

# Parents’ Perception of the Use of Virtual Reality-based Learning Systems for Children with Asperger’s Syndrome

Aiganym Soltiyeva  
SDU University  
Almaty, Kazakhstan  
aiganym.soltiyeva@sdu.edu.kz

Wilk Oliveira  
Tampere University  
Tampere, Finland  
wilk.oliveira@tuni.fi

Madina Alimanova  
SDU University  
Almaty, Kazakhstan  
madina.alimanova@sdu.edu.kz

Juho Hamari  
Tampere University  
Tampere, Finland  
juho.hamari@tuni.fi

**Abstract**—In the last few years, virtual reality began to be adopted as a strategy to enhance the learning experiences of autistic children. However, only a few studies have analyzed the outcomes of using virtual reality for children with Asperger’s syndrome (*i.e.*, a section in the large group of Autism Spectrum Disorders). Simultaneously, many neglect parents’ views on using virtual reality in educating children with Asperger’s syndrome. To address this gap, we qualitatively investigated the perception of parents of children with Asperger’s syndrome about their children’s behavior before and after using a virtual reality-based learning system. Employing Constructivist Grounded Theory, we surveyed and analyzed three parents’ perceptions of their children’s behavior with Asperger’s syndrome before and after continuous system usage for three months. Qualitative findings indicate that parents noticed that their children acquired positive behaviors throughout the use of the system (*e.g.*, interacted with peers, engaged in group activities, and maintained eye contact with others), thus, advancing barriers related to Asperger’s syndrome. Our study contributes to the area of educational technologies and autism, generating new knowledge about the possibility of using virtual reality to enhance positive behaviors in children with Asperger’s syndrome.

**Index Terms**—Virtual reality, Asperger’s syndrome, educational technologies, children, qualitative study

## I. INTRODUCTION

In recent years, the use of virtual reality (VR) in educational settings has gained momentum, particularly in addressing the unique learning needs of autistic children [1]–[3]. VR, with its immersive and interactive features, has been recognized as a potential tool to enhance teaching methods and support the development of children with Autism Spectrum Disorders (ASD) [4]–[6]. VR-based approaches hold promise in fostering a more inclusive and effective learning environment for children facing the challenges associated with autism [7]–[9].

Despite the growing interest in using VR for autistic children [1]–[3], a critical gap exists in the current body of research. First, few studies have explored the use of VR for

children with Asperger’s syndrome (*i.e.*, a section in the large group of ASD) [2], [10]. At the same time, most studies focusing on the efficacy of VR in education tend to overlook the essential perspective of parents [10]–[12]. This lack of attention to parental perceptions in existing studies raises questions about the holistic understanding of the effectiveness of VR in the educational context for autistic children [10], [12].

In response to this gap, we conducted a qualitative investigation into the perceptions of parents of children with Asperger’s syndrome regarding the continued use of a virtual reality-based learning system (for three months). Based on Constructivist Grounded Theory (CGT) methods, we analyzed parents’ perceptions generating a Grounded theory model of parents’ perception regarding virtual reality-based learning systems for children with Asperger’s syndrome.

Qualitative findings indicate shifts in the children’s behavior, encompassing enhanced peer interaction, engagement in group activities, and maintaining eye contact. This qualitative exploration adds insights to the existing body of knowledge and emphasizes the critical role of parental perspectives in understanding the broader implications of VR interventions for children with autism.

## II. BACKGROUND AND RELATED WORK

Asperger’s syndrome is part of a broader category of ASD that is characterized by impaired social interaction and distinctive repetitive stereotyped behavior or activity, as well as an inability to maintain eye contact [13]–[15]. The term “Asperger’s syndrome” was first proposed by Wing [16], [17], characterized by: *i*) lack of understanding of socially accepted norms of behavior, social “naivety”, lack of common sense; *ii*) narrowness and limited interests (while they may be extremely deep); and *iii*) inability to engage in dialogue, a tendency to repetition in speech, and difficulty with nonverbal communication [16], [18]. Barriers to building communication and establishing contact with other people include stereotypical and limited behavior, fear of the world around them, the inability (or difficulty) of children with ASD to perceive other

This work has been supported by SDU University Internal Research Funding. This work has been supported by the Academy of Finland Flagship Programme [Grant No. 337653 - Forest-Human-Machine Interplay (UNITE)].

