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Towards optimised communication: integration of artificial intelligence in adapted physical activities for autistic children

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ABSTRACT: Children with autism spectrum disorder (ASD) often have a combination of countless impairments, including difficulties in language acquisition and use. This negatively affects the quality of their communication and therefore their social integration. Remedial methods are sometimes powerless in the face of the wide range of cases of children with ASD (Rodriguez et al., 2012). These approaches are based on behavioural and educational therapies to develop social and communication skills. These interventions are sometimes not very flexible and cannot meet the needs of all subjects (Haas et al., 2019). In contrast, Lee & Lee, 2021; Hammes et al., (2022) present adapted physical activity (APA) as a structured context that promotes interaction and learning through its power to develop socio-motor and social skills (Marin-Suelves et al., 2023). According to Li et al., 2024; Kamalov et al., (2023), encouraging horizons in the field of ABS are emerging with the advent of new technologies, more particularly artificial intelligence (AI), offering the possibility of personalizing educational paths and optimizing their effects on language acquisition. Given these opportunities offered by AI, Cui et al., (2024) and Iannone & Giansanti, (2023) announce that the individualization of language learning support is now possible through an instantaneous analysis of children's behaviors and the adjustments proposed according to the needs and progressions of the observed cases. The QTrobot, from the company LuxAI, is an illustrative example: through AI tools, it allows ASDs to develop their social and communication skills while adjusting their interactions (Li et al., 2024; Kotsi et al., 2025).

By using AI, APA can provide dynamic learning in which children are motivated and engaged. Many studies state that thanks to APA we can develop motor, behavioral, cognitive and social skills in subjects suffering from neurodevelopmental disorders, including ASD. Climbing helped stimulate sensorimotor development and promote social relationships. Indeed (Musiyenko, O., & Kizlo, N., (2019)). In order to put the project to the test, a proximity investigation is envisaged: we choose to accompany a population of 6 to 12 children, with ASD and with language disorders using an APA program based on AI tools for 12 weeks, at a rate of 3 sessions per week as urged by Frontiers (2024). The evaluation of social interactions and language skills before and after intervention would make it possible to verify the effectiveness of this model (Holmes, 2022). This investigation cannot begin without parental consent and without ensuring the confidentiality of the data and the well-being of the children (Klimova et al., 2023; Folio3AI Blog, 2024) Although we are still in the theoretical phase,

our investigation is based on scientific research that has been able to prove the positive impact of AI on the social and communication skills of ASDs: the QTrobot as an example (Li et al., 2024; Smashing Magazine, 2024). Through the integration of AI into APAs, we aim for an innovative approach that will promote language acquisition in ASD and also better inclusion improving their quality of life (Reis et al., 2024).

Keywords: Artificial Intelligence, Adapted Physical Activity, Language Acquisition, Autism Spectrum Disorders, Personalized Intervention.

1. INTRODUCTION

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental condition characterized by difficulties in verbal and non-verbal communication, as well as atypical social behaviors. These challenges significantly hinder social inclusion and school integration, often limiting access to ordinary learning environments (White et al., 2017). Language acquisition is therefore a central issue, shaping academic success, social integration, and personal development. Traditional interventions rely mainly on speech therapy and specialized educational pathways. However, the results remain uneven due to the heterogeneity of ASD profiles and the intrinsic complexity of these disorders (Wheeler et al., 2014). This situation calls for pedagogical innovation capable of adapting interventions to individual needs. In this context, adapted physical activity (APA) and advances in artificial intelligence (AI) open promising perspectives. Sport-based APA stimulates sensorimotor development and social interaction (Hu, Liu, & Su, 2024), while AI allows for real-time personalization of learning paths (Zhou et al., 2024). This article proposes an interdisciplinary conceptual model that combines APA and AI to optimize language acquisition in children with ASD. It addresses the following research question: **How can language acquisition in children with ASD be optimized by integrating AI into sport-based adapted physical activity?** To answer this question, we (1) outline the theoretical foundations relating to ASD, language, APA and AI; (2) present a conceptual APA–AI prototype for language learning; (3) describe a quasi-experimental research protocol to test its feasibility; and (4) discuss theoretical, practical implications, limitations and future research perspectives.

