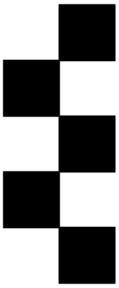

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Module: Research Methods and Professional Practice

Assignment: Literature Review

Research Topic: AI-based assistive technology for individuals with ASD

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition that affects an individual's social and communication skills (National Institute of Mental Health, 2023). It is estimated that approximately 1 in every 100 children have ASD (World Health Organization, 2023) highlighting the urgency in addressing the challenges faced by individuals with ASD. This review explores how artificial intelligence (AI) based assistive technologies impact self-confidence, independence, safety, employability, education and quality of life for individuals with ASD.

Assistive technologies are designed to address specific challenges faced by individuals. In the context of ASD this could relate to social skills, emotional intelligence or independent living. Two examples that demonstrate the use case of assistive technologies for individuals with ASD are AI-powered applications to help individuals identifying emotions of others to improve social skills (Cai et al., 2018) and social robots such as NAO that help individuals engage in interactive activities and reduce anxiety (Scassellati et al., 2018).

This review aims to highlight the benefits, limitations, and ethical implications of these technologies whilst informing caregivers, educators, technologists, developers, policymakers, and researchers about the potential and challenges of AI-based assistive technologies for individuals with ASD. Due to rapid technological advancements and a lack of awareness, there is a lack of analysis on AI-based assistive technologies for ASD specific challenges. This review seeks to address gaps in the current literature by offering a balanced perspective that integrates technical capabilities, clinical outcomes, and ethical considerations. It aims to provide actionable insights, emphasize the importance of regulatory frameworks, and highlight discrepancies in existing research to identify priorities for future investigation.

This review adopts a multidisciplinary perspective citing literature from healthcare, and education on AI based technology and ethics. A thematic synthesis framework was used to organise findings into key themes such as independence, education, safety and employment using data from qualitative and quantitative studies. Sources were identified through systematic searches of academic databases using search terms such as “AI and ASD”, “assistive technologies for autism” and “ethical considerations in AI for disabilities”. I only selected peer-reviewed articles published in the last decade, studies that focused on AI applications for individuals with ASD and studies that covered both technical and ethical dimensions that were either written or translated into English.

AI-based assistive technologies have the potential to significantly improve an individual's independence by increasing their autonomy and supporting them with tasks that may otherwise require caregiver assistance. For example, AI-driven task planners and wearable devices can support individuals who struggle with daily activities such as cooking and dressing. Kim, Park and Kim reported a 35% increase in task completion rates amongst individuals with ASD using wearable AI tools (Kim et al., 2021). In addition to improving independence these technologies create a sense of emotional empowerment. However, despite the transformative potential of AI-based assistive technologies there is a need to guard against overreliance on AI, as it can hinder the development of natural problem-solving skills and coping mechanisms (Lindsay et al., 2020).

AI-based assistive technologies can significantly boost the self-confidence of individuals with ASD. For example, emotion recognition systems and social robots allow individuals to manage their anxiety and practice social interactions in a safe controlled environment enabling them to gradually build confidence in navigating real-world scenarios (Tanaka et al., 2020). These tools provide personalised feedback to help individuals with their social skills, self-esteem and confidence (Voss et al., 2019). Additionally, there are AI powered tools that assist individuals with daily living activities helping individuals to perform activities independently aiming to improve their independence, self-esteem and self-confidence (Kim et al., 2021).

Whilst AI-based assistive technologies have the potential to significantly improve an individual’s self-confidence they can also create an overreliance on the technology which comes with its own set of risks. For example, the dependence on these technologies may actually adversely affect an individual’s coping mechanisms and interpersonal skills (Lindsay et al., 2020). Additionally, AI algorithms are not always accurate, and misinterpretations of user behaviour or errors in feedback could cause a great deal of confusion and frustration (Schmidt et al., 2019). Finally, high costs and technical requirements limit the availability of these tools to socioeconomically privileged groups (Kirkpatrick et al., 2021).

AI-based assistive technologies have the potential to positively impact an individual’s quality of life by addressing communication barriers and enhancing therapeutic engagement. For example, for individuals with nonspeaking autism augmentative and alternative communication (AAC) tools help with social interactions (Fletcher-Watson, 2019). Other examples of AI based assistive technologies for individuals with low functioning autism are behavioural monitoring systems for their caregivers which are used to improve their quality of care (Goodwin et al., 2020), VR-based therapies and gamified AI applications for therapy (Parsons et al., 2018). A survey of 100 caregivers revealed that 80% reported improved stress management and reduced caregiver burden using AI-assisted behavioural monitoring systems (Goodwin et al., 2020).

Despite the potential of these technologies there are privacy concerns relevant to this type of technology as they are collecting sensitive data about vulnerable people's behaviour which could be exploited by unsavoury individuals seeking to exploit vulnerable individuals for financial gain (Shen et al., 2020). Additional potential concerns include how the technology adapts to different cultures (Binns, 2018), the technological barriers and economical barriers (Williams et al., 2021; Chunara et al., 2021) and the potential for reduced human interactions (Dautenhahn, 2019).

AI has revolutionised education as AI-based assistive technologies can be used to create personalised learning experiences for every student not just those with disabilities such as ASD. These technologies analyse students' performance in real time and react to optimise learning. Kientz, Hayes and Abowd's longitudinal study revealed a 40% improvement in reading comprehension amongst students with ASD who used AI powered tools compared to traditional methods (Kientz et al., 2020). Qualitative data from teachers revealed these tools improve inclusivity and allow students with ASD to work at their own pace. Despite the huge potential of AI in an educational context, limited cultural adaptability remains the biggest obstacle we are yet to overcome as many AI systems are designed for specific demographics (Schmidt et al., 2019).

