically developing children (TD) and children with ASD. The researchers found children in both groups had a preference for Keepon, a bright yellow cartoonish creation at 77%. The second preferred robot for TD children was Pleo, a dinosaur robot (68%) and for children with ASD the second preferred robot was Probo (62%). This indicates that children enjoy interacting with novel robot forms that more closely resemble their interests in cartoons or animals. The study also found KASPAR robot, the robot that looks the most humanlike to be the least preferred robot of both groups. The study did not conclude that KASPAR provoked the uncanny, but measured preferences of the children.

Is the child 'deceived' in the Wizard of Oz scenario?

In WoZ conditions, the robot is controlled by a third party, but is not seen by the child. To all intents and purposes the child *experiences* the robot has having autonomous capabilities. From a robotics point of view, the benefit to the robotics researchers and clinical psychotherapist would be to assess if the child's experience of the robot as autonomous positively improves their therapeutic encounter. But to what extent is the WoZ scenario more problematic that a clear operator of a robotic system? (Coeckelbergh 2012). In particular, more discussion about the long term effects on the child of the WoZ.

Recently researchers who have used the WoZ set up have begun to question the effects on the user and initiated experiments in this area (Kory-Westlund and Breazeal 2016; Reik 2012; Reik and Howard, 2014) and begun to reflect on the children's sense-making of robots in different modes of operation. Others (Martelaro 2016; Riek 2012; Reik and Howard 2014) have questioned the effectiveness of the WoZ scenario as a meaningful representation of a robot in autonomous mode.

As children with autism tend to display an interest in physical objects and mechanical things, some researchers Pop, Pintea, Vanderborght and David (2014) have proposed that informing the child of how the robot works will act as a distraction (p. 301-302). Dautenhahn and her colleagues at the University of Hertfordshire make efforts to show the children that KASPAR moves because of remote controlled devices (Dautenhahn et al. 2009). This is all the more important to discuss, as robot studies for children with autism have been primarily led by researchers outside the fields of autism studies and clinical psychology who use different protocols and experimental measures (Diehl, Schmitt, and Crowell 2011). This is the main motivation behind the DREAM project to let the clinical researchers direct the research.

WoZ operations have been described as 'the man behind the curtain' robotics (Scassellati, Admoni and Mataric 2012 p. 285). What information should be communicated to the child in the most appropriate forms to help the child understand the functionalities of the robot in a way that might be helpful for the child?

When conducting studies with psychiatric diagnosis the clinicians consider the APA code. Therefore, we consider the definition provided by APA guidelines for 'deception'. However, we have to accept there is deception in the sense of information is concealed from the child, but that this deception is clinically validated. The information is not concealed from the parents who are informed of this via the consent forms. We follow the American Psychiatric Association codes concerning 'Deception' and 'Debriefing':

Selection from the APA Code: 8.07 Deception in Research

(a) Psychologists do not conduct a study involving deception unless they have determined that the use of deceptive techniques is justified by the study's significant prospective scientific, educational or applied value and that effective nondeceptive alternative procedures are not feasible.

(b) Psychologists do not deceive prospective participants about research that is reasonably expected to cause physical pain or severe emotional distress.

(c) Psychologists explain any deception that is an integral feature of the design and conduct of an experiment to participants as early as is feasible, preferably at the conclusion of their participation, but no later than at the conclusion of the data collection, and permit participants to withdraw their data. (See also Standard 8.08, Debriefing.)

8.08 Debriefing
(a) Psychologists provide a prompt opportunity for participants to obtain appropriate information about the nature, results, and conclusions of the research, and they take reasonable steps to correct any misconceptions that participants may have of which the psychologists are aware.

(b) If scientific or humane values justify delaying or withholding this information, psychologists take reasonable measures to reduce the risk of harm.

(c) When psychologists become aware that research procedures have harmed a participant, they take reasonable steps to minimize the harm.

As the ethics team we agree that a certain level of deception in experiments can be helpful, but we advise the clinical team to take into account the other issues we consider in relation to deception.

Do children with autism anthropomorphise 'anthropomorphic' robots?

Robots in autism therapy show promising results, but can we be sure the child with autism is anthropomorphising the 'anthropomorphic' robot in a way that is socially useful? Anthropomorphism is attributing humanlike characteristic, traits, values, mental states to nonhuman animals and things. Anthropomorphic refers to the morphological resemblance of an entity to the human form. NAO is anthropomorphic, but is the child with autism recognising it as anthropomorphic? And is the child anthropomorphising the 'anthropomorphic' robot?