2. AUTISM SPECTRUM DISORDER, LANGUAGE ACQUISITION AND THE NEED FOR INNOVATIVE APPROACHES

ASD is characterized by a constellation of clinical symptoms, among which communication and language difficulties are central. Delays in language acquisition, deficits in understanding non-verbal cues (facial expressions, gestures, tone of voice) and atypical use of language are frequently reported (Rodriguez, Saldana, & Moreno, 2012). These difficulties have a strong impact on school inclusion and access to ordinary learning contexts (White et al., 2017).

From a theoretical perspective, several models have sought to explain these deficits, including neurodevelopmental approaches and socioconstructivist theories. Vygotsky (1978) emphasizes that language emerges through social interactions, highlighting the crucial role of social context in cognitive and linguistic development. In ASD, the mechanisms involved go beyond mere delay; they include disruptions in information processing that affect the ability to assimilate and use language in context (White

et al., 2017). This complexity requires tailored, dynamic support strategies that address both the cognitive and social dimensions of language.

Traditional interventions speech therapy, specialized pedagogical support and individualized education plans ,remain essential but are not always sufficient. The heterogeneity of ASD profiles, variability in responses to interventions, and the difficulty of maintaining motivation and engagement justify exploring complementary approaches. Hence the interest in APA as a lever for development and AI as a tool for personalization and real-time adaptation.

3. ADAPTED PHYSICAL ACTIVITY AND ARTIFICIAL INTELLIGENCE: TOWARDS AN INTEGRATIVE THEORETICAL FRAMEWORK

3.1. Contributions of Adapted Physical Activity (APA)

APA is recognized as a key lever in the global development of children with disabilities. Beyond its physical benefits, it stimulates both fine and gross motor skills, coordination and attention (Teachflow, 2023). From a social perspective, sport provides a structured environment conducive to learning non-verbal communication norms, emotional regulation and social interaction.

For autistic children who often face challenges in verbal engagement, the sports context offers a privileged environment for practicing relational skills through play and movement. Group activities foster learning through imitation, repetition and modeling, mechanisms that are central to language acquisition. Research by Wang & Wang (2024), among others, has shown that sport practice can significantly improve motivation, concentration and memorization, thereby reinforcing the preconditions for communicative learning.

APA thus appears as a particularly relevant medium for embedding language objectives within meaningful, motivating and socially rich activities. It allows working on communication in a holistic way, combining motor, emotional and social dimensions.

3.2. Contributions of Artificial Intelligence (AI) to Education and Sport

In parallel, AI is making rapid progress in education and sport. In the educational field, it enables the design of personalized learning paths and continuous monitoring of performance and progress using machine learning algorithms (Zhou et al., 2024). AI systems can adapt pedagogical actions according to learners' specific needs, providing real-time, individualized feedback.

In sport, AI has been successfully used for performance analysis and training optimization. Studies by Hammes et al. (2022) and Chmait & Westerbeek (2021) show that AI tools can detect technical errors, adapt training content and process large volumes of data in real time. Techniques such as wearable sensors, computer vision and smart applications allow for precise measurement of physical and behavioral parameters.

The integration of AI into APA-based interventions opens the way to hybrid educational environments where each session is monitored, analyzed and dynamically adjusted. This is particularly promising in the field of special education, where fine-grained personalization is crucial.

3.3. The Gap: Combining APA, AI and Language Acquisition in ASD

Despite the abundance of work on ASD, APA and AI taken separately, the intersection of these three fields remains little explored. Most studies focus either on the benefits of physical activity or on those of AI, without combining them to specifically address the challenges of language acquisition in ASD. This gap underscores the need for an integrative model that articulates (1) the communicative needs of autistic children, (2) the sensorimotor and social benefits of APA, and (3) the adaptive capabilities of AI technologies.

Developing such a theoretical framework is essential to structure future interventions, guide empirical research and support the design of innovative, inclusive action plans.

4. CONCEPTUAL APA–AI PROTOTYPE FOR LANGUAGE ACQUISITION IN ASD AND RESEARCH PROTOCOL

The conceptual prototype in question is based on three interrelated axes:

The first axis is the APA. Through an organized and playful environment, sport encourages the development of natural social interactions and learning through imitation, which promotes the acquisition of language skills. Indeed, Hu, Liu, & Su (2024) and Teachflow (2023) highlight the benefits of physical exercise on sensory and motor development, emotional regulation and coordination.

