

Institution: University of Hertfordshire
Unit of Assessment: Panel B (11): Computer Science and Informatics
Title of case study: Robot-assisted Play for Therapy in Children with Autism
<p>1. Summary of the impact (indicative maximum 100 words)</p> <p>In 1999 Kerstin Dautenhahn proposed a new multidisciplinary research direction encompassing robotics, psychology, assistive technology, interaction design, human–robot interaction and autism therapy. In 2005 she began developing the humanoid robot Kaspar, whose evaluations suggested therapeutic suitability for children with autism. Ongoing research a) led to the development of appropriate human–robot interaction technology, interaction scenarios and methodological approaches b) stimulated national and international public discourse on robot-assisted therapy for children with autism; and c) informed practitioners’ views on using robot technology in autism therapy. A former doctoral student also exploited her Hertfordshire training via an international robotics start-up marketing toys for children with autism.</p>
<p>2. Underpinning research (indicative maximum 500 words)</p> <p>People with autism show impairments in social communication, interaction and imagination and fantasy. Research suggests that they feel comfortable in predictable environments and enjoy interacting with computers, and that computer-based learning in therapy and education can teach language and academic skills to children with autism. Teaching such children about social interaction and enabling them to communicate with others provides essential life skills necessary for independent living; therapeutic benefits that may help reduce the severity of inappropriate social behaviour; a context that allows engagement with friends and family, supporting the development of meaningful relationships with others; and a context in which children can enjoy social interaction and communication within a play setting. Further evidence suggest that some people with autism prefer interactive robots to non-robotic passive toys or humans, and that they respond more quickly to robot rather than human models in imitation games and simple ball games. Psychologists and medical staff see great potential in using interactive robots for autism therapy, especially as research indicates that individuals with autism exhibit strengths in understanding the physical world and relative weaknesses in understanding the social world.</p> <p>In the late 1990s Kerstin Dautenhahn founded the interdisciplinary Aurora project, an ‘umbrella’ project for research in the innovative area of robotic assistive tools for children with autism. The university’s Aurora researchers worked with various different commercially available robots and a research platform developed within the EU project IROMEC, but the most promising results were with the robot Kaspar (Kinesics and Synchronisation in Personal Assistant Robotics’), which became the focus of ongoing research. From 2005, a university research team led by Professor Dautenhahn and including co-investigators Dr Ben Robins, Professor Chrystopher L. Nehaniv and Dr David Lee developed a new, minimally expressive robot that could teach children with autism about social interaction and communication skills, also mediating contact between the children and others. The first ‘Kaspar’ prototype was produced within three months, after which the robot was developed and used in various research projects on developmental robotics and human–robot interaction.</p> <p>Kaspar had several advantages over robots developed by other research teams and companies (such as Robota, Keepon, NAO or Probo). These include: its range of expressions; the design of interaction scenarios adaptable to the developmental and therapeutic objectives for specific children; robustness; and low cost (compared with other expensive laboratory prototype robots), while remaining suitable for real-world applications. Kaspar is obviously a robot but possesses specific and important human features important for human-to-human communication and interaction. Its combination of human and robotic features is deliberate: it is known from the autism research literature that children with autism experience difficulty in generalising learned skills and knowledge.</p>

Impact case study (REF3b)

In August 2012, a two-and-a-half year project phase began with three key aims: redesigning Kaspar for robustness and usability for non-researchers; conducting long-term therapeutic and educational case studies in schools and in the homes of children with autism; and inaugurating a randomised controlled study to provide statistically sound data on robot-assisted therapy for children with autism. The Hertfordshire team collaborates with psychologists, clinicians and assistive technology experts at various centres in the UK and overseas.

3. References to the research (indicative maximum of six references)

Bold type indicates Hertfordshire Aurora (or associated) researchers at time of publication. Three publications that are REF2 outputs, and by which research quality may also be judged, are indicated by asterisks.

