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Adapting Robot-Assisted Therapy of Children with Autism and Different Levels of Intellectual Disability: A Preliminary Study

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ABSTRACT

Autism Spectrum Disorder (ASD) is a complex developmental disorder that requires personalising the treatment to the personal condition, in particular for individuals with Intellectual Disability (ID), which are the majority of those with ASD.

In this paper, we present a preliminary analysis of our on-going research on personalised care for children with ASD and ID. The investigation focuses on integrating a social robot within the standard treatment in which tasks and level of interaction are adapted to the ID level of the individual and follow his progress after the rehabilitation.

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1 INTRODUCTION

ASD can often comorbid with some level of ID [1], in fact it has been reported that 54% of children with ASD have an IQ below 85 [2], which encompasses 4 ID levels: "mild", "moderate", "severe" and "profound" characterised by significant limitations in both intellectual function and in adaptive behaviour.

Robotics research has shown numerous benefits of robot assistants in the treatment of children with ASD [3], however, most of the studies focused on ASD individuals with no ID or neglected to analyse comorbidity. In fact, very little has been done in this area and it could be considered as one of the current gaps between the scientific research and the clinical application [4].

This paper presents preliminary results of our on-going study on personalised care for ASD with ID children via robot-assisted therapy. The aim is to fully integrate the robot within the standard treatment, i.e. the TEACCH (Treatment and Education of Autistic and related Communication Handicapped Children) approach.

To this end, we experimented a robot-assisted therapy adapted on the basis of a standard skill assessment test, in which rehabilitation tasks and level of human-robot interaction was adjusted according to the ID levels of the participants. The purpose was to verify the applicability of robot-assisted therapy to lower ID levels and to define the robot behaviour accordingly.

2 MATERIALS AND METHODS

2.1 Participants

Six children were selected among patients diagnosed with ASD and ID, as shown in Table 1. All are currently receiving treatment at the IRCCS Oasi Maria SS of Troina (Italy), a specialized institution for the rehabilitation of intellectual disabilities.

Participants' ASD and ID levels have been diagnosed before the start of this study with the following standard psycho-diagnostic instruments: Leiter-R, WISC, PEP-3, VABS, ADI-R, and CARS-2. For more details and explanation see [5].

Children follow a clinical daily program of training using the TEACCH approach with psychologists and highly specialized personnel. The core of TEACCH is that structured teaching can effectively work with children with autism.

Ethical approval had been obtained, all the parents signed consent forms before their children were included in the study.

Table 1: Participants description (Age in months)

P	Age	ID Level	Leiter IQ	Age Equivalent
01	103	Profound	22	22
02	121	Profound	22	22
03	118	Severe	27	29
04	116	Severe	38	31
05	66	Moderate	53	26
06	102	Mild	56	35

2.2 Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP)

Gross motor imitation abilities of the participants were evaluated using the Verbal Behaviour Milestones Assessment and Placement Program (VB-MAPP) [6]. The VB-MAPP is a criterion-referenced assessment tool, curriculum guide, and skill tracking system that is designed for children with developmental disabilities. VB-MAPP considers skills that are balanced and sequenced along the three different levels of child development (0-18 months, 18-30 months, and 30-48 months).

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We administered the VB-MAPP in the standard form to each participant also to evaluate the imitative level of the participants. According to the VB-MAPP protocol, 1 is used to indicate the exact execution of the task, 0.5 a partial execution, 0 for no imitation.

2.3 Experimental procedure

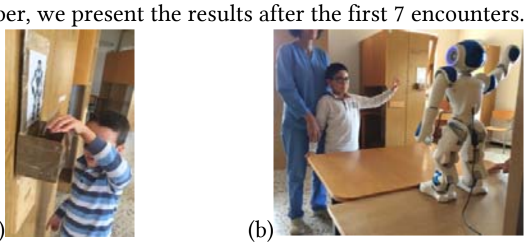
The robot used for experimenting the robot-assisted therapy was the Softbank Robotics *Nao*, which is a small toy-like humanoid robot, very popular for child-robot interaction studies [5], [7].

The robot was programmed to implement the VB-MAPP tasks of the levels 1 and 2, which were then adapted and applied to match the specific level of the participants. For the experiment, we select three tasks (T1, T2 and T3) where the initial imitative score of the children execution was 0 or 0.5.

The procedure comprised a preliminary session to decrease the novelty effect. The robot was presented to all the children in a non-therapeutic context for a total of approximately 10 minutes.

The actual experimentation started after 7-10 days following the preliminary encounter. The experimental study includes a total of 14 encounters over one month, i.e. 3 sessions per week. The experiments were carried out in the same room in which is where children usually do their treatment sessions. Each session was approximately of 6 minutes per child and video recorded by NAO.

In this paper, we present the results after the first 7 encounters.



(a) (b)

Figure 1: (a) daily routine; (b) imitation example

The robot was included in the TEACCH program among the standard activities, which are identified via a specific card (Fig. 1a). For each session, the children performed three gross motor imitation tasks managed by the robot only (Fig. 1b).

