Enhancing the Utilization of Artificial Intelligence and Social Robots in Specialized Units for Children with Autism

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***Abstract*—In France, approximately 700,000 individuals are affected by Autism Spectrum Disorders (ASD), including 100,000 children. ASD is primarily characterized by challenges in social interaction and communication, as well as restricted and repetitive behaviors. Recent technological advances, particularly in robotics, offer new opportunities to enhance social skills interventions for children with autism. Programs such as Treatment and Education of Autistic and related Communication Handicapped Children (TEACCH) and Early Intensive Behavior Intervention (EIBI) have proven effective in promoting communication, adaptive behaviors, and inclusion in mainstream settings. This ongoing study examines how educational teams perceive and integrate social robots into specialized classrooms for children with ASD. Three robots (NAO, Leka, and Buddy) were introduced in two specialized teaching units, with a focus on teacher and health professional acceptance and perceived utility. Data were collected through focus group discussions, Karasek's Job Strain Model questionnaire (decision latitude, psychological demands, and social support), the Self-Efficacy Scale (SES), and The Human–Robot Interaction Evaluation Scale (HRIES). The results indicate that higher decision latitude is positively associated with teachers' sense of self-efficacy. Perceptions of the robots varied significantly: Leka received the highest ratings for sociability and the lowest for disturbance, while NAO and Buddy elicited higher disturbance scores. Focus group discussions revealed several constraints—organizational, communicational, and institutional—that influence the successful adoption of robots. While participants acknowledged the potential of robotic tools to boost motivation and increase student engagement, they also expressed concerns regarding time investment, over-reliance on technology, and reduced human interaction. In conclusion, the findings emphasize the importance of careful planning and the creation of supportive work environments for the integration of social robots. Future research should focus on refining robot design, developing comprehensive staff training, and exploring larger-scale implementations to maximize learning outcomes for children with ASD.**

Keywords-autism; robots; artificial; intelligence; interactions; ergonomics.

I. INTRODUCTION

This section will introduce the subject of ASD and care to follow by the benefits of social robots for autistic people.

A. Autism and Care

In France, approximately 700,000 individuals are affected by Autism Spectrum Disorders (ASD), including 100,000 children. As outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) and International Classification of Diseases (ICD-11), deficits in social interaction and communication are core characteristics of autism. People with autism are a highly heterogeneous group, making it difficult to pinpoint specific defining symptoms. The rapid advancements in technology, particularly in robotics, present significant opportunities for innovation in the treatment of individuals with ASD. Recent developments have enabled robots to perform a variety of human-like functions, offering potential to enhance social skills in individuals with ASD. Autistic children often struggle with social interactions and cooperation. They may appear uncooperative because they haven't yet learned the appropriate behaviors for different social situations, or they may have difficulty managing strong emotions, such as anger, frustration, or anxiety.

Recommendations for providing quality support to children with autism emphasize a multidisciplinary and intensive approach. Recent advances have enabled robots to perform a variety of human-like functions, offering valuable assistance in improving the social skills of individuals with ASD [1] [2] [3]. The process of teaching young learners with ASD is complex and multidimensional, involving numerous cognitive decisions made by educators before, during, and after instruction. This ongoing work examines educator cognition across the broader field of education, with a specific focus on the use of robots in special education settings. To date, research has primarily examined cognitive processes involved in planning, instruction, and reflection separately, often in controlled environments. It is recommended that future research adopt mixed methodologies, such as case studies, to explore educators' thoughts and actions holistically and within natural teaching environments. This would allow researchers to connect actual behaviors with the cognitive processes that underlie them.

ASD is characterized by two key criteria: first, a persistent deficit in social communication and interaction across multiple contexts, and second, restricted and repetitive patterns of behavior, interests, and activities. Children with ASD face challenges in adapting to their environment, including emotional, cognitive, and behavioral difficulties that can impact school learning. They may also struggle to respond to sensory stimuli in their environment [4].

B. Education and Interventions in Autism

The Treatment and Education of Autistic and related Communication Handicapped Children (TEACCH) approach is an educational program designed to support children with ASD and communication difficulties [5]. This method focuses on promoting self-determination and autonomy through the use of structuring strategies. It is applied across various contexts (such as school, work, and family) to improve skills like social behavior, communication, and learning, while also promoting inclusion in everyday settings. TEACCH employs time and space structuring, visual cues, task repetition, and individualized, structured interventions.

