Autism and mobile robotics: a first experience

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Astract. Autistic Spectrum Disorders lead to the necessity of a fully adaptive management. Game is an educational way of intervention. First studies with an automous robot tend to point out that these children's social behaviour would be helped when interacting with a robot toy. With a remotely operated robot prototype, we led a comparative study between a traditional toy play and the remote operated robot play between the two playing conditions. The robot seemed to capture the children's interest. This study has also allowed us to acquire information on the solitary and social play of these children with the robot.

Keywords. Autistic Spectrum Disorders, solitary play, social play, remote operated mobile robot, autonomous behaviour

1. Introduction

Autism is a developmental disorder in which people manifest impairments in social interaction and communication. Specific therapies have been developed, some of them based on therapeutic games with increasing complexity. It seems children like playing with computers or different kinds of machines ([1]). That can be explain in two ways. Firstly, machines follow simple rules when they have been programmed to realise simple actions. Children can then understand their operating modes. Secondly, machines being predictable, they give children a reassuring environment. A first experience has been realised in 1976 with robotic tortoise ([2]). This idea has been again developed for few years. [3] shows that robot can facilitate child attention and increases interaction with persons. Interaction is measured by counting number of glances and number of smiles ([4]). Another work has been done at EPFL. [5] presents Robota, a "clever toy and educational tool". It is a small humanoid robot that can move legs and arms. The idea is to suggest imitation of the toy by the children. Michaud has developed roball ([6]). It is a ball that can move alone on the floor. Its main advantage is to be stable in all positions. This is an important characteristic. Moreover, robot used by autistic children must be very robust.

In this context, a wheeled mobile robot called RobAut has been developed in LSC. The first version presented here is remote controlled by a human operator. Design has been studied with the psychiatrist of the day hospital in which experiments take place. This paper exposes first experiments done with RobAut. Section 2 presents material and methods. Section 3 deals with behavioral criteria studied. Section 4 gives first results which are discussed in section 5.

2. MATERIAL AND METHODS

2.1. Place

This study proceeded with six children (5 boys and 1 girl), whose age lies between 8 and 10 years, presenting an invading disorder of the development. The playing sequences were filmed and recorded for a microscopic analysis. Within the framework of the study two toys were used: i) a small-sized plastic tipper called "truck. When the bucket is filled with small stones, this toy will be then known as "s-truck"; ii) a mobile robot with a simple design ([7]). The robot speed is 30cm/s. First, the robot is inanimate and called "robot". Then, the remote operated robot, called "RobAut", is operated with a joystick by an operator through a wireless connection. The experiments took place in a furniture-free room known by the children. In a first part, the playing sequences concerned the child alone. The second part of the study includes an educator who tooks part as a playing partner with the child.

2.2. Operational protocol

2.2.1. Play with the truck and the inanimate robot

The 5 minutes' playing sessions for the two conditions (truck and robot) proceeded over 2 weeks. The sessions began in an identical way for each child: Truck or robot placed at the centre of the room. Thus, either the child engaged directly in a game alone with the toy or the educator intervened in order to support the game alone or with her. The educator had the initiative of her interventions, as well in the selected moment as in the type of intervention.

2.2.2. Play with the remote operated robot

Over 4 weeks, the playing sessions were divided, for the two conditions, into two 2 minutes 30 seconds' phases (phase A and phase B). Phase A is reserved for the game alone with the toy, the educator only intervening to support the game. Phase B is reserved for the game with the partner via the toy, the educator soliciting the child so that they can play together. The condition s-truck made possible a play of loading/unloading the truck. The condition RobAut made possible a play of pursuit. For RobAut condition, when the child and the educator entered the room, the remote operated robot carried out three movements (go forward, move back, turn) to draw the attention of the child and to support the play of pursuit.

3. BEHAVIORAL CRITERIA

3.1. Duration of the play

The duration of the solitary play (sum of the duration of sequences of solitary play) is defined by an alone and active contact to the toy. Play with the partner, defined by an active and joint contact of the toy by the child and the educator, is equal to the sum of the playing sequences duration with the partner during the session.

3.2. Interventions of the educator

Three intervention categories were kept:
- play alone: attention of the child is directed towards the toy to engage in a play.
- play with partner: the child is solicited for a 2-partners game.
- toy: the toy is broken. Repairs need interruption of the playing sequence.

3.3. Types of games

Ten types of plays with the remote-operated robot (RobAut) were highlighted:
- pursuit: the robot is run after. The inversion of the roles is possible.
- stop: the robot is immobilised because of a pressure exerted on it.
- follow: the robot is accompanied in its displacements.
- push: the toy is moved by pressure.
- examine: the interest is related to the facial representation of the robot.
- noise: the sounds produced by the operation of the robot cause the attention.
- stride over: the robot is crossed by extension of the legs.
- tap: small slaps are given to the robot.
- control: displacements of the robot are verbally controlled.
- handle: the robot is investigated.

