Roles, strengths and challenges of using robots in interventions

for children with autism spectrum disorder (ASD)

Abstract

The aim of this research was to study roles, strengths and challenges of robot-mediated interventions using robot KASPAR for children with autism spectrum disorder (ASD). Twelve focus group sessions were organized in which 70 ASD care and/or education professionals participated. Six roles for KASPAR were identified: provoker, reinforcer, trainer, mediator, prompter, and diagnostic information provider. Strengths of KASPAR are related to personalisation possibilities, its playfulness, the action - reaction principle, its neutral expression, consistent and repetitive application of actions, possibilities to vary behaviour in a controlled manner and having an extra hand. Challenges of working with KASPAR were: limited reaction possibilities, possibility of children being scared of KASPAR, difficulties with generalisation or transfer and finally potential dependence on KASPAR.

***Keywords****: Autism spectrum disorders, Robot, KASPAR, ASD, Children, Robot Mediated Intervention*

Introduction

An upcoming intervention area with promising potential for children with autism spectrum disorder (ASD) (American Psychiatric Association, 2013)) is robot-assisted therapy (RAT) or robot-mediated intervention (RMI). A number of recent systematic literature reviews have covered the majority of the work related to the use of robots for children with autism (Begum, Serna, & Yanco, 2016; Cabibihan, Javed, Ang, & Aljunied, 2013; Diehl, Schmitt, Villano, & Crowell, 2012; Huijnen, Lexis, Jansens, & de Witte, 2016; Pennisi, Tonacci, Tartarisco, Billeci, Ruta, Gangemi, & Pioggia, 2016; Scassellati, Henny Admoni, & Matarić, 2012). However, despite a growing number of human-robot-interaction (HRI) studies for children with autism of which the majority present promising results, advances in robot-mediated interventions have only made minimal progress towards clinical applicability (Begum et al., 2016). Begum et al. (2016) summarise a number of important reasons for this; the potential end-users of this technology (i.e. people with ASD, their caregivers, clinicians) are neither aware nor convinced of the role of robots in an ASD intervention (Diehl et al., 2014, 2012); many of the robot-based studies for individuals with autism fail to meet criteria commonly used to assess the outcome of an ASD intervention (Reed, Hyman, & Hirst, (2011; Grynszpan, Weiss, Perez-Diaz, & Gal, 2014), and finally they argue that demonstrating the ‘likeability’ of robots for children with autism is “not sufficient to formally allow a robot to co-locate and interact with a protected population such as individuals with autism”.

When studying robots presented literature, six different roles can be distinguished: “diagnostic agent”, “friendly playmate”, “behaviour eliciting agent”, “social mediator”, “social actor”, and “personal therapist” (Cabibihan et al., 2013). The authors came up with these roles based on studies in the literature using robots for this target group. Apparently, as Begum et al. (2016) argue, ASD professionals in practice seem to be unaware of the state of the art as well as the possibilities of robots for this target group. At the same time, robot developers are not always aware of the needs and capacities of children with ASD and those who care for them. This creates a gap that hinders the creation of relevant and effective robot interventions for this target group.

Pennisi et al. (2016) found positive implications in their review that robots might provide therapists and teachers with new means to connect with people with autism in support sessions. They report that participants with ASD showed social behaviour towards robots, showed reduced repetitive and stereotyped behaviours and reported spontaneous use of language in sessions with a robot. In some cases people with ASD show behaviours towards robots that people without autism have towards humans (Pennisi et al., 2016). To benefit from the positive effects of the use of a robot in interventions, higher levels of stimulation (interaction) by the robot are better than lower levels of stimulation. However, despite these positive findings, studies need to better clarify whether gender, intelligence and age of the participants affect the outcome of the intervention and whether any beneficial effects are apparent only during the session or whether they are transferred outside the session as well.

One of the robot platforms that is being applied in research for children with autism is robot KASPAR (see [Fig. 1](#Ref454463390)) (Dautenhahn et al., 2009; Robins & Dautenhahn, 2014; Wainer, Dautenhahn, Robins, & Amirabdollahian, 2010; Wainer, Robins, Amirabdollahian, & Dautenhahn, 2014). KASPAR stands for “Kinesics and Synchronization in Personal Assistant Robotics”, and is a semi-autonomous humanoid robot with the size of a sitting infant or toddler and is minimally-expressive (Wainer, 2012).

