Evaluating Emerging Technological Applications in the Identification and Intervention of Autism Spectrum Disorder

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A clinical diagnosis of autism spectrum disorder (ASD) marks a child's neurodevelopmental deficiencies in social communication and interaction, alongside their repetitive and restricted behavioural patterns or interests (American Psychological Association, 2023). To alleviate the challenges experienced by children with ASD, professionals within the human-computer interaction domain continue inventing novel technological identification avenues and testing their effectiveness alongside clinicians. Several eye-tracking software developed to identify ASD-typical slow or absent eye tracking in children have been integrated in the clinical community, signalling more effective development in the early identification process with interdisciplinary collaboration than solely employing traditional diagnostic methods available to clinicians (Alabdulkareem et al., 2022, p. 11).

Although these technological applications abound, the broad clinical acceptance of most technologies remains contested, particularly for intervention purposes. These intervention methods may range from game-based to AI-based social and language learning paradigms. Although social learning robots have historically had demonstrable positive effects on the development of emotional and social learning, applications of emerging technologies such as generative-AI or deep learning (DL) software remain under scrutiny in the psychological community for their ethical concerns, lack of substantive research, and non-clinical roots (Boucenna et al., 2014, p. 1; Alabdulkareem et al., 2022, p. 11). This paper will evaluate these concerns by exploring if bridging the gap between the technological and clinical domains is effective in improving ASD identification in children and alleviating its associated social challenges. To research this growing fascination, this paper presents a literature review on varying emerging technological ASD identification and intervention applications through human-computer interaction, psychology, and other research repositories– namely the ACM Digital Library, Springer, the University of Waterloo library, and the Omni library among others. This exploratory paper concludes on a note addressing the current limitations of emerging technological applications and the particular areas that, if developed, hold significant potential for improving the current repertoire of support options available to children with ASD.

Technological Autism Spectrum Disorder Identification Tools

Autism Spectrum Disorder usually sees its onset in the preschool years, yet the assessment process may begin at the point at which the child arrives at the clinic (American Psychological Association, 2023). Following this, the most widely existing eye-gaze tracking software and datasets, which may be used to track ASD-typical slow or absent eye-gazes in joint attention tasks (which direct others' actions by way of gesturing or making eye contact with them), are those for later identification of children six to eight years of age (Mundy & Newell, 2007, p. 269-7; Qi et al., 2024, p. 5848). However, the current technological exclusion of the age group that sees the onset of ASD lessens the possibility of capturing early deficits within the 9-14-month range, when joint attention typically develops (Clifford & Dissanayake, 2008, p. 1).

Novel technological developments seek to encapsulate this earlier ASD identification age range, through further enriching pre-existing eye-gaze tracking models. It follows that if the measures of successful early identification technologies can record that a one-year-old child lacks the typical level of eye contact, clinicians may reliably predict joint attention and language development deficiencies when they are two years of age, as well as social interactions at nearly four years of age (Clifford & Dissanayake, 2008, p. 1; Charman et al., 2003, p. 319).

As well, pre-existing identification software and datasets lack the ability to pick up on biomarkers for autism due to heterogeneous factors such as gender and age, yet machine learning mechanisms concentrated on interpreting eye-gaze data have also begun making significant headway in early ASD identification. Novel measures integrating eye-gaze velocity with spatio-temporal scan-path images versus samples may stratify children with ASD as distinct from typically-developing (TD) children according to heterogenous differences on a more comprehensive scale (Atyabi et al., 2023, p. 6-18). Improved classification systems for combined eye-gaze and scan-path data may enable clinicians to accurately and reliably judge a child's temporal awareness, through variable measures such as Visual Question Answering (VQA) or video-responsiveness (Qi et al., 2024, p. 5848; Atyabi et al., 2023, p. 7). These measures may involve using machine learning (particularly, deep learning) networks, such as the Dense Neural Network (DNN) and Convolutional Neural Network (CNN), to uniquely interpret and classify data non-linearly (Atyabi et al., 2023, p. 7). Machine learning (ML) and deep learning (DL) identification techniques may also function as a clinician's confirmation of ASD-typical facial features in a child, with a high experimental machine accuracy rate of 96.79% (Munto et al., 2024, p. 1). Such results may enable earlier identification, ensuring better brain development outcomes.

