

Serious Games and Autism: an overview

Vincenzo Suriani¹, Riccardo Bonanni² and Giancarlo Marzano²

¹UNIBAS - Scuola di Ingegneria, Via dell'Ateneo Lucano, Potenza.

²Walk-On Società Cooperativa Sociale, Via AnielloFalcone, 394, Napoli, 80127 (Italy)

Abstract

This article proposes a systematic review to explore the current directions of development and ongoing research on the positive impacts brought about by serious games in the context of autism. Autism Spectrum Disorder (ASD) represents a pervasive developmental disorder involving individuals with varying degrees of impairment. Currently, numerous studies have been conducted on serious games designed for children with autism. They are digital games with educational and entertainment purposes that have been explored as useful tools in autism education and therapy. The systematic review reports that serious games for autism mainly focus on therapy and education. These serious games dedicated to autism have shown positive outcomes in terms of education, communication therapy, psychomotor treatment, and enhancement of social behavior.


Keywords

ASD, serious games, autism, systematic review, education, therapy.

1. Autism Spectrum Disorder (ASD)

Autism is a condition resulting from a brain disorder that manifests in the first 2 and a half years of life [1]. Autism Spectrum Disorder (ASD) is characterized by impairment in three aspects: social cognition, communication, and imagination. These three deficits are considered among the most common and severe developmental disabilities [2, 28, 29]. Some studies indicate that this neurodevelopmental condition occurs in the United States with a frequency of one in 110 children and one in 625 children in Malaysia [3,4]. Five main types of autism are recognized: Autistic disorder Markedly; Asperger's syndrome; Rett's disorder; Childhood disintegrative disorder; Pervasive developmental disorder not otherwise [5].


It is acknowledged that children with autism differ from the group, and the manifestation of autism varies significantly from one child to another [6]. Although children with autism may appear similar to others, their condition compels them to interpret the world differently. Autism Spectrum Disorder represents a pervasive developmental disorder that affects individuals with various shades of impairment [7]. However, several common elements are observed in most people with autism, such as limited or absent motor control, an interest in technology and video games [8], and a strong attraction to a particular topic defined as a "special interest" (e.g., dinosaurs, trains, or outer space). The number of children receiving an autism diagnosis is steadily increasing [9]. Despite significant strides in early diagnosis, the outlook for most children with autism remains unfavorable, with only a few able to achieve independence in adulthood [10,11,12].

Proceedings of the Digital Innovations for Learning and Neurodevelopmental Disorders, May24–25, 2024, Rome, Italy 
vincenzo.suriani@unibas.it (V. Suriani); dott.giancarlomarzano@gmail.com (G. Marzano); bonannir@gmail.com (R. Bonanni);

 0000-0003-1199-83580 (V. Suriani); 0009-0003-6362-5040 (R. Bonanni); 0009-0004-9154-9783 (G. Marzano);



© 2023 Copyright for this paper by its authors.
Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).

 CEUR Workshop Proceedings (CEUR-WS.org)

2. Serious games and ASD

The term "Serious Games" refers to digital games with an educational design and entertainment orientation [13]. The goal of serious games is to leverage the latest gaming technologies for educational purposes, examining the educational, therapeutic, and social effects of digital games developed with or without specific learning objectives [14]. A systematic study by Noor et al. (2012) in the field of serious games for autism conducted between 2002 and 2011 demonstrated that serious games developed for autism primarily serve two purposes: therapy and education, encompassing both learning and training. In terms of educational serious games, they are designed to provide support to teachers and students in the teaching and learning process [15]. For instance, Zelai et al. (2011) introduced an education-oriented serious game for first aid, targeting individuals with autism, utilizing Android mobile devices. Another example is Arshia et al. (2011), who introduced a custom computer game based on digital narration aimed at facilitating understanding of money usage for children with autism aged 9 to 14. This game was designed to teach appropriate social behaviors during shopping. Another study by Barakova et al. (2007) presented an innovative interactive toy designed to express emerging behaviors and used in behavioral training for children with autism. This toy engages children by leveraging their natural interest in regular patterns and order, consisting of cubes that interact and change color based on player placement. User tests demonstrated prolonged engagement of children with the toy, indicating pronounced exploratory behavior and positive outcomes with improvements in interaction during the game. Among other approaches, cMotion stands out for using virtual humans to teach emotion recognition and programming concepts to children. The goal is to engage users in contextualizing emotions, promoting learning of emotional nuances in a cultural context and fundamental principles of computer programming [18]. Other serious games aim to develop narrative understanding, such as TouchStory [22]. Examples of linguistic skill development include games developed by Anika Anwar et al. (2011) and Maite Frutos et al. (2011). The former focuses on improvising language fluency in autistic children, requiring players to pronounce names of objects shown on the screen within a short time [19]. The latter aims to improve everyday language in children and adolescents with autism. This system, consisting of two separate applications, offers a personalized solution centered on individual needs. Results, showing the percentage of correct pronunciation for each word, can be exported and stored to monitor progress over time [20]. Regarding serious games with therapeutic functions, an innovative intervention was introduced by Mohammed E. Hoque et al. (2009) to improve language production in autistic children through the use of vocal games. This personalized approach involved identifying difficulties in language production areas from both clinical and computational perspectives. Preliminary results indicated positive and effective participant engagement in the proposed intervention. Another study devised an interactive computer game aimed at improving language clarity in autistic children, adding a therapeutic option to the traditional approach. Research results confirmed the effectiveness of this additional therapy [24,29]. In the context of promoting collaboration among children with ASD, Alberto Battocchi et al. (2009) introduced the Collaborative Puzzle Game (CPG), an interactive game. The innovative feature of "forced collaboration" embedded in systemic rules made the interaction more intricate but positively contributed to improving collaboration among children during the game. Finally, another study introduced "Serious" Games based on EEG for Medical Applications, analyzing neurofeedback games using electroencephalogram (EEG). The use of fractal dimension improved the efficiency of the classification algorithm, paving the way for future developments in the medical application of such games [26].