**[Place figure 1 here please]**

KASPARis developed at the Adaptive Systems Research Group at the University of Hertfordshire (UK). It uses head, torso, arms and hand movements to make gestures and (limited) facial expressions. Moreover, sound and speech can be used as additional interaction mechanisms. Each arm has 3 degrees of freedom and different parts of its face (e.g. eyes, mouth, eye lids) have separate motors that can be activated. KASPAR sits on a table and cannot stand up or walk away (its legs are not actuated) (Wainer, 2012). KASPAR can be controlled by activating its sensors in various body parts (hands, belly, feet, head) and by using a pre-programmed remote control. Using the remote control, professionals can initiate actions of KASPAR using the Wizard of Oz technique (in which the intention is that the child does not notice that the robot is controlled by the professional).New KASPAR behaviour, also called scenarios, can be easily created by using the KASPAR configuration program installed on a laptop.

Research has shown that the use of KASPAR in interventions contributes to learning body awareness, encouraging collaborative skills among children with autism (Wainer et al., 2014); prolonging children’s attention span (Costa, Lehmann, Robins, Dautenhahn, & Soares, 2013); mediating and encouraging children’s social interaction with other people (Robins, Dautenhahn, & Dickerson, 2009); and learning about body parts and appropriate physical interaction (Costa, Lehmann, Dautenhahn, Robins, & Soares, 2015).

Reviews summarise that often the focus of HRI studies is on skills and behaviours relating to social and communication impairments, but that there are also other relevant target areas in which RMIs are expected to contribute to in a meaningful manner and to be of social significance (Begum et al., 2016; Huijnen, Lexis, Jansens, et al., 2016). This question was addressed in a study that intensely involved ASD professionals to better understand to which therapy and educational objectives of children with ASD, robot KASPAR is expected tobe able to contribute to (Huijnen, Lexis, & de Witte, 2016). Indeed experts expect most potential for KASPAR in the domains of “communication”, “social interaction and relations”, but also for “play”. Next to this, results indicate that professionals expect KASPAR to have potential for contributing to objectives in domains such as “emotional wellbeing” and “preschool skills”. They particularly see a role for KASPAR in the following top 10 objectives: “imitation in play”, “making contact”, “imitation in social/interpersonal interaction”, “turn-taking behaviour”, “orientation to listen”, “social routines”, “attention”, “learning a new form of communication”, “talk – use verbal abilities”, “train or practice skills”, “follow up instructions”, “pose a question/ask for help”, “having fun, experiencing pleasure”, and “developing interest in play” (Huijnen, Lexis, & de Witte, 2016). These insights on top 10 objectives provide understanding on the objectives that can be targeted by RMI, but not in what manner and hów best to utilize the advantages of robots to complement existing interventions already used in practice.

By intensively involving professionals such as therapists and special needs teachers in the present study, we aim to minimize factors that hinder (clinical relevance and uptake and increase chances for) clinical applicability. As mentioned, currently often professionals working in practice with children with ASD are not aware nor convinced of the role of robots in an ASD intervention. An important element in this is understanding what the potential may be of robots in interventions for children with ASD according to these professionals and in what manner both strengths as well as challenges can be taken into consideration when developing interventions.

The aim of the current study was to gain insight into the potential of the robot KASPAR as contribution to interventions according to practitioners in the field. In short, this study addresses the following research questions:

* What possible roles for KASPAR in an intervention for children with ASD are suggested by professionals, and what strengths and challenges related to KASPAR do they foresee?

Method

A qualitative study was performed which consisted of focus group sessions (Morgan & Spanish, 1984) with professionals working in the ASD field. The term “professionals” is used to denote practitioners who’s profession it is to work with children with autism in care and/or special education. The aim was to gather insights on relevant aspects with respect to the role KASPAR could have in an ASD intervention and to identify KASPAR’s strengths and challenges related to using KASPAR in practice.

Setting and Participants

A number of organisations in the domain of ASD, in the south of the Netherlands, were approached by the main researcher (CH). If they expressed their interest and willingness to contribute to the study, a contact person from the organisations checked internally if there were professionals that met the inclusion criteria of the study. Additionally, sampling was conducted based on the snowball method keeping in mind a number of inclusion criteria for participating respondents:

* The professional works with children with ASD in their daily practice
* The professional is working at a special school, care organisation or medical day care centre targeted at children with ASD
* Mastering the Dutch language
* Being able to participate in a focus group session during the period of the study.