A professional educator, selected among those involved in the everyday treatment of the children, was always present to represent a "secure base" for the children. The educator gave positive verbal reinforcement along with a physical reinforcement (a caress). During all the tasks the robot called the children by name to make the intervention more personalized.

2.4 Measures and Analysis

To analyse the child behaviours during the interaction using the following three criteria: **Eye gaze**, when child eye gaze is directed at the robot; **Imitation**, this included active imitation of the robot's movements when prompted; **Educator involvement**, which is when the child looks the educator. Behaviour can be logged simultaneously. The evaluation was made with the use of a record sheet divided into seconds by two researchers, which were separately compiled and the reliability score was 0.85%.

3 EXPERIMENTAL RESULTS AND DISCUSSION

Table 2 presents the video analysis of each task expressed as a percentage of total time, and includes the score of VB-MAPP before (B) and after (A) the robot training. In the first session, P02 was staring at the robot but without interacting with it.

Table 2: Data from video analysis (P= Participant, T=Task)

		Eye Gaze (%)		Imitation (%)		Ed. Involv. (%)		VB-MAPP	
		B	A	B	A	B	A	B	A
P01	T1	13.2	33.8	0.0	5.8	0.0	0.0	0	0.5
	T2	12.5	20.0	0.0	5.7	0.0	0.0	0	0
	T3	19.6	22.2	0.0	6.3	0.0	0.0	0	0
P02	T1	36.7	43.2	0.0	2.9	0.0	0.0	0	0
	T2	100	32.8	0.0	2.8	0.0	0.0	0	0
	T3	100	29.2	0.0	4.6	0.0	4.6	0	0
P03	T1	29.8	62.6	0.0	35.8	5.9	1.4	0	1
	T2	26.4	57.6	0.0	26.0	25.0	1.4	0	1
	T3	36.3	81.2	0.0	21.8	0.0	1.5	0	0.5
P04	T1	88.0	79.4	4.4	44.1	0.0	0.0	0.5	1
	T2	75.0	81.6	5.5	16.9	0.0	0.0	0	1
	T3	80.9	62.1	9.5	40.9	0.0	0.0	0	1
P05	T1	46.2	89.7	0.0	52.9	7.4	0.0	0.5	1
	T2	66.1	86.9	1.4	17.3	12.6	7.2	0	1
	T3	74.2	75.3	7.5	36.9	0.0	4.6	0	1
P06	T1	50.0	64.1	21.2	38.8	9.0	0.0	0.5	1
	T2	52.7	57.1	6.9	31.4	8.3	2.8	0	1
	T3	46.8	48.4	12.5	34.8	4.6	3.0	0	1

4 CONCLUSIONS

Results of our clinical experiment show that the robotic-assisted therapy can be successfully integrated into the standard treatment of autistic children with intellectual disability when interaction is adapted to the individual level. The score of the imitative level significantly increased in 4 out of 6 children with ID. The exception is for lower ID levels, where is needed to find more advanced solutions and approaches for persons with profound ID.

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REFERENCES

[1] L. Underwood, J. McCarthy, and E. Tsakanikos, "Mental health of adults with autism spectrum disorders and intellectual disability," *Curr. Opin. Psychiatry*, vol. 23, no. 5, pp. 421–426, 2010.

[2] J. Baio, "Prevalence of Autism Spectrum Disorders: Autism and Developmental Disabilities Monitoring Network, 14 Sites, United States, 2008. Morbidity and Mortality Weekly Report. Surveillance Summaries. Volume 61, Number 3.," *Centers Dis. Control Prev.*, 2012.

[3] D. Conti, S. Di Nuovo, S. Buono, and A. Di Nuovo, "Robots in education and care of children with developmental disabilities: a study on acceptance by experienced and future professionals," *Int. J. Soc. Robot.*, vol. 9, pp. 51–62, 2017.

[4] J. J. Diehl, L. M. Schmitt, M. Villano, and C. R. Crowell, "The Clinical Use of Robots for Individuals with Autism Spectrum Disorders: A Critical Review.," *Res. Autism Spectr. Disord.*, vol. 6, no. 1, pp. 249–262, Jan. 2012.

[5] D. Conti, S. Di Nuovo, G. Trubia, S. Buono, and A. Di Nuovo, "Use of Robotics to Stimulate Imitation in Children with Autism Spectrum Disorder: A Pilot Study in a Clinical Setting," in *Proceedings of the 24th IEEE International Symposium on Robot and Human Interactive Communication, ROMAN*, pp. 1–6, 2015.

[6] M. L. Sundberg, "Verbal behavior milestones assessment and placement program: The VB-MAPP." Concord, CA: AVB Press, 2008.

[7] P. G. Esteban, P. Baxter, T. Belpaeme, E. Billing, H. Cai, H.-L. Cao, M. Coeckelbergh, C. Costescu, D. David, and A. De Beir, "How to build a supervised autonomous system for robot-enhanced therapy for children with autism spectrum disorder," *Paladyn, J. Behav. Robot.*, vol. 8, no. 1, pp. 18–38, 2017.