The authors utilized generative artificial intelligence (*i.e.*, Microsoft Copilot) to improve the grammatical quality of the text.

people as partners in communication and interaction, and problems in using and understanding speech [14], [19].

VR is an immersive, multimodal technology that immerses users in an artificially created world through technical means and allows interaction with it [20], [21]. Earlier research provides initial support for using VR technologies to train and reinforce specific skills of ASD children that can later be transferred to the real world [22]. Since the core issues of ASD concern social interactions and communication, the use of VR can be an effective alternative to traditional teaching methods, allowing users to practice social skills in a non-threatening, motivating, and controlled environment [9], [23].

Few initial studies have been carried out in recent years covering the perception of parents of autistic children about the use of VR with their children. Across the spectrum of these studies, researchers have focused on qualitative studies, involving using VR-based learning systems with autistic children (e.g., to train the emotional and social skills of ASD children) and then collecting information from parents [22], [24], [25]. Results demonstrated that parents noted that their children became more initiative in greeting and communicating with neighbors and relatives [24], opening space for the use of VR to improve skills needed in people's daily lives, and improving their air mobility skills after the intervention [22], demonstrating the potential of VR to improve aspects more related to physical mobility.

While the current literature begins to investigate the perception of parents of autistic children about the use of VR with their children, they still leave open (and highlight) the need for studies that explore how parents of children diagnosed with Asperger's syndrome perceive their children's behavioral changes after the continued use of VR learning system. As far as we know, we are pioneers in exploring parents' perceptions of children diagnosed with Asperger's syndrome regarding behavioral changes in their children after long-term VR-based usage.

### III. STUDY DESIGN

The main goal of this study is not to analyze the effects between variables, but rather to freely explore parents' perceptions regarding using VR technology in the education of autistic children. For this purpose, we conducted a qualitative study based on CGT.

#### A. Materials and method

In this study, we used a VR learning system called "My Lovely Granny's Farm". This system represents a virtual farm with two virtual characters (a farmer and his son) and different domestic animals, in which the user can walk around the farm, explore, interact, perform tasks, and answer questions. The main reason for choosing the farm scenario is the research evidence that animal-assisted activities could positively impact social interaction, and decrease stress and problem behaviors of ASD children [26], [27]. Furthermore, the system has already been used in previous studies by Soltiyeva *et al.* [28], [29], avoiding biases related to the quality of the system.

To immerse users in the virtual environment, the system utilized the Oculus Quest 2 VR headset with two wireless controllers, enabling free movement for exploring the farm without barriers. Thus, children with ASD can train and improve their communication skills in a safe and controlled environment.

This study used a qualitative method to explore parental perceptions of virtual reality-based learning systems for children with Asperger's syndrome. The qualitative method is flexible, allowing for adaptation to the unique needs and experiences of participants provided a more complete picture of parental perceptions, enabling in-depth interpretations of the data. Given the number of participants in this study, the qualitative method is a more appropriate and feasible means of collecting and analyzing data.

The study consisted of three main steps: *i)* training children using the VR learning system, *ii)* surveying the parents, and *iii)* analyzing the collected data. In the *first step*, the children with Asperger's syndrome used the system for three months. The children explored the virtual farm, interacted with the objects, communicated with the virtual farmer and his son, and performed tasks (during three months). In the *second step*, after completing the training sessions, the parents of the children filled in a survey, which allowed a comparison of the children's behavior before and after the training. The questions for the questionnaire were prepared by the first author in consultation with an expert from a children's correction center for ASD children. Questions focused on child behavior, peer interactions, maintaining eye contact, and engaging the child in group activities independently. In the *third step*, the data were analyzed and processed through qualitative research based on CGT.