3. Conclusion

In conclusion, based on the analyzed meta-analyses, it is evident how games are highly effective in the areas of therapy and education for autistic children. The systematic review has delved into the directions of development and research on the positive impacts of serious games in the context of autism. They clearly emerge as crucial tools in the therapeutic and educational domains for children with Autism Spectrum Disorder (ASD), improving communication, facilitating learning, and promoting appropriate social behaviors. The analysis underscores the importance of customizing

the design of digital games to meet the individual needs of children with ASD, recognizing the diversity of autism manifestations. The variety of therapeutic approaches, from language therapy to the promotion of social collaboration, provides diversified solutions to address challenges related to autism. Furthermore, technological innovation, such as the integration of electroencephalogram (EEG) in serious games, opens promising prospects for future developments in the medical application of such games, enabling personalized and targeted interventions [27; 28]. In summary, the convergence of technology and therapies for autism through serious games offers a continuously evolving field with the goal of improving the quality of life and well-being of children with ASD.

References

- [1] Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child*, 2, 217–250.
- [2] D. V. Keen, F. D. Reid & D. Arnone. (2010). “Autism, Ethnicity and Maternal Immigration”. *The British Journal of Psychiatry*, 196:274-281.
- [3] Center for Disease Control. Prevalence of autism spectrum disorders: autism and developmental disabilities monitoring network [Online]. Available: <http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5810a1.htm>.
- [4] Dolah, J., Yahaya, W. A. J. W. & Chong, T. S. (2011). “Potential of interactive multimedia learning awareness (IMLA) in enhancing awareness of autistic characteristics among parents and society in Malaysia”. *Electronic Journal of Computer Science and Information Technology (eJCSIT)*, 3(1).
- [5] C. M. (2004). “The REACH way to transformation. Pulau Pinang: Association of Resource and Education for Autistic Children.” [Online]. Available: <http://lionsreach.net/resources.htm>
- [6] Seigel B. (2003). *Helping children with autism learn*. New York: Oxford University Press.
- [7] Belanich, J., Mullin, L. N. and Dressel, J. D. (2004). *Symposium on PC-based simulations and gaming for military training*. Arlington, Virginia: US Army Research Institute for the Behavioural and Social Sciences.
- [8] Abt, C. (1970). *Serious Games*. New York: The Viking Press.
- [9] CDC “Autism spectrum disorder”. (2010) [Online]. Available: <http://www.cdc.gov/ncbddd/autism/index.html>
- [10] Billstedt E, Gillberg C. (2005). “Autism After Adolescence: Population-Based 13–22-Year Follow-Up Study Of 120 Individuals With Autism Diagnosed In Childhood”. *Journal of Autism and Developmental Disorders* 35(3):351–360.
- [11] Eaves LC, Ho HH. (2008). “Young Adult Outcome Of Autism Spectrum Disorders”. *Journal of Autism and Developmental Disorders* 38(4):739–747.
- [12] Howlin P, Goode S, Hutton J, Rutter M. (2004). “Adult Outcome For Children With Autism”. *Journal of Child Psychology and Psychiatry* 45(2):212–229.
- [13] Sorensen, b.H. & Meyer, b. “Serious games in language learning and teaching-a theoretical perspective”, in *Proceedings of the 2007 Digital Games research Association Conference*. pp. 559-566.
- [14] Felicia, P. (2009). “Digital games in schools: A handbook for teachers”, *European Schoolnet, euN Partnership AiSbl: Belgium*. [Online]. Available: http://games.eun.org/upload/GIS_HANDBOOK_EN.PDF.
- [15] Noor, H. A. M., Shahbodin, F., & Pee, N. C. (2012). Serious game for autism children: review of literature. *International Journal of Psychological and Behavioral Sciences*, 6(4), 554-559.
- [16] Arshia Zernab Hassan, Bushra TasnimZahed, Fatema TuzZohora, Johra Muhammad Moosa, Tasmaha Salam, Md. Mustafizur Rahman, Hasan Shahid Ferdous, Syed Ishtiaque Ahmed, “Developing the concept of money by interactive computer games for autistic children,” in *Conf. Rec. 2011 IEEE Int. Symposium on Multimedia*, pp. 559–564.
- [17] Emilia Barakova, Gilles van Wanrooij, Ruben van Limpt, MarnickMenting. (2007). “Using an emergent system concept in designing interactive games for autistic children (Published Conference Proceedings style),” in *International Conference on Interaction Design and Children Proceedings: Creativity and Learning, Aalborg, Denmark*, 73-76.