Procedure

The contact person at each organisation approached colleagues who met the inclusion criteria to invite them for the focus group sessions. The sessions were organised at the premises of the participating organisations. The duration of each session was about 2 hours. Two researchers involved in the study were present during each session; one had the role of session moderator and the other of note taker, observer and transcriber of the sessions afterwards. Before the start of the session, informed consent papers (for making audio recordings and pictures), participant demographic sheets and pens where distributed for each participant. The focus groups started with a short welcome, an explanation of the (goal and nature of the) session and a demonstration of KASPAR to give the participants a better idea of what KASPAR is and what it can do. During the demo KASPAR introduced itself, played a song, and additionally the possibilities were explained and shown (such as the use of sensors, the freedom of movement of the motors, speech, sounds, remote control, as well as the possibility to create personalised new scenarios and the use of additional attributes). Participants were informed that behaviour of KASPAR needs to be programmed in advance and that the operator who is remotely controlling KASPAR during a session, can select a behaviour with or without a corresponding sound or utterance. After the introduction, possible questions were answered and the actual focus group discussion started. The focus group sessions were consistent in terms of structure and main questions that were asked. Examples of questions are: do you see possibilities for using robot KASPAR in your organisation? If so, for what objectives and in what way? Are there any challenges to take into account? We stressed the importance of participants being open and free in their reactions (e.g. that there is no “right” or “wrong” answer or opinion) and that every contribution that people give is valuable.

Setting and Participants

A total number of 70 professionals participated during the focus group sessions; 60 were female and 10 were male. All of them were recruited based on their expertise and experience in working with children with ASD (e.g. teaching, providing training or care). The average working experience for the professionals was 13.7 years with a standard deviation of 9.4 years. Table 1 summarizes the main characteristics of the participants. All the participants had a positive attitude towards the use of technology in their daily practices. However, none of them had previous knowledge of, or experience in, working with robots for children with autism.

[Place table 1 here please]

In total, 22 different organisations were represented by 70 ASD professionals in 12 focus group sessions. For people working for the same organisation the session was organised at their premises (all in The Netherlands). The types of organisations that were represented were: special needs schools, child and youth care organisations, (pedagogical) treatment centres, and medical day care centres. The background of the participants varied; ranging from ASD teachers and assistants at special needs schools, psychologists, speech therapists, occupational therapist, physiotherapist, psychomotor therapist, behavioural therapists, treatment coordinator, to people working in care management.

Data collection

The participant demographic forms were filled in and collected on paper and the information was stored in an excel sheet. Audio recordings were made during the 12 focus group sessions and verbatim transcripts were written in Word. Nvivo was used to analyse the verbal material.

Data analysis

To analyse and interpret the content of the qualitative data of the focus groups, conventional content analysis was applied (Hsieh & Shannon, 2005). This entailed that coding categories were derived directly in an inductive manner from the text data rather than from an existing predefined coding scheme. Data triangulation was used to ensure data integrity and validity. Two persons were involved in the collection and analysis of the data (investigator triangulation) (Carter, Bryant-Lukosius, DiCenso, Blythe, & Neville, 2014)). Two researchers were independently involved in creating the coding scheme based on the transcripts from the sessions to ensure inter-subjectivity. Both were present during the focus group sessions. In other to reach saturation, two analytical sessions were organised. When all the focus group sessions were transcribed by one researcher, both researchers read two sessions with the goal to identify main themes or codes to create a tentative coding scheme. After this, an analytical session was organised to compare, discuss and align these two coding schemes. The codes were discussed to understand how the data was perceived by both researchers. On a semantic level (the meaning of the data) the coding schemes were very similar, and the best wording (label) for each code was agreed upon. The resulting coding scheme was used by the main researcher to code three more focus group sessions**.** Subsequently, an additional analytical session with the two researchers was scheduled to finalise the coding scheme to ensure saturation. During the second analytical session some codes were slightly rephrased and finally coding consensus and information saturation was achieved. There was agreement on what code belonged to a certain piece of transcription. The rest of thefocus group sessions were then coded by the main researcher using this final coding scheme (see the appendix for the final coding scheme).

Results

Results of the focus groups indicated that six differentrolescan be distinguished for KASPAR based on the input of the professionals. They argue that depending on the needs and capabilities of the professionals and the training or educational objectives for a child at a certain moment in time, as well as the available other interventions, a certain role for KASPAR may be preferred and chosen. Moreover, rich insight was gathered into the strengths of KASPAR as well as the challenges related to creating robot mediated interventions.

Possible roles for KASPAR

Below, the six roles that professionals envisioned for KASPAR are presented. Professionals indicated that these roles are not mutually exclusive; it may happen that two or more roles apply for a certain task and that another task requires another role. They indicated that the professional shall choose what role(s) are important to reach a certain goal.