#### B. Participants and data analysis

The participants of the study are three parents of children with Asperger's syndrome. All participants (parents) are female, aged 42 years for P1, 34 years for P2, and 29 years for P3. One of them has three children in the family and the other two have one child each. The three children are male, aged seven years with Asperger's syndrome diagnosis. Children face notable challenges in social interaction, yet their cognitive development enables them to comprehend events, and they possess adequate verbal skills to articulate emotions, respond to inquiries, and accomplish tasks. Additionally, the selection of 7-year-old participants in this research is based on their commencement of elementary school attendance at this age. All participants were given clear and complete information about the purpose, procedures, and benefits of the research before taking part in the study. Parents understood that their participation in the study was voluntary. Any identifying information collected during the research process is kept strictly confidential.

To conduct a productive and useful analysis, we have chosen the CGT method [30]. Grounded theory is a qualitative research approach developed by Strauss and Glaser [30], [31]. A well-constructed Grounded theory must meet four central

criteria to judge whether a theory applies to a phenomenon: it must correspond to reality, be understandable, generalizable, and testable [30]. In our specific case, this methodology aided us in gaining a profound understanding of parents' perceptions regarding their children's behavior, allowing us to derive pertinent findings. CGT is a later version of the Grounded Theory that was proposed to understand and explain complex social phenomena that do not have pre-developed theories. This method consists of five main steps: *i*) data collection *ii*) coding *iii*) memo writing *iv*) theoretical sampling, saturation, and sorting *i*) re-constructing theory and writing the draft [32].

#### IV. FINDS

Our analysis based on CGT, generated a Grounded Theory model, with insights into parents' perceptions regarding the use of virtual reality-based learning systems for children with Asperger's syndrome. Table I present the Grounded Theory model.

##### A. Changes in the child's behavior

This action represents a transformation in a child's behavior after an intervention using a VR learning system. The ability to share, negotiate, take turns, and follow the rules is important in building societal behavior [33]. Improving the self-regulation of children with ASD can enable them to change their behavior less frequently and intensively, leading to more positive relationships with the people around them [34]. Parents observed positive changes in their child's condition after finishing the training. In particular, parents reported that their children started to follow the day-by-rules. Parents perceived that it uncovers children's attempts to follow the rules during communication with others. According to the parents, after completing the training, children started to consider other children's opinions and wait for their turn during games:

P1: **"My son used to only talk about planets, now he can ask questions, hold conversations, and follow all the rules"**. P2: **"He has become talk less about self-interest"**. P3: **"He began to contact other children more often, asking for their opinions and questions"**.

Parents also revealed changes in children's behaviors regarding respect and understanding other children's rights during communication. It is challenging for these children to comprehend others, interpret information, discern intentions and emotions, and engage in interactions with them [35]. The lack of understanding of others increases the likelihood of social isolation and reduces social interaction [33]. However, parents noticed that children began to demonstrate empathy, not focus on their interests, and follow the rules concerning other children:

P1: **"Participating in the experiment has greatly improved my son's condition. He became a normal child"**. P2: **"He's become less self-absorbed, and less likely to play the same games. Playing with kids"**. P3: **"That was our big problem, interrupting everyone and only talking about his own thing. Now he has learned to wait and not to interrupt others"**.

##### B. Impact on social skills

Parents reported that children acquired some social interaction skills (which can be difficult for individuals with ASD diagnosis [36]). ASD children, regardless of their intellectual development, are unable to engage in meaningful social contact [36]. For this reason, it is essential to find and select effective interventions to enhance the social interaction of ASD children. Parents reported considerable improvements in communication with peers of their children. They began to ask questions, seek opinions, and play with peers on their initiative:

P2: **"He became interested in what his classmates were talking about, joining in the conversation, asking questions by himself"**. P1: **"My son began to communicate more with his peers"**. P3: **"Before participating in the experiment, he often played with Lego and drew alone. Now he is more socially orientated"**.

