Work in Progress: Promoting Self-Regulation for Children with Autistic Spectrum Disorder with Robots

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***Abstract*—The main challenge in educating children with specific needs, particularly those with Autistic Spectrum Disorder (ASD), revolves around their adjustment to the learning environment and their cognitive functions, notably through information processing, executive function control and emotional regulation, which refer to Self-Regulation (SR). SR deficits address significant hurdles, not only for children with ASD but also for teachers who encounter difficulties trying to implement self-regulation systems. The simplicity of robots, such as facial expressions or monotone voice would create less stressful interactions for children with ASD and would improve SR in educational context. Integration models like the 4A model aim to gradually introduce these tools into the classroom. This experimental study, conducted in an ecological settings (which were not studied in literature), has a dual purpose: first, to evaluate the acceptability of robotic agents among teachers and educators; second, to explore how these artificial agents can enhance self-regulation development for children with ASD. This study will have both, qualitatives and quantitatives measures. We expect that Self-Regulation of a child with ASD using a robot depends on the functionality of the robot. Moreover, the most effective and acceptable robot for teachers will be easy to program, have an intuitive interface, and possess hybrid particularities. Finally, we expect that these robots will support children's self-regulation by a learning effect over the long-term. The aim of this study is to deliver a guide for robots' utilization for SR, and to generalize it in school context.**

***Keywords*—Self-Regulation ; Autistic Spectrum Disorder ; Robotic ; Children ; Teachers ; Learnings.**

I. Introduction

Autistic Spectrum Disorder (ASD) is a public health issue with 1% of the population. It is characterized by "Persistent deficits in social communication and social interaction" and "Restricted, repetitive patterns of behavior, interests, or activities". Presence or absence must be specified of: "intellectual impairment, language impairment, medical or genetic condition or environmental factor, another neurodevelopmental, mental or behavior disorder, or catatonia" [1]. However, one of the main difficulties for children with ASD is their adaptation to the environment and their cognitive functioning, notably through emotional regulation, executive function control and information processing, which refer to Self-Regulation (SR). This concept of SR can be explained as a conscious process by which the person orients their own thoughts, actions, and emotions for a specific goal [2]. SR is essential in learning, more particularly in school learning. In fact, when an individual can regulate their own learning, they can develop autonomy and thinking skills in success of the task to fulfil. Therefore, SR behaviors are aiming children to develop autonomy in learning path [3]. In addition, Whitman [4] explains that people with Intellectual Disabilities (ID) show a bigger deficit in SR, this makes it more difficult to generalize knowledge in unfamiliar situations. For that reason, this leads to adaptation difficulties. Finally, Nader-Grosbois and Thomée [5] complete this statement by explaining that other difficulties are directly related to SR difficulties, such as planning actions, maintain attention, choosing cognitive strategies or staying involved in the task. All these difficulties impact teachers as well, by complex conditions at work with lack of time or feeling of stress. This complicates the implementation of a SR system in a class context for all students and of a new tool's integration [6]. SR deficit damages children's learning and then, has negative impacts on the feeling of efficiency and the support of teachers and professionals.

A. Relationships between Use, Usability and Acceptance of Robots

To prevent professional and children's difficulties, the use of a robotic device, as an addition of the adult's support and adapted for children, could be a practical and a relevant solution. To help teachers and professionals in their support to children, robot would offer help in children SR development, which simplify their learning and teacher's practice. Many advantages of robotic use have been demonstrated in literature to work on executive's functions among the audiences mentioned, which are affected by SR. In fact, Dinet and al. [7] used a Cozmo robot in an ecologic context in Autistic Elementary Education Unit (AEEU) among 9 years old children. Robot allows to improve interaction between robot and children and improve caregiver's perceptions on their own capacity and children's. Cozmo's presence also helped to increase interactions peer-to-peer in role-playing task. In addition, Oesch and al. [8] show the benefits of using the NAO robot in lexical acquisition of children with ASD, highlighting the increase of gaze, lexicon and response time. Finally, Azizi and al. [9] highlighted a greater involvement of children with Learning