Some authors emphasize that TEACCH is a suitable program for the development of children with autism. [6] indicates that children with ASD who participate in Early Intensive Behavior Intervention (EIBI) generally outperform those receiving other treatments or standard care in terms of IQ and adaptive behavior measures. Sensory processing disorders in individuals with autism are characterized by altered perceptions of sensory stimuli. These changes can lead to hypo- or hypersensitivity across various sensory channels. Examples of sensory-specific behaviors include seeking light or reflections, avoiding noise or touch, displaying rigidity, or resisting change. Such behaviors can trigger reactive responses, posing challenges in educational and pedagogical support. To address these issues, a significant reorganization of activities is often required, ensuring both variation and adaptation to individual sensory profiles. Although systematically evaluating sensory differences is essential, creating and arranging activities and spaces that meet these needs remains a considerable challenge for professionals. Conventional interventions often rely on numerous supports and materials, which can limit the efficiency of activities and hinder the child's ability to complete tasks.

C. Benefits of Social Robots for Autism

Robots are increasingly being integrated into human environments. From simple industrial tasks to administrative guidance, they are gradually being deployed across various sectors to assist humans. Their design is becoming more complex, evolving towards humanoid forms. In the field of support, robotic agents are being developed to interact and adapt to intricate mechanisms, such as imitation and emotional expression. These advancements present new opportunities for educational and pedagogical support for children with autism. One key advantage is the predictability of technology, which is simpler and reduces unnecessary sensory information compared to human interaction. Technology is deterministic and predictable. While it doesn't express emotions in the same way humans do, it can mimic them and produce controlled responses during interactions with children, boosting their confidence and self-esteem. Furthermore, repeated interactions provide an ideal environment for trial and error, which is invaluable for learning. Robotic agents can stimulate behaviors such as imitation, joint attention, communication initiation, and social interaction in children with autism.

Several studies have demonstrated that participants with ASD often perform better in Robotic Conditions (RC) than in Human Conditions (HC). [7] suggests that children with ASD, as well as typically developing (TD) children, tend to focus more on the administrator in Robotic Conditions than in Human Conditions. [8] found that autistic children use the same brain resources when interacting with artificial agents as TD children do when interacting with human agents. These findings point to several positive implications for using robots with children with ASD. As a result, there is a growing body of research aimed at exploring whether artificial agents represent a promising new approach for improving deficits in children with autism. Research on social robots has increased in recent years, with numerous studies highlighting the positive interest and benefits these robots can bring to the learning process for autistic children, as well as their potential for regulating cognitive difficulties and reducing stereotypical behaviors.

D. Acceptability of the New Generation of Social Robots by Educational and Pedagogical Professionals

Buddy© is an "emotional" robot whose greatest merit is its ability to improve the quality of life of users of all ages. It can be used by children, adults and the elderly alike. In particular, it can be used to create social links through its various devices, to offer educational activities in a playful way, and to look after the elderly. Equipped with various sensors and cameras, Buddy© features high-performance voice and visual recognition, making it easy to use and interact with. Buddy© also comes with a range of applications to make learning fun. For example, the *Buddy Emoi* application lets you work in different ways on emotions with Buddy© as a student or as a teacher. Buddy© also includes an application, *BuddyLab*, for programming and customizing compositions, sequences of actions or emotions. This is a very interesting option for the rest of our study. Indeed, it will be possible to program Buddy© to give instructions, and express one emotion visually and another audibly.

The integration of robots into the classroom is a subject that raises numerous questions. It has the potential to disrupt certain teaching practices and require additional effort on the part of teachers. The acceptability and adoption of educational robots are influenced not only by their perceived usefulness but also by teachers' ability to integrate these new technologies into their teaching practices. In fact, the form of the robot influences its acceptability, categorizing the object and affecting the intention to interact [9][10]. Furthermore, incorporating a playful dimension into the user experience has been identified as a beneficial factor for enhancing acceptability, whereas an overly affective design can compromise the object's credibility. For example, the Nao robot, despite its affective design, suffers from a lack of credibility, which can represent a challenge for retailers looking to project an innovative brand image.

David et al. [11] [12] highlight the impact of mental anthropomorphism on the acceptability of robots. In fact, attribution of mental states to a social robot has been shown to generate feelings of anxiety and strangeness, which can lead to a decline in acceptability. Conversely, the experience of a sense of control has been shown to encourage the attribution of mental states and the establishment of a connection with robots, thereby reducing reactance. The existing research in this area demonstrates that individuals who experience a sense of control are more inclined to attribute mental states to robots and to feel a greater sense of connection and similarity with machines. However, a perceived absence of control fosters a sense of distance between humans and robots, thus diminishing acceptability.