Engaging in group activities was the main barrier in the daily life of participants before the training. Children preferred to play alone, assembling constructors or drawing, with no desire to join in with other children's activities. Recent studies demonstrate that many children with autism experience social isolation due to poor social skills [37]. Students with autism are also more likely to experience rejection and bullying from others [38]. Therefore, it is important to help them learn to play and socialize with their peers. Parents reported that children began to engage in group activities and play with other children after the training with the VR learning system.

P1: **"He enjoys playing with children, and engages in group games on his own"**. P1: **"Nowadays, my son likes to play with children more."** P2: **"He begins to join other children's play on his own"**. P3: **"Recently he started to play with children, especially in active games. Earlier he only took away toys from other children"**.

Maintaining eye contact is a normal response to speech and an important feedback source to interlocutors [35]. The tendency of children with Asperger's syndrome to avoid eye contact can affect the length of conversations and cause misunderstandings in situations with neurotypical people [35], [39]. Thus, training in eye contact is essential for understanding and improving the social difficulties of children with ASD [35]. In our case, parents noted that their children began to maintain eye contact during conversation for longer periods after finishing training with the VR system:

P3: **"Before the experiment, it was mostly cursory eye contact. After the experiment, practically normal eye contact"**. P2: **"He has started to make longer eye contact during conversation"**. P1: **"My son began to maintain eye contact well"**.

##### C. Discussion

Incorporating new technologies like Virtual and Augmented Reality can enhance communication and social skills for individuals with ASD [40], [41]. VR technology provides a low-stress environment for ASD individuals to practice social skills realistically, mitigating fear of mistakes or rejection [4].

TABLE I  
GROUNDED THEORY MODEL

Condition	Actions/interactions with the VR learning system	Consequences	Outcomes
After using the VR learning system	Changes in the child's behavior	Following the rules Understanding of others' boundaries	Respect and understand other's feelings
	Develop social skills	Interaction with peers Engaging in group activities Maintaining eye contact	Children can interact with peers and join other children's play

Research indicates positive impacts of VR interventions on social cognition, communication, and motivation in children with ASD [5]. However, there's a research gap in understanding parents' perceptions of this technology in children's education. Hence, we examined parents' views on a VR-based learning system for children with Asperger's syndrome.

Parents reported positive changes in their children's behavior after completion of the training. ASD children started asking the opinion of peers, initiating and taking turns in conversation, demonstrating the potential of VR to improve aspects related to children's communication. Parents also reported an increase in their children's voluntary participation in daily social interaction and improvement in interpersonal negotiation after the intervention. The parents reported that children improved their emotional regulation and empathy, *i.e.*, began to respect others' feelings, and not focus on their interests. These perceptions can pave the way for VR as an alternative to face difficulties inherent in the daily lives of children with Asperger's syndrome (*e.g.*, communication, social interaction, and emotions regulation).

Our study's findings can raise awareness of VR technology use among parents and educators, who seek optimal interventions for their children's needs [12]. Social skills deficits in individuals with ASD impact not only the child but also the caring parents, leading to increased levels of anxiety and depression, reduced financial resources, and diminished overall quality of life [42]. Therefore, the parents' perceptions reported in this study, while not considering VR as a new pedagogy for teaching children with Asperger's syndrome, open space for the use of VR as an alternative to improving some aspects related to the social skills of these children.

## V. LIMITATIONS AND FUTURE STUDIES

While our study aimed to provide insights into parents' perceptions of VR in autistic children's education, acknowledging certain limitations is crucial for nuanced interpretation. The study involved only three parents (all female). Although this is a qualitative study, where the focus is not on sample size and a small sample prioritizes depth over breadth, this limitation may restrict the saturation of our findings, not fully capturing the diversity of opinions among parents of autistic children in terms of demographics, socio-economic status, and cultural backgrounds.

The data collection method employed in this study relied solely on self-reported responses obtained through an online survey with open-ended questions. While this approach allowed for an in-depth exploration of parents' perceptions, it introduces the possibility of response bias and reliance

on subjective interpretations. Additionally, the absence of observational data or triangulation methods may affect the comprehensiveness and objectivity of our findings.