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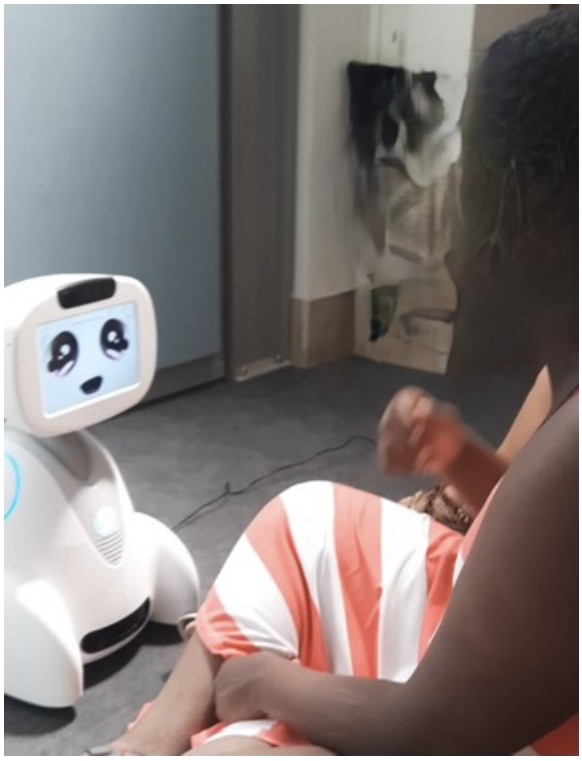

Figure 1: A young child interacting with the Buddy robot

Disabilities (LD) when the task is performed in the presence of the robot (QTRobot). Authors conclude that a social robot can facilitate children's commitment and attention in a educational framework. Both of these capacities are affected by SR, which supports the use of robot in our context. It also provides a way of helping professionals in the field who support children. For example, Figure 1 shows Buddy robot in interaction with a young child.

Nowadays, there are many types of robots on the market (toys, humanoids, animals, machine, etc.). In every type of robots, there are advantages and disadvantages in their use, so it is important to take an interest in a numeric tool integration context for special needs children. In fact, simple robots and animals' ones show their advantages among ASD children, in social skills by facilitating emotional comprehension had to less complex facial expressions. Also, a reduction of sensorial overload and of level of anxiety usually feel with humans have been shown. Concerning android type of robots, they showed no increased capacity on acquired skills over the long term, although some communication improvements have been shown [10]. Moreover, most of experiments were conducted in a laboratory context, which does not allow integration and utilization of tool in an ecological context, suitable and efficient for students and professionals. In a laboratory context, difficulties of teachers' handling, use and acceptability are not considered. Robots can work on each aspect of SR (emotional, behavioural and cognitive) but there are not experimentation which study the effect of robot on global SR yet, this is the goal of this experimentation. Moreover, clinical observation highlights the difficult acceptance and integration of robots by professionals in the field (teachers and educators) in their practice. This emphasize the need for a thorough study of the factors and determinants of the acceptance of robots by teachers in their environment and their practice. To better understand the role of the different parameters explaining the acceptability, and finally the use of a robotic system, the 4A model [11] is the most relevant theoretical background.

B. The 4A Model: Acceptability, Acceptation, Approval, Appropriation

As Figure 2 shows, the 4A model [11] [12] provides an explanation of the temporal process of appropriation of a digital device, such as a robot (for a complete presentation of the model, see [12] [11]. Several studies related to the TAM theory [13] [14] [15] or the UTAUT theory [16] [17] [18] describe the role of attitudes and opinions on future acceptability and acceptance of digital devices [13] [14] [15]. But even if all these studies related to TAM or UTAUT theories provide very interesting results, they have four important limitations that prevent to generalize results: (i) data are often collected by using questionnaires and surveys, i.e., only attitudes, opinions and verbalization are collected; (ii) data are often collected during only one-shot setting, and thus do not investigate the longitudinal and temporal process of appropriation across the time; (iii) they assume that the effective use of a digital device means that this device is accepted; (iv) context and environments (professional, physical, social) are never considered.

The 4A model has several advantages:

- This 4A model allows to better understand the relationships between attitudes, opinions and effective behaviours;
- The temporal and longitudinal dimensions related to the appropriation are included by distinguishing before and after the implementation of the device in the context;
- If attitudes determine effective behaviours, the 4A model proposes that behaviours can also have an impact on attitudes by a reciprocal action (i.e., retro-feedback);
- According to the 4A model, an effective use of a device does not necessarily mean that this device is accepted: in some cases, the use is forced and thus, does not indicate that the device is really accepted.