Provoker

KASPAR is expected to function as a kind of magnet to (some) children; one that evokes, provokes, elicits, triggers, and stimulates them to engage in interaction. This role was suggested in 6 (of the 12) sessions. KASPAR mayremove some barriers that normally prevent these children from feeling free and behaving in certain desired ways. A speech therapist at a special needs school indicated *“KASPAR is calm, and manageable for children, he can provoke the children at a safe, calm and step by step manner”* (Focus Group (FG) 6, speech therapist 1, special needs school, Female (F), 16 years of working experience with children with ASD). A special needs teacher mentioned “*KASPAR might be able to trigger children and give another way of motivation and attention.”* (FG4, special needs teacher, special needs school, F, 7). Once KASPAR has won the children’s attention, “he” can start “working” with them. Professionals highlighted that, currently, often the interaction between a professional and a child is unidirectional; it starts from the professional and stops there when the child does not respond. KASPAR, in their views, may be able to function as a trigger or stimulus that causes initiative from the child. Because KASPAR can always give (the same) reaction, the child might seek contact him-/herself. This creates a safe and predictable atmosphere for the child. KASPAR may stimulate or remove an obstacle so that children might start doing things they normally would not do. A special needs teacher (specialised in physical exercise) indicated that *“KASPAR might be able to give a trigger so that the child takes initiative. Because KASPAR will always give a reaction, the child might seek contact.”* (FG11, special needs teacher, special needs school, Male (M), 17).

Reinforcer

Secondly, professionals indicated that KASPAR can be used to generate success experiences, to positively reinforce the children by giving compliments. “*KASPAR can give compliments to the children”* (FG9, pedagogical staff, ASD care centre, F, 8)*.* This reinforcer role was suggested in 7 (of the 12) sessions. If needed, the professional can control the robot to deliver a certain reaction. Appropriate behaviour of the child can immediately be rewarded by a (consistent) compliment of the robot, initiated by the professional. In the beginning one may give a positive reinforcement after each instance of appropriate behaviour, and over time this can be given less frequently when the child learns*. “We are able to control KASPAR. The reinforcement can be given immediately, or a bit later, or even later after the action. You can give a positive reinforcement after 1 correct action, later after two correct actions...you can play with it”* (FG12, special needs teacher, special needs school, F, 14). When a child finishes a task, KASPAR might say “Well done [name of the child], you finished your task”. In this way the child experiences moments of joy, and success which are very important for them since often things are difficult, challenging or even impossible for them. If the child does something which is less positive, KASPAR might say in a neutral voice without emotions “try it again”. Professionals stressed that it is crucial that children experience success experiences, KASPAR could contribute to these positive moments. “*He [child] will always receive the proper reaction. So when he takes initiative, this will be rewarded by KASPAR as an incentive”* (FG5, ASD teacher 1, special needs day care centre, F, 17).

Trainer

Thirdly, professionals suggested thatKASPAR can be used to repeat certain actions over and over again so that the child can train and practice a (new) skill. *“KASPAR could take over a trainer function. I can say it is your turn, or KASPAR says it. I am curious to see if they learn faster if a robot tells it than I”* (FG9, trainer, centre for ASD care, F, 4). This role has been suggested in 9 of the 12 sessions. This can be related to a wide and diverse scope of skills, examples are given of imitation skills, following up instructions, learning to cope with proximity, learning to work (independently), understanding appropriate behaviour in different contexts, and solution-oriented behaviour. “*Especially with imitation this seems handy; KASPAR can give the**example, you can tell**the child to look at KASPAR to see how it should be done. Normally I give the examples myself plus I have to instruct the child at the same time”* (FG12, speech therapist, medical day care centre, F, 20).

Moreover, a number of special needs teachers suggested that realistic examples from the child’s life could be taken to practice with KASPAR in the sessions. Parents could, for example, provide situations of things that occurred, which will be worked with in the sessions so that the child can actually learn from it. In this case, KASPAR can be used in many different situations that make sense in daily life. By explaining for example that proper behaviour can be context dependent. A certain behaviour might mean different things in different contexts. For example, by simply changing KASPAR’s clothes into a police uniform, the gesture of holding up one hand would change from waving (what it would be when you see a friend on the street) into a formal stop sign.