I introduce this topic by way of trying to understand what is happening from the child's perspective. And this question is not so easy to answer as evidence suggests that children with autism do not spontaneously anthropomorphise because they have primary difficulties in social and communicative interactions. Persons with autism look at the human face differently, and focus their gaze on the mouth, rather than the eyes of a person (Klin et al., 2003). In the case of autism, difficulties in attributing social qualities to human agents, also show deficits 'when reasoning about nonhuman agents' (Epley, Waytz and Cacioppo 2007 p. 867). Children with autism display marked impairments in facial recognition (Adolphs, Sears and Piven 2001), as well as a difficulty in matching the appropriate emotional experience with the expression (Golan et al., 2010).

Even autism expert Baron-Cohen speculates that children with autism may not recognise a human in quite the same way as a typically developing child, framing children with autism as 'mindblind' (Baron-Cohen 1990, 1997). However, while children with autism may not spontaneously anthropomorphise, they can, with adequate support learn how to do this. Novel studies, other than robots, such as the animation The Transporter Project, (designed by researchers at the Autism Research Centre, Cambridge) used objects that children with autism enjoyed interacting with (trains) and attached faces to these objects. The researchers of this study found increased recognition of appropriate facial behaviour and emotion after viewing the videos (Golan et al., 2009). While we cannot be certain of the child's experience, the positive results could open up new avenues of research, showing that in fact children with autism do anthropomorphise and respond to anthropomorphic figures as anthropomorphic as a response to the mindblind hypothesis. Alternatively, the attraction for children with autism to robots is these robots reinforce their interests (which can also be very helpful) in objects (Peca et al., 2014). These are important ethical issues to consider through the duration of the project.

Ethical systems for a robot

Programming**:** How do we begin to create an ethical robot? A robot as an interactive partner must have a concept of itself (a simulation of what it is) and a simulation of others and a simulation that is does not exist alone but is in relation to another. How do we start to encode this simulation of itself and other? Drawing on the work of Alan Winfield's 'Ethical Robot' we propose tying together the robot's actions with the human partner. He proposes:

An Ethical Rule

If for all robot actions, the human is equally safe
THEN (*default safe action *)
output safe robot actions
ELSE (* ethical action *)
output robot action for least unsafe human outcome

Winfield, Blum and Liu (2014) refers to this as a description of ASIMOV's first law of robotics 'A robot may not injure a human being or, through inaction, allow a human being to come to harm'. As our robot will be working with children we recommend this first law of robotics be implemented. This rule may be 'when a therapist is not present, do not activate'. We suspect the robot will be able to make some judgement of who is the therapist and who is the child based on height, or recognition software.

A safe word: As the robot is expected to develop supervised autonomous capabilities, the therapist should feel a sense of control over the robot, and may need to terminate its actions quickly. We recommend the use of a safe word to reduce direct contact with the robot, or to be able to terminate the robot's actions from a distance.

Language of the robot: How do we begin to implement an ethical language system in a robot? Aldeberan robotics have not programmed the Romanian language, so NAO uses a voice recording of a Romanian voice. In keeping with the constraints of the project, we suggest that specifically tailored therapeutic language be used by the robot, at a level and in tone and manner that is comforting and supportive and addresses the child's chronological or development age as appropriate. Emotional content can be communicated by the robot but it should not communicate any internal distress to the child to gain some action from the child e.g., 'I am hurt, can you help me?'

Behaviour of the robot – we suggest that all behaviours of the robot be developed within the boundaries of the experimental process, turn-taking, imitation and joint attention activities. Data and privacy protection inherent in the robot - the robot when sensing and interpreting information should ensure that data protection and privacy is alluded to at all times. For example, firewalls should be used to protect the data is transmitted over a wireless network.

Findings and recommendations

1. We explored the meaning of autonomy, supervised autonomy and the usefulness of the WoZ scenarios as enacted in the DREAM project.
2. We discussed WoZ and understand that psychologists use WoZ so they can test an interaction without the need to have the robot in an autonomous state. Informed by the clinical team, we agree that a degree of deception (or concealing information) from a subject is useful and necessary as long as that deception is not proved to be harmful.
3. We asked researchers to think more carefully about what anthropomorphism means to a person who has difficulty anthropomorphising as a primary deficit.

4. We invite researchers to reflect on the terms they may use in robotics such as breathing, or human-child social bonding.

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