This 4A model is the only one model that considers representations, cognitive biases, as well as the tool's ease of use and adaptability, offering insights into the integration process. This model is also interesting from an ecological point of view by its consideration of professional's perceptions of robots and their interaction with them. The 4A model highlights that the acceptance of the tool impacts its adoption and incorporation. Hence, professional's view of the robot, its ease of use and the associated usage-related challenges serve as perspective factors for its practical utilization. A progressive handling of the tool allows to facilitate teachers' comprehension and to focus on the use to offer an efficient support, with less workload for professionals.

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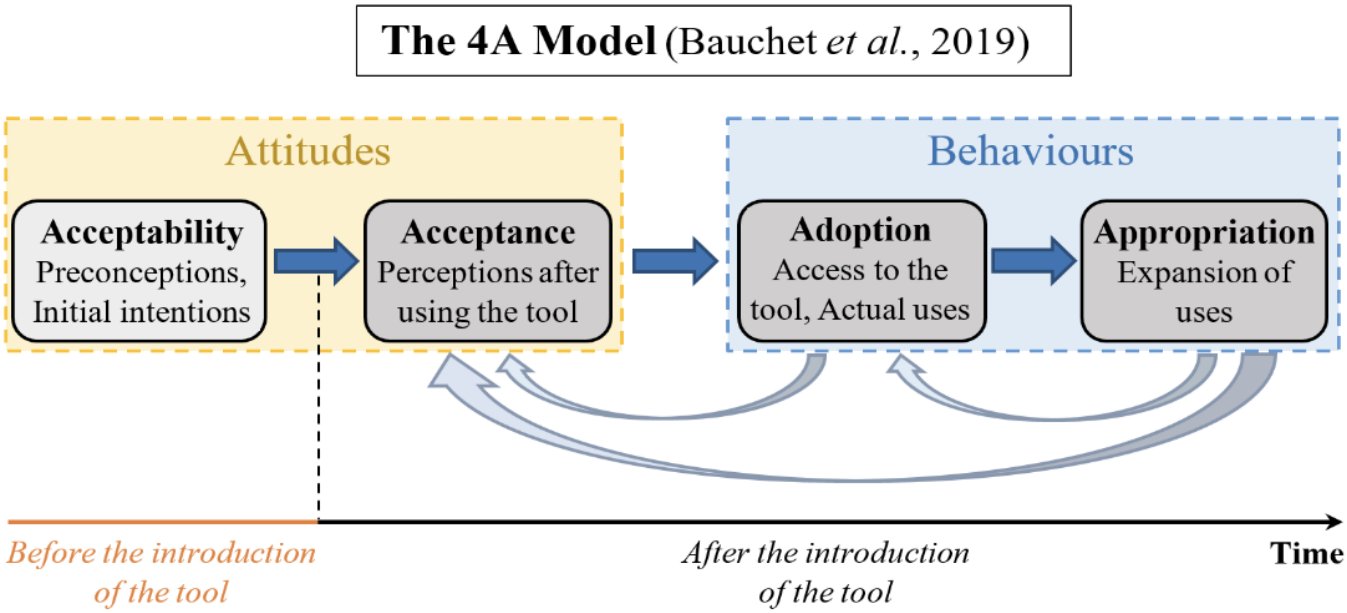

Figure 2: The 4A Model [12] [11]

This research project is based on the premise that robots can be beneficial in developing self-regulation in children with autism. To this end, it emphasizes the importance of comparing the benefits of different robots in an ecological context, and the need to study the factors of acceptability to teachers, as Figure 3 shows.

Following this introduction which presented concepts of ASD and SR, the relationships between Use, Usability and Acceptance and completed by a presentation of the 4A model, the article is structured as follows: in section 2, methodology will be presented, specifying firstly the problematic, secondly hypothesis, thirdly the population and finally the material used. In section 3, discussion and conclusion will be proposed.

II. Method

This study aims in one hand to evaluate a robotic agent's acceptability criteria among teachers and educators. In the other hand, it purposes to the agent's integration in educational system to a self-regulation development of Children with Autistic Spectrum Disorder (ASD). This study will begin by focus groups and questionnaires with specialized professionals, to study needs and expectations. The aim is to create a collaboration between both and collect the point of view of different context on inclusion, difficulties, and intervention with children.

