Utilising humanoid robots to assist children with autism learn about Visual Perspective Taking

Luke Jai Wood, Ben Robins, Gabriella Lakatos, Dag Sverre Syrdal, Abolfazl Zaraki and Kerstin Dautenhahn
Adaptive Systems Research Group, School of Computer Science, University of Hertfordshire, United Kingdom
{l.wood, b.robins, g.lakatos, d.s.syrdal, a.zaraki, k.dautenhahn}@herts.ac.uk

Introduction

In this paper we provide an overview of the study we have recently conducted investigating the possibility of using humanoid robots to teach children with Autism Spectrum Condition (ASC) about Visual Perspective Taking (VPT). VPT is the ability to see the world from another person's perspective, something that children with ASC often find difficult. Using a humanoid has a distinct advantage in this situation because the robots Field Of View (FOV) can be shown directly to the children using a screen to display what the robot can see from the camera in its eye. Our study working with 12 children in a local special needs secondary school indicates that using this approach to teach children with ASC about VPT has some potential.

Background

Since the late 90’s a vast amount of research has been carried out investigating how robots can be used to encourage communication, social interaction and collaborative play amongst children with ASC [1-5]. However, to date very little research has been conducted into investigating the possibility of using robots to assist develop the VPT skills of children with ASC. VPT is the ability to see the world from another person's perspective, taking into account what they see and how they see it, drawing upon both spatial and social information [6]. According to Flavell there are two levels of VPT: VPT1, the ability to understand that other people have a different line of sight to ourselves and VPT2, the understanding that two people viewing the same item from different points in space may see different things [6]. The research outlined in this paper provides a brief overview of the games we developed and tested with 12 children aged between 11 and 14 that had been diagnosed with ASC or similar condition in a local special needs school.

Method

Equipment setup

The standard equipment layout can be seen in Figure 1. The cameras used to record the sessions had wide angled lenses to ensure that the child was always in view and the Kinect sensor was also used to record data for future analysis and testing of activity recognition algorithms. The screen was placed next to the robot in order for the child to see what the robot could see. There were some small variations on this setup with additional equipment being used.

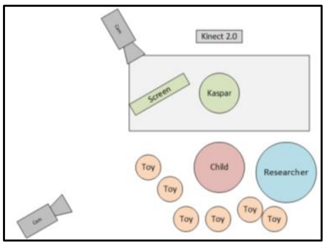

Figure 1. Generic equipment layout

Games devised

In attempting to devise an approach teaching children with ASC about VPT, we developed 9 games that started out very basic and incrementally become more difficult, but are all focused on the concepts of VPT. Some of these games included elements of well-known games such as “I Spy” and “Hide and Seek” that the children could play with the Kaspar robot [7, 8]. The games involved a number of different combinations of actions, starting with moving objects into and out of the robots FOV, and then physically controlling the robot’s line of sight. The key to these games is giving the children the ability to see the world from the robot’s perspective and to assist them in learning about VPT. Details of the individual games are as follows:

Game 1: Show me an animal and I’ll make the sound: This is a VPT1 game as the children learn that Kaspar has a different line of sight from their own. This game involves the child freely showing Kaspar animal toys of the child’s choice while Kaspar looks straight ahead not moving its head or eyes.

Game 2: I’ll ask for the animal, you find me the animal: Building on game 1 in this game the children perform the same task but have to follow the robots instructions on what toy to show it.

Game 3: Make me look and I'll tell you what it is: This is again a VPT1 game but in this game the children will physically manipulate the orientation of the robots head to view toys placed around the room. Similar to game 1, the children have the freedom to show Kaspar any toy without limitation.
Game 4: I'll tell you what I want to see and you need to show me: Combining aspects from both games 2 and 3, in this game the child controls where Kaspar looks by physical manipulation of the head, but must follow the robots instructions on what toy it wants to see.
Game 5: What you see is not the same as what I see: This game is a VPT2 exercise the children are given a cube with different pictures on each side. The child must follow Kaspars' instructions and show the robot the requested toy, see Figure 2 (B).
Game 6: I spy with my little eye…: This game is based on the well-known game I spy. The toys are placed around the room and the child needs to work out and pick up the toy that Kaspar is referring to and show the toy to Kaspar.
Game 7: What can we see?: In this game a turntable with a divider is placed on the table and a child places a toy on the turntable. The researcher then moves the turntable into different positions and asks the child questions about the visibility of the object in relation to the robot, this is therefore a VPT2 exercise.
Game 8: Who can see what?: Similar to game 7, the child will answer questions on the visibility of toys placed in a holder, however in this game the child will place three toys into the holder and the holder has 3 different positions in terms of the toys visibility to the robot.
Game 9: Where will I look?: This game is inspired by the well-established Sally-Anne test [9] that is a psychological test, used in developmental psychology to measure a person's social cognitive ability to attribute false beliefs to others. In this game there are two boxes, a blue box and a red box, both have lids. The child has one toy and Kaspar asks the child to put it one of the boxes then place the lid on it whist Kaspar watches. The robot then goes to sleep and closes its eyes. Whilst Kaspar's eyes are closed and the robot is "sleeping", the researcher encourages the child to move the toy into the opposite container and place the lid on it. The researcher then asks the child to wake Kaspar up to continue playing. When the robot wakes up, the researcher asks the child to point where the robot would look for the toy to establish if the child has a Theory of Mind.