P. Dickerson, **B. Robins** and **K. Dautenhahn** (2013). Where the action is: A conversation analytic perspective on interactions between a humanoid robot, a co-present adult and a child with an ASD, *Interaction Studies*, 14(2), 297–316. doi: 10.1075/is.14.2.07dic

****B. Robins, K. Dautenhahn, E. Ferrari**, G. Kronreif, B. Prazak-Aram, P. Marti, I. Iacono, G.J. Gelderblom, T. Bernd, F. Caprino and E. Laudanna (2012), Scenarios of robot-assisted play for children with cognitive and physical disabilities, *Interaction Studies*, 13(2), 189–234. doi: 10.1075/is.13.2.03rob

F. Amirabdollahian, B. Robins, K. Dautenhahn and **Z. Ji** (2011). Investigating tactile event recognition in child-robot interaction for use in autism therapy, *Proceedings 2011 Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 11)*, Boston, MA, USA, 30 August to 3 September 2011, 5347–51. doi: 10.1109/EMBS.2011.6091323 ISBN 978-1-4244-4121-1

** J. Wainer, **K. Dautenhahn, B. Robins, F. Amirabdollahian** (2013). A pilot study with a novel setup for collaborative play of the humanoid robot KASPAR with children with autism. *International Journal of Social Robotics* [published online, Sept 2013]. doi: 10.1007/s12369-013-0195-x

D. Francois, S. Powell and **K. Dautenhahn** (2009). A long-term study of children with autism playing with a robotic pet: Taking inspirations from non-directive play therapy to encourage children's proactivity and initiative-taking, *Interaction Studies*, 10(3), 324–73. doi: 10.1075/is.10.3.04fra

** **K. Dautenhahn, C.L. Nehaniv, M.L. Walters, B. Robins, H. Kose-Bagci, N.A. Mirza** and **M. Blow** (2009) KASPAR – A minimally expressive humanoid robot for human–robot interaction research, *Applied Bionics and Biomechanics*, 6(3–4), 369–97. doi: 10.1080/11762320903123567

Grants

1. RoboSKIN Project (www.roboskin.eu/), May 2008–April 2012: **€576,000** awarded to Professor Dautenhahn (Principal Investigator, University of Hertfordshire team).
2. University of Hertfordshire fundraising campaign (running since 2010): donations from 15 national and international foundations, charities and individuals, to fund the Kaspar project's first phase (August 2012 to January 2015). At end July 2014, the fund stood at **£571,714**.

4. Details of the impact (indicative maximum 750 words)

Stimulating Debate

Research into Kaspar's therapeutic and educational use with children with autism is advanced, although much more work is needed to further show the therapeutic/educational benefits for children with autism. The greatest impact between 2008 and 2013 lay in stimulating public and practitioner debate, and advancing understanding of robots and autism therapy.

Public discourse was informed via national and international television, internet and print media coverage. Between January 2009 and July 2013, over 120 press and online stories appeared on robot therapy, each citing or focusing on Kaspar; in March 2012 alone, 11 Canadian newspapers picked up a Reuters report on autism that featured Kaspar prominently. These sources – chiefly in the UK, US and Canada but also India and Australia – included prestigious outlets such as the *Los Angeles Times*, *The Hindu* and *BBC News* online. In-depth TV coverage of the university's work appeared on Japanese national TV (24 May 2008), and Fern Britton's show and *The One Show* (both 2011), and an Associated Press report was watched by over 24,000 Youtube viewers between March 2011 and July 2013.

The team frequently attends public events. On 28 November 2012, for example, Kaspar and associated research was presented at the London Science Museum's public 'Lates' evenings. Of 120 attendees, 58 completed a questionnaire: 83% said they found the research surprising and 74% that it changed their views on robots; 91% wanted to know more about how robots could assist people with special needs, and 97% felt the event had stimulated public discussion on assistive robots. Similarly, 2011–12 saw Kaspar at the Autism Show (London), Autism Central (Birmingham), NAIDEX (London), and the National Autistic Society conference (Manchester). Kaspar-related talks, lectures and demonstrations occurred at a symposium celebrating 100 years since the birth of Alan Turing (Edinburgh, May 2012); the National Autistic Society professional conference (Manchester, March 2012), the regional Speech and Language therapists gathering (Hertford, December 2012), and a symposium for autism clinicians (Israel, June 2012). In May 2013, 145 people saw Kaspar demonstrated at a healthcare event at the University of Hertfordshire, with a keynote address by Jane Asher, the National Autistic Society's president.