Spatola et al. [13] proposed a multicomponent evaluation of anthropomorphism in their article. This innovative approach focuses on four key aspects: sociability, agency, animacy, and disturbance. These dimensions significantly influence perceptions and attitudes toward robots, highlighting the importance of considering them in the development and implementation of educational robots. The attribution of human characteristics to robots—such as "sociability," "agency," "animacy," and "disturbance"—can enhance their acceptability by fostering familiarity and reducing perceived threats.

E. Objectives and Research Question

The main objective of this study is to investigate the impacts of the integration of different robotic tools into specialized teaching units (nursery and elementary), in natural settings, for children diagnosed with autism spectrum disorders. The work is being carried out in collaboration with educational and teaching professionals who work with these children. Our main research question is: What are the conditions required for the integration of artificial intelligence and social robots to be accepted by education and health professionals in specialized units for autistic children?

This paper is structured as follows. In Section 2, we describe the methodology, detailing the participant demographics, hypotheses examined, and materials employed in data collection. Section 3 presents the main results obtained from quantitative measures and qualitative discussions within focus groups. Section 4 discusses the implications of these findings, particularly focusing on psychosocial factors influencing the acceptance of robots, perceptions of robot anthropomorphism, and insights gathered from educators. Finally, in Section 5, we summarize the conclusions drawn from this study and outline directions for future research aimed at enhancing the integration and effectiveness of artificial intelligence and social robots in specialized autism education settings.

II. METHOD

Three different robots have been integrated and compared to determine which is best suited to the context of specialized classes, while respecting the usual working conditions of professionals and children. The focus group method is employed for each group, with each session lasting for a duration of one hour. The objective of this method is to facilitate a discussion concerning the participants' feelings of self-efficacy in the workplace, their stress levels, and their perceptions of digital technology, with a particular emphasis on robots. The discussion is initiated in a general context and subsequently continues through the utilisation of anonymised individual questionnaires, which are completed on an individual basis.

A. Participants

The present study sample comprised eight female (2 teachers and 6 educators), all over 18 and of French nationality. They are from the educational and teachings professionals from two specialised teaching units (nursery and elementary) of the Association Jean-Baptiste Thiéry, located in the East of France.

B. Hypotheses

In our study conducted in natural settings, we examined three hypotheses.

1) Decision Latitude–Workload Hypothesis: Professionals who experience higher decision-making latitude will be more inclined to adopt AI-driven social robots, even when these tools introduce additional tasks or complexities. Greater autonomy in planning and execution is hypothesized to buffer the perceived workload increase.

2) Self-Efficacy–Workload Hypothesis: Professionals with a strong sense of self-efficacy are expected to display more positive attitudes toward integrating AI-equipped social robots, as they perceive themselves capable of managing the extra workload and adapting new procedures in ASD interventions.

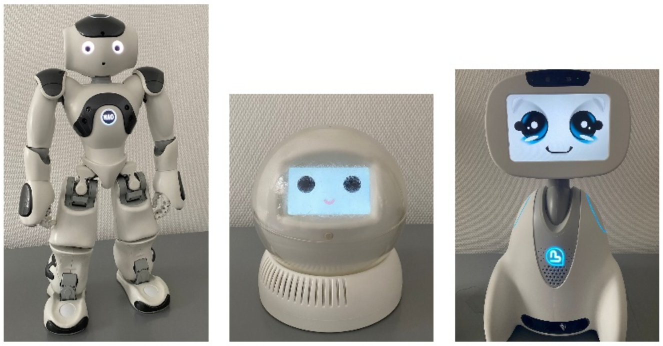
3) AI Functionality–Workload Trade-off Hypothesis: If the perceived benefits of the robot's AI capabilities (e.g., improved engagement, more targeted interventions) outweigh the added workload, professionals will exhibit higher acceptance and integration of social robots in specialized education settings.

C. Material

In the context of the focus group, a microphone is employed for the purpose of recording the conversation. The audio recording is anonymized and confidentialized, ensuring that only the participants have access to it. For this reason, the groups will be anonymized and named Group 1 and Group 2. The SWOT method (strengths, weaknesses, opportunities and threats) is utilized during the discussion of the difficulties encountered in the workplace. Furthermore, a table is compiled, detailing both the expectations and fears concerning the integration and utilization of robotic tools.

The Karasek test [14] is utilized to evaluate the stress levels experienced by the professionals, while their sense of self-efficacy is measured using the Self-Efficacy Scale (SES) [15]

[16]. To assess the degree of anthropomorphism of the various robots employed in conjunction with the educational teams, Spatola's HRIES scale [13] is employed. The statistics were made with Jamovi and R softwares.[17][18].