Figure 2. Children interacting with robot during study

Discussion

The 12 children that took part in this study all possessed different levels of ability and as a result took part in a different number of sessions. In total 69 sessions were run at the school and the games that we devised flowed well and were playable for the children. All of the children managed to complete the most basic games successfully, see Figure 2 (A). Some of the more complex games such as the VPT2 task some children struggled with but most eventually managed this successfully, see Figure 2 (B). The final game that was a Theory of Mind exercise many of the children still struggled with, however some children did make some progress in learning about this, see Figure 2 (C). Generally the games worked as anticipated and the lessons learned from this first pilot-study will be taken into account when conducting our next study in the field.

Future work

Because this research is part of the EU Horizon 2020 BabyRobot project, a project which aims to develop semi-autonomous robotic systems that can work in real world settings and assist with real world problems, a semi-autonomous implementation of the games will be implemented and tested in a school [10]. Prior to developing the games for this work there were some technological considerations take into account and all of the games devised had the potential to apply a level of automation to them which is what we will focus on in the near future.

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References

[1] P. Pennisi, T. Alessandro, T. Gennaro, B. Lucia, R. Liliana, G. Sebastiano, and P. Giovanni, "Autism and social robotics: A systematic review" *Autism Research,* 2015.

[2] B. Robins, K. Dautenhahn, L. Wood, and A. Zaraki, "Developing Interaction Scenarios with a Humanoid Robot to Encourage Visual Perspective Taking Skills in Children with Autism–Preliminary Proof of Concept Tests," in *International Conference on Social Robotics*, 2017, pp. 147-155: Springer.

[3] L. J. Wood, A. Zaraki, M. L. Walters, O. Novanda, B. Robins, and K. Dautenhahn, "The Iterative Development of the Humanoid Robot Kaspar: An Assistive Robot for Children with Autism," in *International Conference on Social Robotics*, 2017, pp. 53-63: Springer.

[4] L. J. Wood, H. Lehmann, K. Dautenhahn, B. Robins, A. Rainer, and D. S. Syrdal, "Robot-Mediated Interviews with Children: What do potential users think?," *Interaction Studies,* vol. Vol. 17:3, pp. pp. 439–461, 2016.

[5] L. J. Wood, K. Dautenhahn, H. Lehmann, B. Robins, A. Rainer, and D. S. Syrdal, "Robot-Mediated Interviews: Do robots possess advantages over human interviewers when talking to children with special needs?," presented at the International Conference on Social Robotics, Bristol, UK, 27th - 29th October, 2013.

[6] J. H. Flavell, "The development of knowledge about visual perception," in *Nebraska symposium on motivation*, 1977: University of Nebraska Press.

[7] K. Dautenhahn, C. L. Nehaniv, M. L. Walters, B. Robins, H. Kose-Bagci, N. Assif Mirza, and M. Blow, "KASPAR: A minimally expressive humanoid robot for human–robot interaction research," *Applied Bionics and Biomechanics,* vol. 6, pp. 369-397, 2009.

[8] L. Wood, K. Dautenhahn, B. Robins, and A. Zaraki, "Developing child-robot interaction scenarios with a humanoid robot to assist children with autism in developing visual perspective taking skills," in *Proceedings of the 26th IEEE International Symposium on Robots and Human Interactive Communication (Ro-Man)*, 2017, pp. 1-6.

[9] S. Baron-Cohen, A. M. Leslie, and U. Frith, "Does the autistic child have a “theory of mind”?," *Cognition,* vol. 21, no. 1, pp. 37-46, 1985.

[10] A. Zaraki, K. Dautenhahn, L. Wood, O. Novanda, and B. Robins, "T*oward Autonomous Child-Robot Interaction: Development of an Interactive Architecture for the Humanoid Kaspar Robot*," presented at the 3rd Workshop on Child-Robot Interaction (CRI2017) in International Conference on Human Robot Interaction (ACM/IEEE HRI 2017), Vienna, Austria, 6-9 March 2017.