The study exclusively employed CGT for qualitative exploration of parents' perceptions, limiting the ability to triangulate findings through other analytical perspectives. Incorporating diverse methodological approaches could have provided a more comprehensive understanding of the complexities surrounding parents' perceptions of VR in autism education.

Based on the sample chosen for our study, and considering aspects such as participant size and demographics, we recommend that **future studies should prioritize the inclusion of a more diverse sample of parents of children with Asperger's syndrome**. This diversity could encompass variations in demographics, socioeconomic status, and cultural backgrounds, which can generate new insights into how VR can interfere with children's education.

To overcome the limitations associated with relying solely on self-reported responses, **future research could employ a mixed-methods approach**. Combining qualitative data from surveys or interviews with quantitative measures or observational data could provide a more robust and triangulated understanding. Given the potential for evolving perceptions over time, **future studies should consider adopting a longitudinal design**. By tracking parents' perceptions and children's behavior over an extended period, researchers can gain deeper insights into the sustained findings of using VR-based learning systems.

Conducting comparative analyses across different educational interventions for children with Asperger's syndrome, including but not limited to VR, can provide a more nuanced understanding of the unique contributions of each approach. Thus, **future studies should consider analyzing different technologies in teaching children with Asperger's syndrome**. Collaborative efforts between researchers and educational professionals can enhance the practical applicability of findings. Thus, **future studies should consider involving educators, therapists, and other professionals working directly with children with Asperger's syndrome**.

Recognizing the heterogeneity within the population of children with Asperger's syndrome, **future research could investigate individual differences in response to VR-based interventions**. Understanding how factors such as sensory profiles, cognitive styles, and communication abilities influence the effectiveness of VR in enhancing behavior would contribute to personalized and tailored educational approaches.