The second axis is the integration of AI technologies that can instantly analyze the performance collected during sports activities. According to Zhou et al., (2024) and Li et al. (2022), by using wearable sensors, educational robots, and interactive digital applications, AI can collect key cues such as the frequency of interactions, the level of engagement, and the behavioral responses of the subjects. Through this data, AI is able to personalize the pedagogical action by adapting the level of difficulty of the proposed exercises, and by providing instant feedback, essential for learning adapted to children with ASD.

The third axis is the continuous self-regulation of the educational pathways offered, which is essential for regular progress. This feedback provided by the AI from the data collected is sent to teachers so that they can immediately adjust their interventions according to the observed progressions. For Wang & Wang (2024) and Hammes et al. (2022), these adaptations will gradually improve the language skills of these children and improve the integration of learning into sports practices.

Our research protocol will follow the following steps:

- Choice of target population:

The participants in this study are children with ASD between the ages of 6 and 10 years, chosen according to the DSM-5 criteria, (Diagnostic and Statistical Manual of Mental Disorders, (APA, 2013)) who are regularly monitored in a medical and educational setting, without medical contraindications to practice sport and with parental approval.

- Proposed interventions:

Sports activity sessions, lasting 45 to 60 minutes, supervised by professionals trained in the particularities of children with ASD, will be given two to three times a week. During these sessions, the technological devices previously presented will be used to instantly collect and analyze the behavioral and motor responses of the subjects facilitating the personalization of the intervention.

- Evaluation measures:

Integrated AI systems will make it possible to collect and analyze the data collected in real time and generate reports in order to adjust educational actions. To measure the subjects' sports performance and engagement, the sensors will provide quantitative data such as heart rate, active engagement time and range of motion among others. Video analyses will make it possible to meticulously observe the subjects' behaviours and interactions.

For language skills, standardized tests will be used to measure receptive and expressive skills. Tests will be conducted before, during and after the procedure. Evaluation grids will also be used for qualitative observations on the verbal and non-verbal interactions of these children.

This study is quasi-experimental. It will include an intervention group following the hybrid protocol (APA + AI) adopted and a control group (if possible) benefiting from an ordinary sports project. The support will be spread over a period of 8 to 12 weeks to be able to monitor language and behavioural changes in an appropriate way. Quantitative data will be statistically analyzed to compare pre- and post-interventions. Qualitative studies will be based on the analysis of observations and semi-structured interviews with parents and educators.

For the ethics of this investigation, consent from the parents or guardians of the children must be obtained in addition to the children's acceptance if possible. The anonymity of the data collected is essential. Finally, regular medical follow-up is imperative to ensure the physical and psychological safety of the children.

In short, this work protocol will seek to verify the feasibility of the proposed prototype and to have initial data on the impact of the intervention on language acquisition. The technological tools used

will be refined according to the results obtained, resulting in personalized educational paths according to the needs of the subjects.

This method presents, through the combination of AI and ABS, an innovative theoretical framework that would fill the shortcomings of the usual approaches. It is a theoretical model that can significantly improve the language skills of ASD by taking advantage of the sensorimotor and social benefits of physical activity, and the advantages of AI to personalize and optimize pedagogical actions (Zhou et al., 2024; Hu, Liu, & Su, 2024). Theoretically, this process is based on the fact that language is only acquired through different social interactions and sensory experiences, and cannot be obtained on its own. The iterative nature offered by AI in data analysis is a major contribution that makes it possible to adjust educational actions in real time and to respond immediately to the needs of beneficiaries. These theoretical benefits will make it possible to personalize interventions in parallel with advances in neuroscience and learning sciences.

In practice, the adoption of such a model would radically transform contemporary educational and therapeutic interventions. The use of AI devices in PE sessions would allow teachers to accurately monitor the individual progress of each child. According to Wang & Wang (2024), this would be an unparalleled opportunity to adjust teaching methods following the instant feedback produced by the system, thus optimizing the quality and efficiency of the intervention. In addition, the fun learning and interactivity of sports activity, reinforced by digitalisation, could stimulate essential elements for overcoming language difficulties, namely motivation and commitment in these children. These mixed interventions would then allow for better social inclusion and a positive evolution of educational dynamics, by developing the ability of these children to interact in a structured and responsive environment.

