Using Artificial Intelligence to Strengthen Joint Attention in Children with Autism

Nathalia Assis Valentim[1],**Fabiano Azevedo Dorça** [1], **Valéria Peres Asnis**[1] **Nassim Chamel Elias**[2]

[1]Universidade Federal de Uberlândia, Uberlândia, Minas Gerais, Brazil

[2]Universidade Federal de São Carlos, São Carlos, São Paulo, Brazil

{nathaliavalentim,fabianodor,valeria.asnis}@ufu.br, nassim@ufscar.br

The use of assistive technologies, with an emphasis on artificial intelligence (AI), aimed at improving the learning process of children with autism, focusing on joint attention (JA). Joint attention is a crucial skill in child development, referring to a child's ability to follow and direct gaze toward objects or events of common interest. Children with Autism Spectrum Disorder (ASD) often exhibit deficits in this skill, which directly impacts their learning process and social interaction. In this context, an Intelligent Tutoring System (ITS) was developed to interact with autistic children aged 4 to 5, with the goal of helping them improve joint attention and, consequently, their communication and socialization skills. The ITS proposed an adaptive and dynamic virtual environment in which AI guided the child through a series of exercises. These exercises were designed to become progressively more challenging, adjusting to the performance and needs of each child.

To achieve this level of personalization and adaptation, techniques such as convolutional neural networks and reinforcement learning algorithms were used, allowing for the creation of a personalized learning environment that aimed to enhance the child's interaction and engagement. AI was employed to adjust the complexity level of the exercises, monitoring factors such as response time and task accuracy. Additionally, the ITS included a facial emotion detection system, using neural networks to identify emotions such as satisfaction, neutrality, and dissatisfaction during the activities. This ability to monitor the children's emotional state allowed for real-time adjustments, fostering a more responsive and empathetic learning environment.

The combination of these techniques enabled the creation of an adaptive system that tracked the student's progress, positively reinforcing their achievements and offering support when necessary. An important component of the proposed solution was the dashboard developed for professionals and caregivers. This dashboard allowed detailed monitoring of each child's progress, facilitating pedagogical decision-making and the planning of personalized educational interventions. Thus, the ITS not only adapted to the children, but also provided valuable information to the adults involved in their development.

Experiments conducted with the ITS showed promising results, with a significant improvement in the joint attention levels of the participating children. This demonstrates that the use of intelligent tutoring systems, combined with artificial intelligence, can be an effective solution to strengthen joint attention in autistic children, promoting their cognitive and social development. Furthermore, the developed approach can be expanded to other educational areas, serving as a model for new assistive technologies aimed at teaching children with ASD.

Throughout the development and implementation process of the ITS, various technical and pedagogical challenges were faced and overcome. The design of the exercises required interdisciplinary collaboration between autism specialists, educators, and AI developers to ensure that the activities were not only challenging but also engaging and accessible to the children. The implementation of convolutional neural networks and reinforcement learning algorithms

DOI: 10.5753/cbie_estendido.2024.243589

required a robust technological infrastructure and the ability to process large amounts of data in real time, as the system needed to continuously monitor and adjust the children's interactions with the virtual environment. An additional important aspect was the concern for privacy and data security, as the ITS collected sensitive information such as facial expressions and behavioral patterns. Strict security policies were implemented to ensure that all data was protected and used exclusively for research and system improvement purposes.

The impact of the ITS on the social and cognitive development of the children was measured through a series of evaluations conducted before and after the system's use. These evaluations focused on indicators such as the ability to maintain joint attention, response times to visual and auditory stimuli, and interaction with other children and adults. The results of these evaluations were highly encouraging, with reports from parents and educators indicating improvements not only in joint attention skills but also in communication and the children's willingness to engage in social environments.

As a result, it can be concluded that the use of intelligent tutoring systems supported by AI represents a powerful tool for teaching autistic children, potentially becoming a key component in the development of new educational methodologies. The success achieved in strengthening joint attention with this system suggests that AI has enormous potential to transform the way children with ASD are educated, offering more personalized, dynamic, and effective teaching. Additionally, this technological approach can be adapted to other age groups and developmental conditions, further expanding its impact in the field of special education.

Finally, the advancements made through this work open doors for future research and innovation at the intersection of education and artificial intelligence. Continuing this work could include expanding the capabilities of the ITS to address a broader range of skills and challenges faced by children with ASD, as well as exploring new technologies such as augmented and virtual reality to create an even more immersive and effective learning environment. Thus, the combination of AI and personalized pedagogy emerges as a promising frontier for the development of assistive technologies that can benefit not only autistic children but any student in need of adaptive educational support [1].

Acknowledgment

This research was supported by Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) - UNIVERSAL DEMAND Process: APQ-00837-21.

References

[1] Valentim, N., Dorça, F., Asnis, V., Elias, N.: The artificial intelligence as a technological resource in the application of tasks for the development of joint attention in children with autism. In: Anais da XII Brazilian Conference on Intelligent Systems. pp. 306–320. SBC, Porto Alegre, RS, Brasil (2023), https://sol.sbc.org.br/index.php/bracis/article/view/28364