Reactions to Kaspar can be critical – it reminds adults of 'evil' fictional robots. But once it is 'in action' they can see a complex system with specific features aimed at helping children with autism to learn about human communication and interaction. When parents observe their children interacting with Kaspar, they realise its therapeutic possibilities, and that it is not meant to be a cuddly toy. One comment from a public event is typical: 'Initially I thought Kaspar was creepy, but after seeing how he improves the children's behaviour I was very impressed.' (Section 5, Ref. 7)

Working with Parents and Carers

Close collaboration with carers and teachers of children with autism has helped define Kaspar sessions adapted to individual therapeutic and educational needs. About forty families attended events in 2009 and 2011, and a professional day involved around thirty practitioners working with this client group. Such events aimed to gather structured feedback from potential primary and secondary users; informal comment also informed research directions and appeared to indicate that Kaspar could help some children socially. One woman said of her daughter:

She's actually got proper friendships now. Children used to approach her and she'd be a bit [wary]. Around the same time as working with Kaspar, she'd start to embrace this a little bit more and she was happy to hold hands and hug. Affection used to always be on her terms and if you didn't say, 'Can I have a hug?' and you just went and hugged her, then you might have got scratched or something like this, so you always had to pre-warn her. Whereas now it's much more spontaneous. (Ref. 8)

Such tentative, encouraging input has been important in Kaspar research development.

Dissemination to Other Researchers

In terms of number of long-term studies performed, the team's work with Kaspar is advanced, and Dautenhahn and Robins are often invited to give presentations to other research groups. In 2013, Kaspar was included in the Dutch healthcare project 'Social Robots in Care', whose leader wanted social robots that had the 'potential to actually solve a care problem' and 'already were heading in the right direction'. The project leader reported that the Hertfordshire team had 'demonstrated with KASPAR a remarkable sensitivity of what is important for care', and believes that its inclusion in his project is one of the reasons it received national funding (Ref. 10).

Commercialisation

Tamie Salter, a former Hertfordshire doctoral student, now CEO of Canada-based Que Innovations, has said: 'My PhD . . . completely inspired my decision to start a company that develops robotic devices for children with Autism' (Ref. 10). Que Innovations has completed the design and initial trial phase for the **QueBall™** (previously 'Koule')

[text removed for publication]

5. Sources to corroborate the impact (indicative maximum of 10 references)

Selected Media Coverage

Television

1. *Fern*, Channel 4, 21 April 2011. Video available at:
<http://homepages.stca.herts.ac.uk/~comqbr/C4_Fern.htm>
2. *The One Show*, BBC1, 18 August 2011. <www.youtube.com/watch?v=TjWObFi2bS4>
3. 'Kaspar the friendly robot helps autistic kids', Associated Press video, uploaded to Youtube 8 March 2011: <www.youtube.com/watch?v=D6gTHPoO9VI>

Press

4. 'Kaspar the friendly robot teaches autistic children how to enjoy a simple hug', *Mail Online*, 9 March 2011, <www.dailymail.co.uk/health/article-1364585/Autism-Kaspar-friendly-robot-teaches-autistic-children-enjoy-simple-hug.html>
5. Chris Woolston, 'Robots built to help autistic children: An effective therapist might just be metallic, mechanical and nonhuman.' *Los Angeles Times*, 17 October 2011. <www.latimes.com/health/la-he-autism-robots-20111017,0,5798122.story>
6. 'Robot at Hertfordshire University aids autistic children', *BBC News Online*, 25 December 2011, <www.bbc.co.uk/news/uk-england-beds-bucks-herts-16261057>

Professional Events: Questionnaire feedback

7. A file is available of collated feedback forms and questionnaire data from the public and professional events described above; this includes the visitor comment cited in section 4.

Video

8. University of Hertfordshire KASPAR Campaign video (source of parent's quote on page 3 above): <www.youtube.com/watch?v=wdF7TwhUgLY>

Institutional Corroboration

9. Tamie Salter, 'From Robotics Research to Enterprise' (Salter describes her commercial activity deriving from the Aurora project). University of Hertfordshire blog:
<<http://blogs.herts.ac.uk/research/2012/11/27/from-robotics-research-to-enterprise/>>
10. Details of two individuals who can corroborate aspects of the impact described in section 4 are supplied separately.