For this exploratory work, according to conditions, we compared and calculated the average percentages of playing duration for the solitary play and the play with the partner in a general way and an individual way. The results of these comparisons are presented in the following section.

4. FIRST ANALYSIS OF THE CHILDREN BEHAVIOURS

4.1. Play wit the inanimate robot

Table 1 shows the duration of the play alone and the play with the partner for the whole group of children. The average number of interventions of the educator for the two conditions, to support the play alone, the play with the partner and the interventions concerning the toy, is significantly lower under the condition robot than truck.

Game duration Average %	Play alone	Play with partner
Truck	82,34	17,66
Robot	78,13	21,87

Table 1: Duration of play alone and play with the partner for the whole group of children

4.2. Play with the remote operated robot

4.2.1. Duration of playing alone and playing with partner during phases A and B

Game duration Average % Phase A	Play alone	Play with partner
S-truck	86,24	13,76
RobAut	93,19	6,81

Table 2: Duration of solitary play and play with partner for the whole group of the children during phase A

In phase A (table 2), duration of playing alone would last a little bit more than with the

condition RobAut. There is, during this phase, few sequences of game with the partner due to interventions of the educator to support the child to play.
For the phase B (table 3), there would be, with RobAut condition, compared to s-truck, a little less of play with the partner and a little more of play alone. During phase B, there would be almost as much playing alone than with the partner for the two conditions. In this phase, even if children are invited to play with the partner, then spend half their time playing alone.

Game duration Average % Phase B	Play alone	Play with partner
S-truck	44,3	55,7
RobAut	53,12	46,8

Table 3: Duration of solitary play and play with partner for the wholegroup of the children during phase B

4.3. Type of play with the remote operated robot

From the analysis of the types of play with the RobAut, the most frequent ones have been highlighted. This analysis also made possible a comparison between the types of game played alone with the types of game played with the partner for this condition.
One can notice that the most frequent types of plays are: stop, follow and handle. The less played game is examine. The atypical games are control, tap, noise and stride over. The most frequent types of game are to follow, push, handle, span and block. Noise is a rare type of game. The games of pursuit, control and examine are atypical. We will keep in mind these two analyses that, in the playing alone, the most frequent games are follow, block and handle. These games are found, in the play with the partner, as belonging to the most frequent games with stride over and pushes. Also, only two boys engaged in a play of pursuit.

5. DISCUSSION ET PERSPECTIVES

The first part of the study has shown that the requests of the educator could inhibit the child who would react to the intrusion by a withdrawal. This withdrawal is interpreted like an expression of a conflict of approach/avoiding ([8]). In the second part of the study, we highlighted that, for the traditional toy, the more there were interventions of the educator, the more there were sequences of play during phase A. This effect was opposite for the remote operated robot. The solitary play could thus be preferred by the child when it is placed in situation of play with the robot. The average number of interventions of the educator, more important at the time of the play with the remote operated robot, involving the interruption of the sequence of play, could partly explain the absence of significant difference of duration of play between the play with the traditional toy and the remote operated robot.
The types of play that the children established with the remotely operated robot consisting in handling, blocking and following the robot are frequent as well in the solitary play as in the social play ([9]). The analysis of the types of play shows that locomotion plays can be developed alone and with the partner. The play of pursuite, possible with the robot, was carried out only by two children. The types of play like following the robot, blocking it or spanning it could lead to a pursuit. So, these plays imply a play with a distance with the robot which could, perhaps, be adopted by all the children. The child's withdrawal. reaction to the approach of the other could, instead of

being a system of defence, becoming a play ([10]). Plays of exchange would be more stimulative for the child. The situation of exchange implying an object is a mean of communication ([11]).
It clearly appears, with the analysis of the first results of this exploratory work, that the presence of the educator is a very perturbing factor. In addition, the behaviour of the remotely operated robot depends mainly on the operator, on his own behaviour, on the steadiness of his behaviour, the vision that he has of the scene and on the interpretation of the instructions given to the operator at the beginning of the session. It is important to eliminate these disturbing factors and to integrate in the robot a certain number of autonomous behaviours mainly those favoured by the child.
Until now, the robot properties have been defined according to psycho-therapists who knew the children. They have also been defined according to the technological constraints of reliability and robustness of the existing robot.
These behaviours (escape when a child approaches, a move back to the child in the case of a loss of interest…) should moreover be able to be individualised according to each child. Our work goes in the near future being characterised by the following points:

-equipping the robot with sensors of presence and displacement
-providing to the robot effectors to draw the attention of the child to cause the play,
-seeking means to adjust the magnitude of these behaviours,
-defining them so that the therapist can adapt them to the child and to the therapeutic goals,
-giving to the robot a set of semi autonomy,
-training the robot to adapt its reactions to the child.

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