Investigating the Use of a Mobile Robotic Toy as an Imitation Agent for Children with Autism

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Abstract

Unpredictability and complexity of social interactions are important challenges for a low functioning autistic child. The objective of this research is to explore if a mobile robot could, by being more predictable, attractive and simple, facilitate reciprocal interaction such as imitation. By conducting an exploratory study involving four children, we found that forms of share conventions such as imitation of body movements and of familiar actions are higher with two children paired with a human mediator, compared to two children paired with a robot mediator. The two children paired with the robot mediator demonstrate better shared attention (visual contact, physical proximity) and imitate facial expressions more than the children paired with the human mediator.

1. Introduction

Compared to 8-9 months old regular development children, 5 years old low-functioning autistic children present the same sensory interests. However, their sensory plays are more repetitive (Blanc *et al.,* 2002), their imitation is selective and used with an aim of increasing the stimuli (Lemay, 2004). They also present unexploited abilities (e.g., attribute intentions to the imitator; plan and induce imitative behaviors and understand incitation to imitate) (Nadel 2002) and deficits in sharing attention (avoids eye contact, does not smile) and conventions (poor imitation of facial expressions and gestures) for communicating common interests (Lemay, 2004). Also noted is the quasi-absence of verbal language and pretend play (Blanc *et al.,* 2002). These deficits are explained by a difficulty in perceiving and treating stimuli from their environment, affecting comprehension of social signals (gestures, words and intentions of others) (Zibovicius, 2004). Thus, low-functioning autistic children need interventions which take into account their particular interests and their decoding deficits by a predictable and simple medium, able to catch their attention and easy to decode.

Mobile robots show potential in that regard because they are predictable and simple medium, easy to decode and can be designed in accordance with particular interests and decoding deficits of children with autism. They generate more interest and a wide variety of interplay situations compared to static objects, and bring into play social interactions skills (visual contact, imitation) (Robins *et al.,* 2004).

This study aims to verify that an animated object, more predictable and less complex than interacting with humans, would make the autistic child demonstrate reciprocal communication, observed by: 1) the reduction of avoidance mechanisms, namely repetitive and stereotyped plays with inanimate objects; 2) the increase in shared attention and shared conventions; and 3) the manifestation of symbolic mode of communication like verbal language.

2. Methodology

Our methodology consists of conducting an exploratory study following a single case protocol (Kazdin, 1976) (22 exposures, 5 min cases, 3 times/week over 7 weeks). We evaluated shared attention and shared conventions with four 5 years old low-functioning autistic children (3 boys and 1 girl) selected in the Centre de réadaptation le Florès of Laurentides, Québec, Canada. The experimental procedure exposes a pair of children in interaction with a robotized mobile mediator (animated object with human-like appearance) and the other pair in interaction with a human mediator (the experimenter). The two mediators execute the same imitation plays of facial expressions, body movements and familiar actions with or without objects.

The robot mediator, named Tito, is shown in Fig. 1. Tito is approximately 60 cm tall and is colored, red, yellow, and blue. Its clothes are washable and made of soft material. It uses wheels to move, but its structure shows two feet and two legs. It has two arms that can move up and down rapidly, a head that can rotate (to indicate `no') and rise up (to express surprise), a mouth (for smiling), two eyes, a nose and hair (made from fiber optic cable to illuminate). Also, a small wireless microphone-camera device was installed in one eye of the robot. Different parts of Tito's body can be illuminated and it is able to sense if it is being shaken

or if it has flipped over. The robot is also equipped with ultrasonic range sensors for simple obstacle avoidance. Tito generates vocal requests through pre-recorded messages. A wireless remote control (using a video game controller) was designed for teleoperation, and an on-board microcontroller enables pre-programmed sequences of behaviors (motion and vocal messages). Examples of pre-programmed behaviors are: moving the left arm while saying goodbye, expressing happiness by moving its arms, singing and rotating on the spot, or shaking its head to indicate no. Tito records and stores internally the timing between the interactions of the child (from sensory data and according to the experimental scenarios). Tito also emits a sound when it starts the execution of an experimental scenario, allowing synchronization of video data recorded with an external camera. The activation button of Tito is hidden at the bottom of the robot so that the child is not tempted to play with it.

Fig. 1 – Tito, the robot mediator

3. Results

Three variables were observed in our trials: shared attention (visual contact / eye gaze directed toward the mediator for more than 3 sec; physical proximity; imitation of facial expression or gesture, but not directed toward the mediator); shared conventions (facial expression, gesture, actions and words, all directed toward the mediator); absence of sharing (no visual contact, leave the communication area, avoid the mediator, sensorimotor play, mannerisms, ritual, aggression). These variables were coded over 12 sec. Windowing, by two coders (98% fidelity) and video footage of the trials (Camaioni *et al.*, 2001).

We observed that children paired with the robot mediator show better shared attention (visual contact, physical proximity) than the children paired with the human mediator in all types of imitation plays including facial expressions, body movements, familiar actions with objects or without objects. This validates the hypothesis that the robot has appealing characteristics for interacting with autistic children. However, we observed that forms of shared conventions such as imitation of body movements and of familiar actions are higher with the two children paired with the human. This may be explained by working with low-functioning autistic children having more difficulty understanding communication intent from the limited motion capabilities of the robot. On the other hand, the two children paired with the robot mediator imitate facial expressions more than the children paired with the human mediator. Imitation of words only appeared for one participant, paired with the human mediator. Children paired with the robot mediator were also observed imitating motor noise made when the robot's articulations are moving.

4. Conclusion

Our study helps understand the processes for decreasing autistic children anguish and increasing their attention to learn certain forms of communication. Our results are very encouraging and support the continuation of work on this research question, repeating the trials with a greater number of subjects and consolidate these conclusions.

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