Mediator

Additionally, professionals indicated thatKASPAR could be used as a medium to enable contact, interaction and communication with the child and another person. This role was mentioned in 8 of the 12 sessions and participants had lively discussions about it. They envisioned that a triangle of joint attention could be established via KASPAR (to a professional, another child or an object). Joint attention is a prerequisite to learn to interact together and KASPAR might help in establishing it. At first, KASPAR has the focus of attention which can be extended to other objects or topics. He can be an attention-, communication- and interaction mediator. Also KASPAR does not always have to be directly or primarily used to actually train certain skills, but he can function as a medium to engage in a moment or activity together as well. It can be a kind of subject of conversation that functions as a bridge to other topics; to support triangulation (involving a person and another person and an object or the robot). *“I can imagine this happening with two of those little ones of us. Play a turn taking game together, listen to each other, wait for each other. KASPAR could be the third person taking the lead, for example “hey guys…”* (FG9, ASD trainer 1, centre for ASD care, F, 4). Professionals envisioned that it is not always so important what KASPAR does, but that just simply being there would already make a difference. “*For me as ASD therapist, there are so many means, but sometimes I cannot find a fit to the needs of the child. We could use KASPAR as another medium. It will not be so much about what he does, but more about that he is there. Then you use KASPAR as a medium for shared activity, or as a conversation topic to reach other topics, together”* (FG9, ASD trainer 2, centre for ASD care, F, 8). Moreover, KASPAR could be used to advise the children to talk to the teacher, their mum or dad. Finally, they indicated that children could also use KASPAR as a voice of their own, to express their wishes or needs if they experience difficulties with this themselves (similar as they do with a speech computer in a sense). An ASD care therapist who supports children and parents with ASD also a mum of two sons with ASD argued (FG7, ASD care therapist, care organisation, F, 18): “*It would be wonderful if we could use KASPAR to stimulate or learn solution oriented behaviour. Imagine I am angry, that you can use KASPAR to show what being angry looks like. And that together you can start to think, what would KASPAR do now? Because that is not as scary as when you have to look at yourself. That would be wonderful, if you can use KASPAR as a tool to discuss feelings…that seems less intimidating to me. It could work with other feelings as well. Some children are too happy, what is appropriate and when. KASPAR can mediate in that.”*

Prompter

A fifth role that was mentioned was thatKASPAR might be used to give (concrete, specific and clear unambiguous) instructions or prompts to the children. This role was suggested in 8 of the 12 sessions and participants considered this role of value in practice. They indicated that often children need quite a high level of (physical) proximity to complete a task (on their own). They know, for example, how to perform a certain task, but as soon as they finished that task, they wait and wait. Often they need a person to actually tell them that they need to move on to the next task (which in turn they can perfectly complete themselves again). KASPAR might fulfil that prompting role to give them a little ‘hand’ to pursue their work. At the end of their task, a KASPAR picto could be used, so that they know they have to interact with KASPAR, who might say “Well done [name child] now you can take the yellow basket and make the next task”. In the words of a teacher assistant (FG6, teacher assistant, special needs school, F, 11): *“KASPAR can give instructions to the child, go on, well done, please sit down, take the next task, please continue”*. Or more in general, KASPAR can be used to give instructions or a day/task structure to the children. One example was given by a teacher of a special education school (FG4, special needs teacher, special needs school, F, 25): “*When the children arrive at school in the morning, they need to do three things: hang up their coat, put their breadbox in the drawer, and sit at their desk. These are three different things and KASPAR could provide a structure and guidance to complete these step*.” Or as another participant indicated *“KASPAR might be used to plan and organise when there is a range of activities….. “in 5 minutes we will stop and have lunch*” (FG8, ASD coach, care organization, M, 20). In this case the dependency of the human might become smaller, and step by step one can work towards a more independent working style (if the dependency of KASPAR of course is gradually decreased as well). If a certain child has sensory difficulties when there are more children around, KASPAR could be placed next to him/her so that more isolated instructions or prompts can be given.

Diagnostic information provider

A sixth and final role that was suggested by the professionals was a diagnostic information provider. By observing how the child interacts with KASPAR, professionals might learn more about the behaviour of the child. This role was brought up by participants in 4 of the 12 sessions. It might provide some diagnostic information that would be difficult to get when the child was interacting with the professional rather than with the robot. From the perspective of a person without autism, KASPAR might look ‘clean’, awkward, or even ‘scary’ due to the absence facial expressions and details. For people without autism, facial expressions often provide a sense of safety, security, clarity. For children with autism, this is (completely) different, which might be a reason why they show different reactions and behaviour to KASPAR than to a human being. Professionals expected to be surprised by the children’s reactions to KASPAR. This might help professionals to understand the children better and possibly learn them more about their own behaviour towards the children (i.e. “why does the child react in this way to KASPAR and differently to me”) and give them more insight in how to improve their behaviour towards the children. So, professionals thought that from observing the child’s interaction with KASPAR, professionals might learn about the child on the one hand, and about their own behaviour on the other hand. A number of quotes from participants illustrate this: “*KASPAR can help me understand why does this child react this way and another child that way. And what does the child apparently need, also from me. In this way it is a beautiful diagnostic information tool”* (FG7, mental health psychologist, ASD care organisation, F, 30); *“I do think it works in two directions; it is not just very clear for the child but we [teachers] we will see that KASPAR will provoke reactions that we just cannot provoke. Then you will start to think “why does he [child] do it with KASPAR and not with me? Maybe in this way you will search yourself for better ways of communicating with the child”* (FG, special needs teacher, ); and *“KASPAR can help us to get a better understanding in what a child can actually do”* (FG5, ASD teacher 1, special needs day care centre, F, 17).