Although this method is advantageous theoretically and practically, there are several limitations. Klimova, Pikhart, & Kacetl (2023) state that the adoption of digitalization and AI tools presents significant ethical and technical constraints: the confidentiality of personal data, the management of algorithmic biases and the adaptation of devices to the specific needs of ASDs are challenges to which special attention must be paid.

In addition, the generalization of the results represents an important constraint that should not be neglected given the heterogeneity of ASD profiles. Each of these children has specific needs, which makes it difficult to universalize a single path. Therefore, for effective intervention, the design and application of tools must be highly flexible.

There are many future research perspectives that can be undertaken to overcome these constraints and optimize this model. Controlled pilot studies, among others, should be carried out, by carrying out investigations with intervention groups and control groups to verify the efficiency of the approach and adjust actions according to feedback. Interdisciplinary collaboration between AI experts, special educators, psychologists, speech therapists and sports professionals could take

place to refine technological devices and ensure consistency of interventions. In the same vein, the development of machine-learning algorithms would guarantee the perfected personalization of interventions by taking into account the diversity of the subjects' individual responses. In addition, the study of the ethical aspects related to the use of AI tools in a specific environment will make it possible to put in place protocols to guarantee the transparency and confidentiality of the corpus. The exploration of the possibility of an extension to other educational and therapeutic contexts could be considered in order to verify the feasibility of the model to move towards an inclusive and fair approach for all.

To conclude, this contribution proposes an interdisciplinary and innovative approach to promote language acquisition in children with ASD through the integration of AI into APA. It is demonstrated, via an in-depth literature review and the presentation of an integrative conceptual prototype, that by juxtaposing AI (through its ability to singularize educational actions in real time) with the sensorimotor and social benefits of APA, we will be able to exploit a promising avenue to overcome language difficulties in children with ASD.

Although this proposal is conceptual and requires empirical verification through proximity studies, it opens up new horizons through individualized and adjusted interventions. The potential benefits of this approach are numerous, both in terms of education and therapy: they could promote better social inclusion and a good quality of life for these children.

The success of this research is conditioned by effective collaboration between the various partners, including education professionals and experts in AI technology, to successfully develop tools adapted to the individual needs of children. However, it is necessary to consider the ethical and technical dimensions of the use of AI devices in these specific environments, with the aim of ensuring the safety and accountability of these innovations.

Also, this proposal wishes to be the basis for future research based on field studies through which we can validate and refine the proposed prototype. In the same vein, a broader reflection must be initiated on the adoption of digitalization in educational and therapeutic actions for the development and inclusion of all children.

5. CONCLUSION

This article proposes an innovative, interdisciplinary approach to promoting language acquisition in children with ASD by integrating AI into sport-based adapted physical activity. By articulating theoretical foundations, presenting a three-axis conceptual prototype (APA, AI integration and continuous self-regulation) and outlining a quasi-experimental research protocol, it highlights a promising avenue for overcoming language difficulties. Theoretically, the model is based on the idea that language emerges from social interactions and sensory experiences rather than in isolation. APA offers a rich environment for such experiences, while AI provides the capacity to personalize and dynamically adjust pedagogical actions in real time (Zhou et al., 2024; Hu, Liu, & Su, 2024). Practically, the use of AI-enhanced APA sessions could

enable teachers and therapists to monitor individual progress in detail, adjust interventions instantly and foster motivation and engagement, two key factors in addressing language difficulties.

However, the proposal remains conceptual and requires empirical validation. Its implementation is constrained by ethical and technical issues (data confidentiality, algorithmic bias, tool adaptability) and by the heterogeneity of ASD profiles, which complicates the generalization of results (Klimova, Pikhart, & Kacetl, 2023). Future research should therefore focus on controlled pilot studies, interdisciplinary collaboration (AI experts, special educators, psychologists, speech therapists, sports professionals) and the development of refined machine-learning algorithms capable of accommodating individual variability. Despite these limitations, this model lays the groundwork for rethinking educational and therapeutic interventions in ASD in the era of digitalization. It calls for a broader reflection on the responsible integration of AI into educational and therapeutic practices, with the goal of building inclusive, equitable and personalized pathways that support the development and social inclusion of all children.

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