(a) (b) (c)

Figure 1. The three robots used in our study: NAO (a), Leka (b) and Buddy (c)

The robots NAO, Buddy, and Leka each offer complementary features, addressing specific goals in interaction, education, and mediation for children, particularly those with neurodevelopmental disorders. NAO, developed by SoftBank Robotics, is a sophisticated humanoid robot equipped with multiple sensors (tactile, sonar, inertial), HD cameras, multilingual voice recognition, and grasping capabilities, making it particularly suitable for teaching STEM subjects, providing assistance, or supporting educational activities. It can be programmed using interfaces like ZoraBot or AskNAO Tablet, which allow for highly customizable activities without requiring advanced technical skills. Buddy, created by Blue Frog Robotics, is a mobile, teleoperated robot on wheels, designed for intuitive interaction through a touchscreen, speech synthesis, and various sensors (infrared, touch, QR code). It serves as an emotional and educational companion, capable of displaying multimedia content and following programmed action sequences. Leka, on the other hand, stands out with its spherical, child-safe design and playful sensory features (LED lights, vibrations, sounds, movement) aimed at stimulating cognitive, emotional, and social development. Its intuitive software platform allows for easy adaptation to the individual needs of children, particularly in therapeutic contexts. Thus, NAO is positioned as a versatile, programmable tool for complex applications, Buddy as an interactive multimedia companion, and Leka as a sensory and educational device designed for mediation and stimulation of children with special needs. The professionals observe a demonstration of the robots in the classroom after the focus group. The discussion groups are convened in the respective classrooms of each group. Each participant is seated on a chair facing a table, with a distance of one meter maintained between each pair of participants. This configuration ensures sufficient visual privacy and facilitates effective interaction. Jamovi and R were used to analyse the results.

III. Main Results

Group 2 has a high degree of decision latitude, with an average of 80.5. Group 1 has lower decision latitude, with an average of 63.5. Both groups show moderate to high levels of psychological demand, with a combined mean of 22.75. Social support was rated as moderate to good, with an overall mean of 22.5.

TABLE I. DESCRIPTIVE STATISTICS OF ANTHROPOMORPHISM FACTORS FOR THE ROBOTS NAO, LEKA AND BUDDY USING THE HRIES SCALE [13].

Robots	Factors	Mean	Median	S-D	Minimum	Maximum
NAO	Sociability	2.46	2.46	1.817	1.180	3.75
	Animacy	2.41	2.41	1.549	1.310	3.50
	Agency	2.00	2.00	1.506	0.930	3.06
	Disturbance	3.12	3.12	0.707	2.620	3.62
Leka	Sociability	3.09	3.09	2.701	1.180	5.00
	Animacy	1.78	1.78	1.103	1.000	2.56
	Agency	2.00	2.00	1.414	1.000	3.00
	Disturbance	2.37	2.37	1.061	1.620	3.12
Buddy	Sociability	2.34	2.34	1.541	1.250	3.43
	Animacy	1.78	1.78	1.018	1.060	2.50
	Agency	1.81	1.81	1.237	0.930	2.68
	Disturbance	3.03	3.03	1.103	2.250	3.81

Pearson's correlation test revealed a moderate positive correlation between decision latitude and SES ($r = 0.78$, $p = 0.01$). The Pearson correlation test revealed a moderate non-significant correlation between social support and the robots' perceived sociability ($r = 0.49$, $p > 0.05$).

The Leka robot is perceived as very sociable with an average score of 3.09 and moderately disturbing with a score of 2.37. The NAO robot is considered very animated with a score of 2.41 but also very disturbing with a score of 3.12. The Buddy robot was considered very disturbing with a score of 3.03 and animated with a score of 1.78. The NAO and Buddy robots recorded the highest disturbance scores, 3.12 and 3.03 respectively.

Professionals in Group 2, with more decision-making latitude and better social support, perceived the robots more favourably, but reported higher levels of disturbance, especially for Buddy (3.81).

The focus groups identified the groups' vulnerabilities, including deficiencies in organisation, memory and rigour. Constraints revealed included transparency, professional cohesion and communication. External opportunities include interaction with diverse teachers, varied learning methods, training and supervision. External threats include lack of time, limited human resources, institutional constraints and bureaucracy.

The groups' expectations and fears centred on better understanding of the students, increased motivation, adoption of innovative tools, loss of time, dependence on technology and reduced social relations.

IV. Discussion

Data collected in natural settings allow to demonstrate several interesting findings.