Strengths of KASPAR

The focus group results indicated that professionals envisioned a number of strengths inherent to KASPAR that could be exploited or utilised in order to optimally complement current ASD practices. Often these strengths are expected to create desirable states of wellbeing for the child such as safety and trust which better enable the child to feel pleasant, motivated and more able to develop to their fullest potential. These characteristics were the following:

1. **Personalize and apply in a multifunctional manner**; KASPAR can be programmed in a tailored individualised manner to meet every child’s needs, wishes, learning objectives, capabilities and preferences. Personalisation is important for children with autism and KASPAR is expected to be able to have an answer to this since new scenarios and KASPAR behaviour can easily be created or fine-tuned. This applied both for the training and educational goals that are relevant for that particular child and will be addressed using the robot, but also to the way these are addressed. KASPAR should look accessible and friendly and children should be able to identify with him. KASPAR is currently a boy, but can be changed into a girl when his hair, clothes and voice is adapted into a female version of the robot.
2. **Playful**; it is expected that (some) children will enjoy interacting with KASPAR, that they will like it, experience fun, which increases chances for enjoyment, motivation, attention and drive for initiative or exploration. For children with autism this can be a very important positive aspect.
3. **Action - reaction**;the child is in control; the initiative lies in the hands of the child. Many children with autism are fond of interactive technology such as computers or tablets. One of the underlying causes is, in the eyes of the professional, that the child is in charge of the initiative and control which gives a feeling of predictability and safety. It is expected that the ‘action-reaction’ mechanism of KASPAR is a strong asset for being a successful tool for children with autism.
4. **Neutrality**; approachability, lack of “noise” or ambiguous disturbances; due to KASPAR’s lack of extreme realistic human facial expressions and emotions he is expected to be more approachable (than humans) for children with autism. It is expected, that in the eyes of the children, KASPAR is thought to be more ‘clean’, predictable, safe, less distracting, trustable, and less ambiguous and less threatening than a human person would be.
5. **Consistent and repetitive application** (creates predictability); KASPAR is able to say or do something in exact the same manner for an endless number of times. For humans this is not possible: we will always (unconsciously and unintentionally) vary in some way; our tone of voice, volume, pitch, facial expressions, or speed might alter. For training and practicing purposes this consistent repetition is expected to be extremely beneficial. KASPAR’s behaviour and/or reaction can be the same, over and over again. This consistency creates predictability which in turn can create a feeling of safety for the children (i.e. KASPAR will not perform any unexpected ‘strange’ actions). KASPAR always sits, so they do not have to be ‘afraid’ that he will just get up and move away. Moreover, KASPAR is always there and available, whereas some professionals work part-time, are replaced or are on (sick)leave every now and then which might upset some children. KASPAR might be a stable and constant factor alongside these (changing) professionals.
6. **Vary in a controlled manner**; according to professionals, with KASPAR you have the ability to deliberately chance only some selective and isolated aspects in his reaction or behaviour. Variation or change can be done in a controlled and conscious manner. For humans this might be more challenging since we unconsciously and unintentionally sent numerous messages with our voice, facial expressions, odours, body posture that children sense, perceive and possibly react to. KASPAR is in that sense more focused and selectively controllable when professionals wish to change or vary gradually to work towards transfer and generalisation.
7. **Extra hand**; professionals highlighted that at the moment often professionals occupy a double or triple function. They fulfil multiple roles simultaneously often at a single moment in time in one person; a trainer, an observer, a motivator, a corrector and often a kind of coach. Professionals indicated that this causes a large burden on them and might cause a lack of clarity or maybe even distress or overload for the child. With the use of KASPAR in one of these roles, the professional gets more ‘space’ to focus and or even to take some (physical) distance. For the child it is expected to be less ambiguous.