The second step of this work will be to study the robots' efficiency both on self-regulation for children and on integration for professionals (depending on the results of the precedent step by carrying out a data analysis between step 1 and 2). For them, the goal is to determine several features, such as: ease of use, predictability, flexibility, difficulties, and robots' representation. For children, the goal is to increase self-regulation capacities, more precisely on executives' functions (inhibition, visual attention, and tasks memorization). This stage will consist of the development of activities on executives' functions with robot to work on self-regulation in a school context.

The third step will consist of passing new focus groups and questionnaires, to study the efficiency of robots' integration in school context and the impact on inclusion, from professionals' point of view. In those new focus groups, questions will be raised about: representation, integration, permanence over time, generalizing learning and perpetuation.

The fourth step of this study will be data analysis of step 2 and 3. Focus group analysis will provide qualitative measures for children and professionals. Self-regulation analysis will provide quantitative measures for children on cognitive and behavioral self-regulation. There will be different statistical models used, such as Pearson correlation and repeated measures ANOVA.

A. Research Question

All our previous thoughts lead us to study the integration of robots into a teaching system. Therefore, we investigate the question : to what extent can a robot be integrated into a teaching system adapted to develop the self-regulation of a child with an Autistic Spectrum Disorder?

B. Hypothesis

H1: SR of a child with ASD using a robot depends on the robot's functionalities.

H2: Robot facilitates the SR of children through a long-term learning effect.

H3: The integration of robots depends on the user experience (the user's acceptance of the tool).

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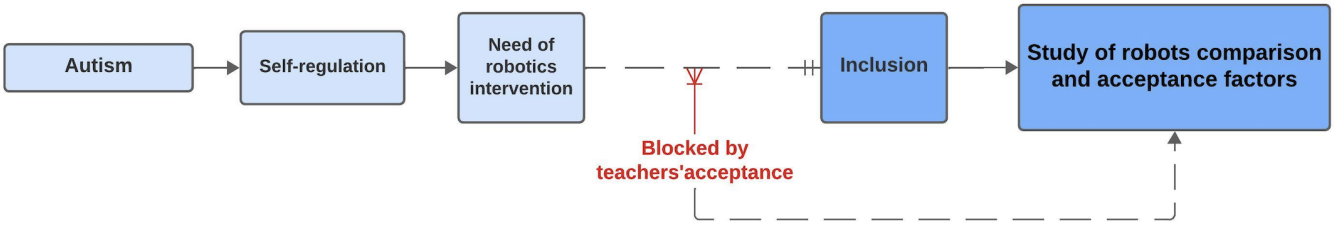

Figure 3: Proposition of a visual presentation of our subject

C. Population

To answer this question, our population will be composed of 50 to 70 children between 3 and 11 years old, with ASD. Data collection will be in educational units of National Education in the Nancy-Metz Academy perimeter and in educational units of J.B. Thiéry Association, in collaboration with pedagogic and educational team.

D. Material

This experiment consists of evaluating 3 dimensions: Children's SR, professionals' perception, and robot's acceptability. Mixed evaluation method will be used to evaluate these 3 dimensions, by using qualitative and quantitative measures (interviews, questionnaires, observation grid). Measures and evaluation scales are under development. The days of presence with the robot will be agreed with the structure's professionals. The Association J.B Thiéry owns several robots: Leka, NAO and Buddy. These robots will be used as part of this study and will be brought in on the agreed days. The project will be studied by an Ethics Committee and will be the subject of a free and informed consent addressed to the parents. Data will be anonymized.

III. Conclusion and Future Work

A fundamental issue for children with ASD is their difficulties in adapting to the learning environment and managing cognitive functions like information processing, executive control, and emotional regulation, which are part of self-regulation (SR). Self-regulation, as the ability to establish strategies and implement means to achieve a goal, is increasingly emerging as a major deficit in autism, and a target for strategic support. The effectiveness of certain robots for developing self-regulation functions in controlled environments means that they need to be evaluated in depth in schools. However, their acceptance by professionals has been hampered by a number of obstacles, such as representations or high cognitive costs. The aim of the study presented in this article is to observe the nature of these obstacles, and to determine the best ways to overcome them. At the moment, a guide is being produced to facilitate robot's utilization and to determine which capacities of children are involved. This will be used to generalized the use of robots in educational context.

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