## REFERENCES

- [1] J. Garzón, J. Pavón, and S. Baldiris, "Systematic review and meta-analysis of augmented reality in educational settings," *Virtual Reality*, vol. 23, no. 4, pp. 447–459, 2019.
- [2] N. Honorato, W. Oliveira, J. Hamari, and S. Delabrida, "Gameful approaches for the education of autistic children: A systematic mapping and research agenda," in *2023 IEEE International Conference on Advanced Learning Technologies (ICALT)*, 2023, pp. 116–120.
- [3] A. Parmaxi, "Virtual reality in language learning: A systematic review and implications for research and practice," *Interactive learning environments*, vol. 31, no. 1, pp. 172–184, 2023.
- [4] M. Zhang, H. Ding, M. Naumceska, and Y. Zhang, "Virtual reality technology as an educational and intervention tool for children with autism spectrum disorder: current perspectives and future directions," *Behavioral Sciences*, vol. 12, no. 5, p. 138, 2022.
- [5] M. A. Mosher, A. C. Carreon, S. L. Craig, and L. C. Ruhter, "Immersive technology to teach social skills to students with autism spectrum disorder: A literature review," *Review Journal of Autism and Developmental Disorders*, vol. 9, no. 3, pp. 334–350, 2022.
- [6] J. Hutson, "Social virtual reality: Neurodivergence and inclusivity in the metaverse," *Societies*, vol. 12, no. 4, p. 102, 2022.
- [7] F. Ke and T. Im, "Virtual-reality-based social interaction training for children with high-functioning autism," *The Journal of Educational Research*, vol. 106, no. 6, pp. 441–461, 2013.
- [8] M. E. Minissi, G. A. R. Landini, L. Maddalon, S. C. Torres, I. A. C. Giglioli, M. Sirera, L. Abad, S. Gómez-García, and M. Alcañiz, "Virtual reality-based serious games to improve motor learning in children with autism spectrum disorder: An exploratory study," in *2023 IEEE 11th International Conference on Serious Games and Applications for Health (SeGAH)*, 2023, pp. 1–6.
- [9] B. N. Kadir<sup>1</sup>, M. H. Sahid, M. Noviana *et al.*, "Effectiveness of virtual reality (vr) in improving social skills in autism spectrum disorder cases: A literature," in *Proceedings of the International Conference on Vocational Education Applied Science and Technology (ICVEAST 2023)*, vol. 783. Springer Nature, 2023, p. 45.
- [10] N. Honorato, A. Soltiyeva, W. Oliveira, S. Emanuel Delabrida, J. Hamari, and M. Alimanova, "Gameful strategies in the education of autistic children: a systematic review, bibliometric analysis, and future research roadmap," *Smart Learning Environments*, vol. 11, no. 1, 2024.
- [11] M. Wilson, T. Whelan, L. Milne, D. Hamilton, D. Jacobs, and P. Pilkington, "A thematic analysis of influences on parents' autism intervention decisions," *Research in Developmental Disabilities*, vol. 117, p. 104035, 2021.
- [12] F. H. Abdeen and W. S. Albiladi, "Factors influencing the adoption of virtual reality (vr) technology among parents of individuals with asd," *Interactive Learning Environments*, pp. 1–18, 2022.
- [13] C. Hadjipanayi and D. Michael-Grigoriou, "Conceptual knowledge and sensitization on asperger's syndrome based on the constructivist approach through virtual reality," *Heliyon*, vol. 6, no. 6, 2020.
- [14] V. Motlani, G. Motlani, A. Thool, and A. R. Thool, "Asperger syndrome (as): a review article," *Cureus*, vol. 14, no. 11, 2022.
- [15] M. Tremolada, M. Rosa, R. M. Incardona, L. Taverna, and M. Guidi, "Impact of the covid-19 pandemic on psychosocial well-being and adaptation in children and adolescents with asperger's syndrome," *International journal of environmental research and public health*, vol. 20, no. 3, p. 2132, 2023.
- [16] L. Wing, "Asperger's syndrome: a clinical account," *Psychological medicine*, vol. 11, no. 1, pp. 115–129, 1981.
- [17] F. R. Volkmar and M. Woodbury-Smith, "Whither asperger's post dsm-5? an opinion piece," *Review Journal of Autism and Developmental Disorders*, pp. 1–7, 2024.
- [18] A. Aktypi-Bampouranou, E.-M. Kalogirou, I. Skamnakis, D. Vlachodimitropoulos, and K. I. Tosios, "Spongiotic gingival hyperplasia in a child with asperger syndrome: a case report," *Journal of Oral & Maxillofacial Research*, vol. 14, no. 3, 2023.
- [19] A. Klin, J. McPartland, and F. R. Volkmar, "Asperger syndrome," *Handbook of autism and pervasive developmental disorders*, vol. 1, pp. 88–125, 2005.
- [20] I. Wohlgenannt, A. Simons, and S. Stieglitz, "Virtual reality," *Business & Information Systems Engineering*, vol. 62, pp. 455–461, 2020.
- [21] D. Deng, M. Bujic, and J. Hamari, "Understanding multi-platform social vr consumer opinions: A case study in vrchat using topics modeling of reviews," in *Wuhan International Conference on E-business*. Springer, 2023, pp. 35–46.