- [18] Samantha L. Finkelstein, Andrea Nickel, Lane Harrison, Evan A. Suma, Tiffany Barnes, "cMotion: A new game design to teach emotion recognition and programming logic to children using virtual humans," in Conf. Rec. 2009 IEEE Virtual Reality, pp. 249-250.
- [19] Anika Anwar, Md. Mustafizur Rahman, S. M. Ferdous, Samiul Alam Anik, Syed Ishtiaque Ahmed, "A computer game based approach for increasing fluency in the speech of the autistic children," in Conf. Rec. 2011 11th IEEE Int. Conf. on Advanced Learning Technologies, 17-18.
- [20] Maite Frutos, Itxaso Bustos, Begoña García Zapirain, Amaia Mendez Zorrilla, "Computer game to learn and enhance speech problems for children with autism," in Conf. Rec. 2011 The 16th International Conference on Computer Games, pp. 209-216.
- [21] Zelai Sáenz de Urturi, Amaia Méndez Zorrilla, Begoña García Zapirain. (2011). "serious game based on first aid education for individuals with autism spectrum disorder (ASD) using android mobile devices," in Conf. Rec. 2011 The 16th International Conference on Computer Games, 223-227.
- [22] Megan Davis, Nuno Otero, Kerstin Dautenhahn, Chrystopher L. Nehaniv, Stuart D. Powell, "Creating a software to promote understanding about narrative in children with autism: reflecting on the design of feedback and opportunities to reason," in Conf. Rec. 2007 6th IEEE Int. Conf. on Development and Learning, pp. 64-69.
- [23] Mohammed E. Hoque, Joseph K. Lane, Rana eKaliouby, Matthew Goodwin, "Exploring speech therapy games with children on the autism spectrum," in Conf. Rec. 2009 10th Annual Conference of the International Speech Communication Association. [Online]. Available: <http://dspace.mit.edu/handle/1721.1/56580>.
- [24] Md. Mustafizur Rahman, S. M. Ferdous, Syed Ishtiaque Ahmed, (2010) "Increasing intelligibility in the speech of the autistic children by an interactive computer game," in Conf. Rec. 2010 IEEE Int. Symposium on Multimedia, pp. 383-387.
- [25] Alberto Battocchi, Fabio Pianesi, Paola Venuti, Ayelet Ben-Sasson, Eynat Gal. (2009). "Collaborative puzzle game: Fostering collaboration in children with autistic spectrum disorder (ASD) and with typical development," in Proc. International Conference on Interactive Tabletops and Surfaces, 197-204.
- [26] Qiang Wang, Olga Sourina, Minh Khoa Nguyen, "EEG-based serious games design for medical applications," in Proc. 2010 Int. Conf. on Cyberworlds, pp. 270-276.
- [27] Frolli, A., Ciotola, S., Esposito, C., Frascetti, S., Ricci, M. C., Cerciello, F., & Russo, M. G. (2022). AAC and Autism: Manual Signs and Pecs, a Comparison. Behavioral sciences (Basel, Switzerland), 12(10), 359. <https://doi.org/10.3390/bs12100359>.
- [28] Rega, A., Castellano, L., & Vita, S. (2021). Develop educational technology tailored for people with autism: a children's observation grid to build better tools. In Proceedings of the First Workshop on Technology Enhanced Learning Environments for Blended Education (teleXbe2021), January 21-22, 2021, Foggia, Italy.