Current and Emerging Technological Interventions

Preceding the current exploratory interest in generative-AI applications, earlier technological software adopts interactive technologies such as social robots to support social communication deficiencies (Boucenna et al., 2014, p. 722; Pennisi et al., 2016). These social robots may target a range of empathy-centric areas, particularly reading facial and emotional cues (Bakir, 2025, p. 4). Additionally, embodied technological play that interconnects motor and social learning using both tactical and audiovisual elements may reduce the experienced social pressure on children with ASD in collaborative spaces to motivate their development of social skills and joint attention (Zhu et al., 2023, p. 611; Boucenna et al., 2014, p. 724).

Significant research-backed role- and game-based player games have also successfully been integrated into support tools to alleviate experienced language comprehension and expression delays in social communication for children with ASD (Boucher, 2012, p. 225). Games focused on gamification (non-game scenarios adopting game-typical elements), narratives, enhancing user interface, implementing minigames within themselves, and reducing non-compatible errors show promise in being able to support the social integration of children with ASD (Jiménez et al., 2023, p. 1-5).

Technological developments continue to build on these intervention measures, seeking to use generative-AI to improve the children's engagement with these games, improving the social and emotional learning of children with ASD (Tang et al., 2024). Employing narrative structures within these paradigms shows potential to support typically-developing children develop digital literacy while engaging cognitively and emotionally

(Moore et al., 2024, p. 18). In the context of ASD children, then, some social conversation partners and game-based paradigms adopt similar narrative structures, whose findings support that this framework encourages healthy social, emotional, and communicative development in children with ASD (Tang et al., 2024, p. 9).

Artificial intelligence conversation robots build on these traditional robotic conversational partners for children with ASD by way of their adaptive responsiveness, yet they build on successful findings from past social robots concerning narrative or game-based frameworks (Tang et al., 2024, p. 9). Unlike the preexisting technological conversation partners, which are limited by their adherence to rules, lack of language comprehension, high resource usage, and general ineffectiveness, artificial intelligence robots are more tailored to and accessible for individual children with ASD. Adaptive speech-generating devices (SGDs) may intervene in enhancing the social communication utterances of children with ASD past the preschool age, by way of improving their joint attention, symbolic play, engagement, and regulation (Kasari et al., 2014; Jia et al., 2022, p. 1466). Therapist training, as well as design and implementation costs pose a central concern of clinicians about the viability of technological integration into practice (Alabdulkareem et al., 2022, p. 11). SGDs may then be considered for their cost-effectiveness against social robots, since training on Large Language Models (LLM)-based programs is more generalizable than variable social robots, and in terms of manufacturing robots versus designing interface, the latter may implement a coded set of instructions on more accessible at-home devices. Socially assistive robots (SARs) may be further improved by focusing on real-time adaptiveness rather than costly anthropomorphic social robots that unsuccessfully attempt to replicate complex motor muscle configurations to depict human emotions (Scassellati et al., 2012, p. 279-91). This adaptiveness might be developed in the adoption of LLMs into these SARs, which would enable their greater contextual understanding of variations in an individual child with ASD. They may also take the form of touchscreen interactive programs, such as Proloquo2go, whose voice output feature may enhance academic performance in nonverbal children with ASD (Collette et al., 2019, p. 148).

Specifically, generative-AI conversational partners using LLMs and personalized text-to-visual components can effectively address ASD across the spectrum, meeting those who classify as having high-functioning autism (HFA) (Tang et al., 2024, p. 17). This is explained by generative-AI being able to contextually tailor itself; for example, social robots such as EmoEden meet children with HFA according to their specific needs, significantly improving deficits in emotion expression and recognition. However, maintaining an ethical balance between use of social robots and generative-AI conversation partners with real-life social interactions is integral so that children with ASD are not deprived of the opportunity to develop their natural social skills (Bakir, 2025, p. 4).