A. Psychosocial Analysis

1) Psychosocial dimension (Karasek and SES questionnaires): The results of the decision latitude scores demonstrate a considerably elevated level of autonomy for group 2 (mean: 80.5) in comparison with group 1 (63.5). This heightened autonomy has the potential to result in enhanced job satisfaction and a more favorable perception of their abilities. Indeed, a moderate positive correlation ($r = 0.786$, $p = 0.010$) between decision latitude and SES demonstrates that professionals with greater autonomy in their work tend to have a more positive perception of their personal effectiveness.

With respect to the psychological demand dimension, both groups exhibit moderate to high levels, with a pooled average of 22.75. However, this pressure appears to be manageable for the majority of participants. The stress associated with high demands could increase the perception of disturbance generated by the robots, particularly NAO and Buddy, which record the highest disturbance scores (3.125 and 3.031, respectively).

The social support received is considered to be moderate to good (pooled mean: 22.5). This factor is closely linked to the positive perception of the robots, with a moderate non-significant correlation ($r = 0.493$, $p > 0.05$) between social support and the perceived sociability of the robots. Furthermore, it is observed that professionals benefiting from a favorable collegial environment appear more inclined to accept robots.

2) Perceptions of Robots (HRIES): The robots evaluated (Buddy, NAO, and Leka) demonstrate significant variation in terms of sociability, animation, and disruption. Leka is distinguished by its notably high sociability (mean: 3.094) and moderate disturbance (2.375), which leads to its emergence as the most popular robot. Conversely, NAO is regarded as the most animated (2.406) but also the most disruptive (3.125), which may impede its acceptance. Buddy, with balanced but lower scores, is perceived as neutral.

An intergroup comparison reveals that professionals in one of the two groups, who have greater decision-making latitude and better social support, perceive the robots more favorably. Conversely, these professionals report higher levels of disturbance, particularly in the case of Buddy (3.813).

3) Focus Group: A comprehensive analysis of the specialised units has revealed several pivotal aspects. The analysis has exposed inherent vulnerabilities within specific groups, manifesting as deficiencies in organisation, memory, and rigour. Conversely, other groups encounter constraints in terms of transparency, professional cohesion, and communication. An examination of external opportunities reveals that the groups benefit from interaction with a diverse range of teachers, varied learning methods, training, and supervision. The sharing of experiences and professional development stand out as significant assets. Conversely, these groups are confronted with external threats, including but not limited to: paucity of time, limitations in human resources, institutional constraints, unfamiliarity with management, timetabling constraints and bureaucracy. The expectations and fears of these groups centre on three key areas: improved understanding of pupils, heightened motivation and the adoption of innovative tools. However, these groups also express concerns regarding potential losses, including a loss of time, a dependence on technology and a diminution of social relations. This analysis underlines the multifaceted challenges and opportunities confronting special education groups, underscoring the necessity for a balanced approach to optimize benefits while mitigating risks.

V. Conclusion and Future WOrk

This study aims to explore the professional acceptance of AI-equipped social robots in specialized classrooms for children with autism, focusing on the interaction between decision latitude, self-efficacy, and the balance between perceived benefits and workload. The findings suggest that greater decision latitude helps offset the additional tasks associated with robot integration, while high self-efficacy promotes a more positive response to technology-induced challenges. Crucially, successful adoption depends on whether the educational advantages provided by the robots outweigh the time and resource investments required. Lessons learned from this study underscore the importance of organizational readiness, clear communication, and comprehensive initial training sessions. Failed attempts highlighted challenges such as robot-induced disturbances, and difficulties maintaining consistent engagement across diverse classroom contexts. The limitations of this study include a small sample size, limiting generalizability, and the specificity of the cultural and organizational contexts which may affect broader applicability. Technical limitations of the robots themselves, such as restricted adaptability and user-friendliness for non-specialist educators, also emerged as significant barriers. In conclusion, our analysis highlights the challenges and opportunities faced by special education groups, emphasizing the importance of a balanced approach to maximize benefits while mitigating risks. The integration of robots into these environments must be carefully planned to minimize perceived disruption and foster a collaborative, supportive work environment, ultimately enhancing interactions between children and professionals in autism therapy. The adoption of educational robots is influenced by numerous factors, including affective and social variables, robot design and configuration, and anthropomorphism. Future research should investigate these dimensions more precisely, focusing on technical enhancements such as adaptive algorithms for real-time behavioral analysis, machine learning-driven predictive engagement models, and modular robot designs. Additionally, future efforts should include larger-scale, multi-site studies and extensive educator training programs to improve usability and effectiveness, thereby better aligning educational robots with teachers' needs and expectations while minimizing potential resistance.

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