- [22] I. T. Miller, B. K. Wiederhold, C. S. Miller, and M. D. Wiederhold, "Virtual reality air travel training with children on the autism spectrum: A preliminary report," *Cyberpsychology, Behavior, and Social Networking*, vol. 23, no. 1, pp. 10–15, 2020.
- [23] F. Ke, J. Moon, and Z. Sokoljic, "Virtual reality-based social skills training for children with autism spectrum disorder," *Journal of Special Education Technology*, vol. 37, no. 1, pp. 49–62, 2022.
- [24] S. N. V. Yuan and H. H. S. Ip, "Using virtual reality to train emotional and social skills in children with autism spectrum disorder," *London journal of primary care*, vol. 10, no. 4, pp. 110–112, 2018.
- [25] C. Boo, N. Alpers-Leon, N. McIntyre, P. Mundy, and L. Naigles, "Conversation during a virtual reality task reveals new structural language profiles of children with asd, adhd, and comorbid symptoms of both," *Journal of Autism and Developmental Disorders*, pp. 1–14, 2022.
- [26] M. E. O'Haire, "Animal-assisted intervention for autism spectrum disorder: A systematic literature review," *Journal of autism and developmental disorders*, vol. 43, pp. 1606–1622, 2013.
- [27] L. O. Nieforth, A. Schwichtenberg, and M. E. O'Haire, "Animal-assisted interventions for autism spectrum disorder: A systematic review of the literature from 2016 to 2020," *Review Journal of Autism and Developmental Disorders*, vol. 10, no. 2, pp. 255–280, 2023.
- [28] A. Soltiyeva, W. Oliveira, A. Madina, S. Adilkhan, M. Urmanov, and J. Hamari, "My lovely granny's farm: An immersive virtual reality training system for children with autism spectrum disorder," *Education and Information Technologies*, vol. 28, no. 12, pp. 16887–16907, 2023.
- [29] A. Soltiyeva, W. Oliveira, M. Alimanova, J. Hamari, K. Gulzhan, S. Adilkhan, and M. Urmanov, "Understanding experiences and interactions of children with asperger's syndrome in virtual reality-based learning systems," *Interactive Learning Environments*, vol. 32, 2024.
- [30] J. M. Corbin and A. Strauss, "Grounded theory research: Procedures, canons, and evaluative criteria," *Qualitative sociology*, vol. 13, no. 1, pp. 3–21, 1990.
- [31] K. Deering and J. Williams, "Approaches to reviewing the literature in grounded theory: a framework," *Nurse researcher*, vol. 31, no. 3, 2023.
- [32] K. Charmaz, *Constructing grounded theory: A practical guide through qualitative analysis*. sage, 2006.
- [33] K. Özerk, G. Özerk, and T. Silveira-Zaldivar, "Developing social skills and social competence in children with autism," *International Electronic Journal of Elementary Education*, vol. 13, no. 3, pp. 341–363, 2021.
- [34] C. S. Rohr, S. Kamal, and S. Bray, "Building functional connectivity neuromarkers of behavioral self-regulation across children with and without autism spectrum disorder," *Developmental Cognitive Neuroscience*, vol. 41, p. 100747, 2020.
- [35] S. Uono, S. Yoshimura, and M. Toichi, "Eye contact perception in high-functioning adults with autism spectrum disorder," *Autism*, vol. 25, no. 1, pp. 137–147, 2021.
- [36] O. Bogdashina, *Communication issues in autism and Asperger syndrome: Do we speak the same language?* Jessica Kingsley Publishers, 2022.
- [37] C. Kasari, S. Freeman, and T. Paparella, "Joint attention and symbolic play in young children with autism: A randomized controlled intervention study," *Journal of child psychology and psychiatry*, vol. 47, no. 6, pp. 611–620, 2006.
- [38] C. Kasari, E. Rotheram-Fuller, J. Locke, and A. Gulsrud, "Making the connection: Randomized controlled trial of social skills at school for children with autism spectrum disorders," *Journal of child psychology and psychiatry*, vol. 53, no. 4, pp. 431–439, 2012.
- [39] M. Wiklund, "Gaze behavior of pre-adolescent children afflicted with asperger syndrome," *Communication & Medicine*, vol. 9, no. 2, pp. 173–186, 2012.
- [40] A. Dechsling, S. Orm, T. Kalandadze, S. Sütterlin, R. A. Øien, F. Shic, and A. Nordahl-Hansen, "Virtual and augmented reality in social skills interventions for individuals with autism spectrum disorder: A scoping review," *Journal of autism and developmental disorders*, pp. 1–16, 2021.
- [41] G. Mak and L. Zhao, "A systematic review: the application of virtual reality on the skill-specific performance in people with asd," *Interactive Learning Environments*, vol. 31, no. 2, pp. 804–817, 2023.
- [42] N. A. Nik Adib, M. I. Ibrahim, A. Ab Rahman, R. S. Bakar, N. A. Yahaya, S. Hussin, and W. N. A. Wan Mansor, "Perceived stress among caregivers of children with autism spectrum disorder: A state-wide study," *International journal of environmental research and public health*, vol. 16, no. 8, p. 1468, 2019.