Challenges related to KASPAR

The results also indicated that professionals envisioned a number of challenges related KASPAR that should be given attention to in order to optimally complement the current ASD practices. These challenges werethe following:

1. **Limited reaction possibilities**; according to the professionals, currently, KASPAR has limited mobility capabilities (i.e. he cannot walk, grasp or fetch objects, make fine gestures with his hands or fingers). Since KASPAR is semi-autonomous, a number of pre-defined actions can be programed on the remote control. This means the professional has these and only these reaction possibilities at hand; KASPAR itself has no contextual sensitivity to purposefully react in a situation.
2. **Some children might be scared of KASPAR**; professionals thought that it might very well be that not all children like KASPAR, some children might even experience aversion towards the robot.
3. **Generalisation / transfer**; professionals indicated that KASPAR might be able to train new skills, however, the intention is not to teach the child to optimally and only perfectly behave in the interaction with KASPAR. The goal is that children are able to apply the learned skills also in real live situations. Professionals raised the issue of transfer or generalisation to humans and/or other situations. Also, some professionals were afraid that some children might copy KASPAR in an extreme realistic manner causing them to show ‘robotic’ behaviour themselves.
4. **Dependence on KASPAR**; it may occur that children with autism have a dependency to some of their teachers or therapists. If a child learns some words with KASPAR as a trainer, coach, or medium in the intervention, professionals wondered if this dependency might shift towards KASPAR. Therefore, attention needs to be devoted to the matter of dependency as well.

Discussion and Conclusion

Results from focus groups with professionals working intensively with children with autism and other stakeholders delivered 6 roles for a robot in the work they do: provoker, reinforcer, trainer, mediator, prompter, and a diagnostic information provider. These roles were defined based on their expertise of what children with ASD need in education and training in order to support their independence in daily life. The roles of the robot were formulated in terms of delivering added value to the already existing work practices and interventions.

Professionals considered the use of robots to be of high potential. In order to achieve this potential, it is crucial that the strong assets of robots (e.g. action-reaction principle, consistent and repetitive application) are carefully implemented in practice while taking into account and utilising the strong characteristics of people (e.g. being able to ‘read’ the child with autism very well). As a result, they expect that robots can become valuable tools in the hands of professionals.

Results indicated that, depending on the needs of the child and the professional a certain role might be chosen in a certain moment while another role might be needed at another moment in time. Moreover, findings showed thatthese roles are not mutually exclusive, multiple roles can be applicable or needed for a certain task or activity. Professionals indicated, for example, that for the role of trainer compliments of the reinforcer role are needed as well.

The roles from the ASD professionals are quite similar to those identified in state of the art robotics: “behaviour eliciting agent”, “diagnostic agent”, “friendly playmate”, “social mediator”, “social actor”, and “personal therapist” (Cabibihan et al., 2013). On the other hand, when taking a closer look, the roles from the professionals seemed to be more concrete and slightly more intervention oriented when implementing them in a real education or care practice. For example, when looking at the “diagnostic information provider”; the professionals envision a two way interaction, not only to establish information related to the diagnoses of the child’s abilities (as suggested in the categorization based on the state of the art of robot literature), but also a feedback mechanism for the professionals to learn and possibly adjust their own behaviour towards the child.

The goal of the study was to get insight into as many different roles that could be envisioned for robot KASPAR in ASD interventions. Since people with autism might have a different perspective or experience, we also invited three adults with ASD in an additional focus group as an extra source of information and to check if their ideas align with what the professionals mentioned. They indeed confirmed the results of the professionals. Moreover, they delivered interesting additional information. They came up with a 7th possible role; a buddy. They argued that KASPAR might say “*Hello, my name is KASPAR, I am a little bit different, just like you”*. So that the child learns it is alright to be different and still be part of the group. This might enable a different connection or relationship, more like a friend rather than a teacher. An adult male with ASD indicated *“He [KASPAR] is a friend and does not have a teaching role*”. If the child then establishes a trust relationship with KASPAR, it might feel safer. KASPAR might be able to ‘help’ then in difficult cases in which it is hard for the child to express its needs or wishes to a human. KASPAR might fulfil the role to stand next to the child and help to understand what really happened.

More research is needed to systematically and intensively involve people with ASD in the process of researching and developing valuable robot-mediated interventions for children with ASD.

A strength of the present study was intensively involving professionals in the creation of new robot mediated interventions to utility mutual awareness and expertise to better guide robot mediated interventions. Professionals see a strength and advantages of robots for this target group, maybe even more than in other domains were robots are suggested for care (e.g. independent living, service robotics for elderly care as described in for example in (Draper et al., 2014)). Possibly this is due to the nature and complexity of the disorder, the difficulty of delivering proper care especially as human beings and the open mind that many of these professionals have towards trying out new ways of working with this target group. More robotic appearance and behaviour might be ‘better’ or preferred in some moments with this target group which is particularly difficult for expressive people. This relates to findings in which children showed more interaction with a ‘robot looking man’ than with a typical human being (Robins, Dautenhahn, & Dubowski, 2004).

