EVALUATING THE RESPONSE OF CHILDREN WITH AUTISM TO A ROBOT

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ABSTRACT:
Since 1998, the Aurora project has been investigating the use of a robotic platform as a tool for therapy use with children with autism. A key issue in this project is the evaluation of the interactions, which are not constricted and involve the child moving freely. Additionally, the response of the children is an important factor which must emerge from the robot trial sessions and the evaluation methodology, in order to guide further development work.

BACKGROUND:
The term autistic spectrum disorder (ASD) encompasses a range of disabilities and includes Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS), Aspergers Syndrome and the diagnosis of autism. Depending on the designation, ASD affects between five and fifteen people in every ten thousand. The effects vary considerably between people, but common symptoms are hyper-sensitivity, learning and developmental problems and problems and avoidance of social interaction. The National Autistic Society state three main symptoms of autism, which they term the 'triad of impairments'. These are deficits in 1) social interaction, 2) social communication and 3) imagination and generalisation. While autism is a life-long disability, a number of therapy programs exist to help the person to cope with daily living. One of the most popular of these is the TEACCH program (Treatment and Education of Autistic and related Communication handicapped Children) [1] which centres on a philosophy of promoting pro-active behaviours by using unrestricted learning and positive reinforcement.

THE AURORA PROJECT:
The Aurora project (Autonomous Robotic Platform as a Remedial Tool for Children with Autism) [2, 3, 4] was started in 1998 to investigate the use of a robotic platform as an aid to the therapy of children with autism, specifically in the area of social interaction and communication. In line with the TEACCH program, where situations are presented to the child who is able to respond, it was thought that a robot would allow the child to interact in an unrestrained manner. Also, it was thought that a wheeled robotic platform would be most familiar and reassuring for the children, due to television and similarities with vehicles.

In the long term, the project aims to provide an additional method of therapy and learning for the teachers of autistic children. Short term goals of the project are to allow the children to experiment and interact with the robot and to gauge the response that this platform elicits from the children. One of the most challenging aspects of the project is to develop a methodology to evaluate the interactions between the children and the robot. Since the project does not aim to constrict the children in any way, both the robot and child are able to move around a room and to interact in any way that they are able. However, the unrestrained nature of the interaction makes evaluation of the effects difficult. In response to this, a micro behaviour analysis was developed, based on [5]. The next sections focus on methods and results of a comparative study involving the robot and a non-robotic toy.

METHOD:

Robot trials take place in a room – approximately 2 meters by 3 meters – at a school for autistic children and the robotic platform used is robust enough for the children to push it around and play naturally. Four male children interacted with the robot, with ages ranging from 7 to 11 years and all where mid to high functioning. The robotic platform is 30cm by 40 cm and weighs 6.5kg. Eight infrared sensors allow obstacle avoidance and a pyro sensor to detects the children, while it is programmed with a library of behaviours such as obstacle avoidance and speech output. Average trials last for ten minutes, for four minutes the child was able to interact either with the robot, or with a similar size and shape toy truck, for two minutes both the toy and the robot (which is now turned off) are present and the last four minutes involve the toy or robot (whichever was not used previously). However, this plan is occasionally altered, by a teacher from the school, who is on hand in case the children become distressed and in order to observe when the child should end the interaction.

Trials are evaluated using the video record and each second of the video is analysed for a number of behaviour parameters, to quantify the interaction. The behaviour parameters used fall into two categories – the first category consists of behaviours where the focus of the behaviour is important, eg the child handling the robot or an object in the environment, and the second category consists of behaviours where the focus is indeterminate or less important, for example the child may say a phrase where it is difficult to determine the target. The behaviour parameters are:

Category One: *eye gaze, eye contact, operate, handling, touch, approach, move away, attention.*

Category Two: *vocalisation, speech, verbal stereotype, repetition, blank*

Operate (to use the robot by its sensors), handling (moving the object through force) and touch are grouped into a single category to represent the total contact time. Eye gaze attempts to describe what the child is looking at, while eye contact is judged as situations when the child looks at the perceived ‘head’ of the object (the heat sensor for the robot, the front windscreen for the toy. The blank parameter record the instances when the child is doing nothing or very little and notes are made to catch any behaviours which may be relevant but which are not otherwise covered.

RESULTS:

		Touch	Handle	Operate	Seconds	Contact	Gaze
Child A	Robot	26.33%	42.70%	0.00%	452	69.03%	81.64%
	Toy	11.79%	45.12%	-	246	56.91%	40.24%
Child B	Robot	18.61%	5.28%	18.06%	360	41.95%	60.56%
	Toy	3.33%	57.22%	-	360	60.55%	71.67%
Child C	Robot	11.26%	72.64%	0.00%	435	83.90%	93.33%
	Toy	0.00%	2.99%	-	134	02.99%	14.18%
Child D	Robot	1.93%	0.23%	17.08%	363	19.24%	53.99%
	Toy	19.33%	37.67%	-	300	57.00%	60.33%

Figure 1: The percentage of time for behaviour parameters. Contact time is the total of touch, handle and operate.

These results in figure 1 show that the robot and the toy have similar contact times, with two children having a higher percentage for the robot and two with the toy. However, the trial times are generally longer for the robot, indicating that the children are happy interacting with it.

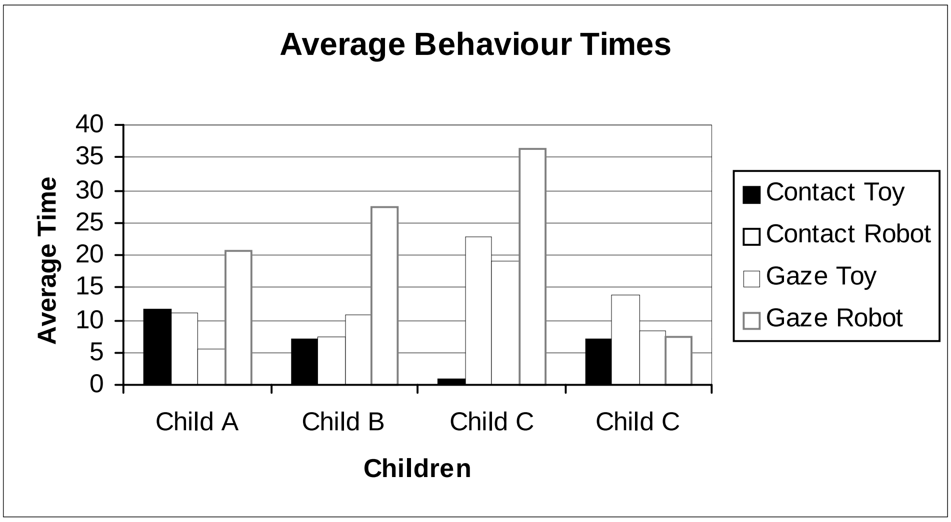

Figure 2: The average time of behaviours for toy and robot.

Figure two shows the average length of the behaviours, with most averages being higher for interaction with the robot. The results show that the children are not afraid of the robot and that they are able to interact and to play with it at ease. This quantitative characterisation of human-robot interaction patterns with individual children provides a foundation for further work in order to develop the robot as a therapy device.

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