Speech language pathologists (SLPs) further consider the implications of generative-AI and LLMs for intervention approaches to children with ASD (Lewis et al., 2025). Children with ASD may exhibit phonological difficulties pertaining to pronunciation or random utterances, as has been supported by pattern-recognition measures (Jia et al., 2022, p. 1466). These phonological difficulties may be mitigated with the use of speech understanding, language production, and language communication training administered through speech recognition devices such as dynamic augmented reality (AR) mobile application systems (p. 1465). Similarly to embodied technological play, generative-AI measures such as the application of Chat-GPT 4.0 simultaneously ease the child's learning in the low-pressure environment (Zhu et al., 2023, p. 611; Boucenna et al., 2014, p. 724; Du & Juefei-Xu, 2023, p. 2).

This follows from children with disabilities, including ASD, showing high levels of comfortability with social robots and entrusting them to conduct therapy (Robles-Bykbaev et al., 2017, p. 356). Additionally, LLM-based chatbots such as Chat-GPT 4.0 show high accuracy for their clinical assistance in report-writing, diagnostic support, and material drafting. However, Chat-GPT 4.0 does not presently integrate into therapy planning otherwise with much success (Birol et al., 2025). Its reliance on open-source data to train its accuracy may also over-enhance the generalization of its produced clinical judgement, as well as impede on the privacy of previous clients (Du & Juefei-Xu, 2023, p. 2).

Limitations and Ethical Considerations of Technological ASD Applications: Future Directions

Limitations in the clinical research on the effectiveness of generative-AI, machine learning, and other emerging technological applications persist, particularly in the identification of ASD symptoms in the preschool age group. Machine learning (ML) and deep learning (DL) identification techniques of ASD-typical facial features continue to require clinician expertise on individual variation (Munto et al., 2024, p. 1). More research is also needed in the amount of use that constitutes the detrimental “overuse” of intervention measures such as social robots (Bakir, 2025, p. 4). Additionally, insight into if children with ASD develop digital literacy as typically developing children demonstrate when engaging with narrative- and/or game-based digital paradigms would benefit future research directions (Moore et al., 2024, p. 18). Yet, novel research addressing these gaps in the literature using technological applications are promising: the early stratification of ASD and TD diagnosis grows stronger, heterogeneous differentiations between age and gender are being established, and ASD subtypes (ex. HFA) continue gaining contextual support (Atyabi et al., 2023, p. 18; Tang et al., 2024, p. 17). The bank of evidence presently supports the clinical use of significant diagnostic and intervention ML and AI measures (Atyabi et al., 2023; Joudar et al., 2023, p. 58). Once the preschool age group is encapsulated within literature and existing datasets, the broad applicability of AI measures across age groups may be interpreted as a strength of the technology (El Shemy, 2022, p. 659-60). Moreover, intervention measures rooted in generative-AI and DL software are promising for their significant results in participant completion of the programs and positive engagement thus far, which has historically proven difficult for children with ASD to accomplish using traditional intervention measures (Tang et al., 2024, p. 13; Alabdulkareem et al., 2022, p. 11).

As these applications operate at the confluence of clinical work and software development, those in policymaking, research, practice, and parenting roles should similarly continue to inform their practices in raising and supporting children with ASD by situating and understanding emerging technologies from a multifaceted perspective (Alabdulkareem et. al, 2022, p. 11). This would fulfill experienced gaps between clinicians’ skills, social acceptance, and reliability of these designs. Exploring emerging technologies within the human-computer interaction domain may also broaden cost-effective approaches for researchers and clinicians alike, enabling researchers to widen their applications’ reach and clinicians’ access to them (Scassellati et al., 2012, p. 279-91). While policymakers and researchers respectively continue minimizing privacy concerns and the homogeneous generalizability of client training data, parents and clinicians, such as speech language pathologists, might find integrating the clinical potential of these innovations rewarding for their significant developments in the emotional and social learning of children with ASD (Lewis et al., 2025; Dangol et al., 2025). As literature on this topic continues developing at a rate aiming to shore the gap between itself and the rapid development of emerging technologies, the practical limitations of generative-AI and other emerging technologies may continue being reduced with such cross-disciplinary collaboration.