The potential that was identified using robot KASPAR, can also be applied to many similar other robots that are used in interventions for training or education for children with ASD, as often on an abstract level many robots have similar characteristics. For example, other robots (e.g. Nao as presented in (Miskam et al., 2013; Tapus et al., 2012) can also provide a possibility to personalise the behaviour of a robot to the needs of a specific child, can be playful in the interaction or appearance, and provide a kind of action – reaction mechanism that allows the child to be in control. Depending on the appearance of the robot platform**,** interaction with a robot can be neutral and approachable for a child with autism**.** Depending on the implementation (or to some extent the level of autonomy) of the robot, many robots can provide consistent interaction, the option to vary in a controlled manner and provide an extra hand for therapists or teachers. The same holds for the need to pay attention to a number of aspects when working with robots for children with autism; the robot will always have some limitations, for some children or some moments a robot will not be the most optimal choice, prevent dependence on the robot, and take into account matters of generalisation and transfer. The robot shall be an additional tool in the hands of the professionals, not a goal in itself. The aim is to support children in their development so that they can function in the real world with real people, not (only) show great performance in front of a robot.

A limitation of the study could be the snowballing sampling method that was used; due to possible anchoring (not knowing if the sample is an accurate reading of the target population). However, this is a high risk only if only a few people would be included, which is not the case in this study in which a large number diverse professionals (N=70) participated from many different and diverse organisations.

Previous studies already show that professionals have positive expectations of using KASPAR to work on the education and/or training objectives for children with autism; that they see potential for KASPAR for more ASD training and educational objectives than currently proposed in robot studies in peer reviewed literature (Huijnen, Lexis, & de Witte, 2016; Huijnen, Lexis, Jansens, et al., 2016). They clearly can see KASPAR as a tool in the hands of the professional to work on a larger range of objectives. This study contributes to this mission by creating understanding of where the strengths or advantages of robots might bein an intervention for children with autism. By intensively involving professionals we aimed to increase chances for clinical relevance and uptake and overcome typical barriers for robot mediated interventions to reach clinical applicability as stated by Begum et al. (2016) (such as unawareness or lack of believe in the potential of robots by end-users).

The next step will be to co-create and pilot new robot-mediated interventions using these insights as well as the gained awareness and knowledge of the professionals in the field as well as people with autism. Moreover, effort will be given to minimize the reported challenges, for example by co-creating new robot mediated interventionsaiming to enhance the robot design and optimize personalised interaction possibilities and dialogues. When truly implementing robots into current practices, also aspects other than the roles, strengths and challenges need to be in place. These can be technical aspects such as technical infrastructure, maintenance effort and costs, as well as stability. Additionally, also many practical requirements need to be taken into account in order to truly implement robot assisted interventions (e.g. a specification of the target group, factors related to the environment, integration into common practices and individualised education/training plans**)** (Huijnen, Lexis, Jansens, & Witte, 2017).

Ethical approval: This article does not contain any studies with human participants performed by any of the authors.

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**Appendix**

This is the final coding scheme used to code the focus group sessions.

Possible roles for KASPAR

1. Provoker
2. Reinforcer
3. Trainer
4. Mediator
5. Prompter
6. Diagnostic information provider
7. Buddy

Why could KASPAR work - strengths of KASPAR

* + Personalize and apply in multifunctional manner
	+ Vary in a controlled manner
	+ Action –reaction
	+ Playful
	+ Neutrality
	+ Consistent and repetitive application
	+ Extra hand

Why could KASPAR NOT work – challenges related to KASPAR

1. Generalisation / Transfer

2. Limited reaction possibilities

3. Some children might be scared of KASPAR

4. Dependence on KASPAR

KASPAR

 Appearance

Voice or Sound

Operation of KASPAR

Behaviour / actions of KASPAR

KASPAR’s Attributes / Toolbox

Target Group

 Specification of target who will probably benefit from KASPAR

Specification of target who will probably NOT benefit from KASPAR

Environment

Professional

Intervention implementation

Integration in individualised education/therapy plan

Phase in the intervention trajectory

Session characteristics

individual vs group, spontaneous vs structured, duration

 integration on organisation level and connecting to parents

Fig. 1 Robot KASPAR



***Table 1. Demographic characteristics of the participants***

|  |  |
| --- | --- |
| Description/VARIABLE | Value (n (%)) |
| Gender  |  |
| Male | n=10 (14%) |
| Female | n=60 (86%) |
| Total | **(N=70)** |
| Number of years working experience with ASD (professionals) |  |
| 0-5 years | n=15 (21%) |
| 6-10 years | n=19 (26%) |
| 11-15 years | n=10 14%) |
| 16-20 years | n=14 (19%) |
| 21-25 years | n=3 (4%) |
| 26-30 years | n=5 (6%) |
| 31-35 years | n=4 (5%) |