Safety is a major concern for individuals with ASD as many individuals with ASD face heightened risks navigating unfamiliar environments or managing crises. AI-based assistive technologies equipped with GPS tracking and emergency alerts have proven to be effective in helping to ensure the safety of individuals with ASD. Goodwin, Velicer, and Intille reported a 50% reduction in wandering incidents among children with ASD using wearable devices that support GPS tracking (Goodwin et al., 2020). An additional benefit of this type of technology is it offers peace of mind to parents and caregivers. Whilst tracking technologies are vital for the safety of these individuals there are significant privacy concerns surrounding the potential misuse of sensitive location and behavioural data hence the need for robust data protection frameworks (Shen et al., 2020).

AI-based technologies to support employment are becoming increasingly common not just for individuals with ASD but for individuals with any type of disability. AI-driven job-matching platforms and workplace training programs match individuals with suitable roles enhancing job retention. Parsons, Yuill, and Good reported a 25% increase in retention rates amongst ASD employees supported by AI-based systems (Parsons et al., 2018). However it's worth noting that there is the potential for bias in algorithmic decision-making, which may exclude candidates with atypical profiles due to the training data lacking diversity (Mehrabi et al., 2021).

The long-term impacts of AI-based assistive technologies for individuals with ASD requires further exploration due to the lack of longitudinal studies on the topic. Consistent use of AI based assistive technologies has the potential to significantly enhance skill retention, social integration, and independence and may reduce caregiver burden. However, prolonged reliance on AI tools could inadvertently suppress natural coping mechanisms and adaptive behaviour's (Lindsay et al., 2020) hence the need for longitudinal studies to evaluate these impacts and ensure that AI technologies foster sustainable benefits while mitigating risks and ethical concerns.

The integration of AI into assistive technologies raises plenty of social, legal and ethical challenges. The social challenges are related to the negative stigma and perception surrounding assistive technologies (Neff & Nagy, 2016), the digital divide caused by socioeconomic disparities (Chunara et al., 2021) and how the technology adapts to different cultures (Binns, 2018). The ethical challenges are related to biases in algorithms if the training data has any inherent biases or is lacking diversity (Mehrabi et al., 2021), informed consent for vulnerable people (Vayena et al., 2018) and the balance between autonomy and dependence (Floridi et al., 2018). Floridi highlighted the delicate balance between promoting user autonomy and fostering reliance on assistive systems (Floridi et al.,2018). For example, while AI tools empower users to accomplish tasks independently, prolonged reliance may undermine the development of adaptive behaviour's critical for real-world functioning. Vayena argued that obtaining informed consent from vulnerable populations, such as individuals with ASD, poses challenges as they may not fully understand the data collection and decision-making processes of AI systems (Vayena et al., 2018). Furthermore, the opacity of many AI algorithms complicates accountability, raising questions about who should be held responsible in cases of malfunction or harm (Pagallo, 2017). Ethical design principles, such as transparency, fairness, and inclusivity, must be integrated into AI development to ensure these technologies benefit users without creating new ethical dilemmas. The legal challenges are related to data ownership, privacy, compliance and liability. For example, international regulations such as the GDPR and HIPPA regulations must be adhered to for protecting user privacy and rights (Tene & Polonetsky, 2013). Additionally, there are questions regarding ownership of sensitive data (Mittelstadt et al., 2016) and liability in the event of AI malfunction (Pagallo, 2017) that must be answered.

The effectiveness and accessibility of AI-based assistive technologies for individuals with ASD is significantly influenced by cultural and demographic factors as many existing AI systems are developed using datasets primarily derived from Western populations, limiting their applicability in diverse cultural contexts. For instance, Schmidt, Lesch, and Weber revealed that emotion recognition tools often fail to account for cultural variations in facial expressions and social norms, which can reduce their effectiveness for non-Western users (Schmidt et al., 2019). Additionally, socioeconomic disparities further exacerbate access to these technologies as families in low-resource settings often face barriers such as high costs, lack of internet infrastructure, and limited awareness of available tools (Chunara et al., 2021). These challenges highlight the need for culturally adaptable AI systems designed to address the unique needs of underrepresented populations.

The main findings from this review were even though AI tools significantly enhance autonomy in daily tasks they may impede natural skill development, in an educational context AI-driven adaptive learning platforms improve academic outcomes but face cultural adaptability issues, monitoring devices reduce safety risks but raise privacy concerns, in the context of employment AI-based job-matching systems increase job retention but risk bias in algorithmic decision-making. In short whilst there are plenty of potential benefits there are also plenty concerns regarding data security, accessibility disparities, and algorithmic fairness that must be considered.

The existing literature demonstrates substantial evidence of the benefits of AI based assistive technologies, supported by both quantitative and qualitative data. However, there are notable gaps in the existing literature such as a lack of longitudinal studies to assess long-term impacts and insufficient representation of diverse populations. Additionally, discrepancies exist in findings regarding the effectiveness of AI in improving social skills, with some studies highlighting positive outcomes and others suggesting potential drawbacks.

It is my recommendation to policymakers that they work on establishing ethical guidelines to address some of the challenges related to data usage and privacy. It is my recommendation to developers and organisations that they take steps to design more affordable and culturally adaptable tools. It is also my recommendation to researchers that they conduct longitudinal studies to analyse the long-term impact of AI based assistive technologies which continuing to investigated cultural differences and it is my recommendation that educators, clinicians and individuals with ASD collaborate to create user-centred solutions.

In conclusion whilst AI based assistive technologies have transformative potential in all aspects of life for individuals with ASD there are plenty of challenges such as cost, accessibility and algorithmic bias that need to be addressed in future research to ensure these technologies empower individuals with ASD without creating any new challenges.

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