

government investments to build infrastructure and allocate resources in rural areas. This can bring about sustainable changes, and continue to provide a unique solution to the challenges of accessing healthcare experienced by rural populations of LMICs.

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Video Game Interventions for Children with Autism Spectrum Disorder:

a systematic review

Research Article

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Introduction

There have been a growing number of children identified with neurodevelopmental disorders, including autism spectrum disorder (ASD). Around 1 in 68 children have been diagnosed with ASD in USA alone, along with the rising prevalence globally, thereby making ASD a relevant global mental health issue.¹ ASD is characterized by deficits in verbal and non-verbal social interactions.^{2,3} Treatments at an early age may assist in improving these symptoms for better social development; however, individuals may continue to face difficulties that extend into adulthood.³ Despite the increasing number of diagnosed cases, there

is no cure for ASD currently, with medications that only help to manage attention and other atypical states.¹

Consequently, there have been studies in recent years investigating the use of video games for neurodevelopmental rehabilitation, such as virtual reality simulations, video modelling, and neurofeedback approaches.^{4,5} Nevertheless, there is still a lack of high-quality study trials on these types of interventions.^{6,7} Greater assessments on their effectiveness are necessary to further their development.

This systematic review aims to investigate the effectiveness of video game interventions on the

social deficits of children with ASD from studies around the world.

Methodology

Younger children with ASD can reach a period of maximum plasticity where intensive therapy can be more effective, and hence this review explored the effects of video game therapy on a younger population.^{8,9} The following inclusion criteria were adopted: (i) preschoolers (ages 3 - 5) and middle childhood children (ages 6 - 11) with ASD, (ii) video game interventions, (iii) difficulties with social interaction and communication, (iv) publication date between January 2006 and August 2017 in peer-reviewed journals, and (v) empirical studies written in English.

Studies were also excluded as follows: (i) single-case study (sample size < 10), (ii) single intervention session, (iii) no video game component, (iv) insufficient data, and (v) no focus on improving social impairments.

Results

Study Selection

Studies were gathered from two databases: PubMed (n = 130) and PsycINFO (n = 80), along with additional references (n = 4). Key words included autism spectrum disorder, children, video game intervention, multimedia device, and neuro-developmental rehabilitation.

214 studies were screened for eligibility based on their title and abstract, where 184 were excluded. In completing a full-text assessment afterwards, 10 empirical studies were included.

Study Characteristics

Methodologic Features

Five were randomized controlled trial (RCT) studies second phase, while the others were cohort studies.¹⁰⁻¹⁴ Two cohort studies had two intervention groups,^{15,16} whereas the remaining cohort studies had only one first phase.^{8-10,17}

Regarding outcome measures, three studies favoured both parent reports and game related-

measures,^{10,14,15} while one focused solely on parent reports,¹² and another utilized teacher-completed questionnaires.¹¹ Interestingly, one study relied on children-report measures,⁸ while majority stood firm on game-related measures tracked by computers and study assessors.^{9,13,16,17}

Sample Characteristics

Three studies were conducted in the UK,^{11,12,15} one in France,⁹ one in Spain,⁸ one in Israel,¹⁶ one in UK (phase one) and in Israel and Sweden (phase two),¹⁰ one in USA,¹³ one in Brazil,¹⁷ and one in Australia.¹⁴ Interestingly, several studies were conducted across Europe, which demonstrates much about the interest in the implications of video game therapy purveyed within that region.

The studies totaled to 462 participants, with 100 as the largest sample¹¹ and 10 as the smallest.⁸ Majority recruited more males (n = 326, 83.59%) than females (n = 64, 16.41%).

Targetted Social Impairments

One study targeted joint attention (concentration and cues),¹² while another focused on facial recognition.¹³ Four studies wanted to improve emotion recognition and regulation.^{9,10,14,15} One focused on increasing positive social interactions, including sharing and conversational behaviours.¹⁶ Similarly, another study targeted social initiation (motivation and collaboration).⁸ One study assessed improvements in social functioning during a physical education program.¹¹ The last focused on social-cognition, including imitation and cooperative play.¹⁷

Game Interventions

One study utilized iPads for joint attention training.¹² Five studies used computer games to train emotion recognition and face processing.^{9,10,13-15} Similarly, one study employed computer-based games in language therapy sessions to improve socio-cognitive performance.¹⁷ Another used a multi-touch table screen to direct a collaborative puzzle game.¹⁶ One study created

a Kinect console-based video game to promote social initiation,⁸ while another used an existing Nintendo Wii™ game.¹¹

Game Protocols

There were three studies that had one video game intervention session each week,^{8,14,17} three studies with two to three sessions per week,^{9,11,15} and one study with two sessions in total.¹⁶ Three studies were based on gameplay times.^{10,12,13} Sessions ranged from 15 minutes to 2 hours.

The longest regimen was over a 9-month period,¹¹ while the shortest was 2 weeks.¹⁶ Seven studies had their sessions over 4 to 10 weeks.^{8-10, 12, 14, 15, 17} One had theirs over 19 weeks.¹³

Findings

One study showed no significant differences between groups for joint attention, but no significant negative changes were observed.¹² Another study noted general improvements in facial recognition.¹³

Two studies focusing on emotion recognition and responsiveness showed significant improvements in emotion regulation and coping strategies ($p < 0.01$).^{14, 15} Two other studies targeting emotion recognition specifically showed significant improvements in most of the emotion recognition conditions ($p < 0.02$).^{9, 10} Three studies presented significant improvements in positive social interactions, imitation, and cooperation ($p < 0.05$).^{8,16,17} Furthermore, a newer study showed significant improvements in social functioning for boys specifically ($p < 0.05$).¹¹

For follow-up sessions, only two RCTs had follow-up assessments,^{12,14} while the cohort studies had none. For one RCT, there were no differences between the groups afterwards.¹² The second RCT showed maintained improvements in emotion management at the 6-weeks and 5-months follow-ups.¹⁴

Generalization

There were a few studies that incorporated life settings to facilitate the transferability of learned skills, such as using role-plays.^{14,15,16} One study also utilized a virtual environment.⁹ However, there was no significant observable impact on real-world communication skills for joint attention.¹² Moreover, four studies did not evaluate the transferability of learned skills.^{8,12,13,17} In addition, two studies experienced difficulty with generalizing test results as a consequence of their main intervention group being too heterogeneous.^{9,17}

Study Challenges

The study quality can be limited depending on the experimental procedures, such as studies with the lack of randomization and blinding and no additional participant/control group for comparisons.^{8,9,10} first phase.¹⁷ One of the main challenges faced was having a small sample size.^{8,15,16} There were also studies that used insensitive outcome measurement tools (subjective report measures),^{12,14,16} with the inconsistent use of diagnostic instruments across all participants,¹⁵ or testing sites.¹⁰

Discussion

Many of these studies faced potential confounding variables due to their methodology, uncontrolled participant characteristics, and insensitive rating tools. Additional variables included unmatched IQ level between groups, participants' gender, and unknown/undocumented outside treatments. Moreover, the small number of intervention sessions may be inadequate in eliciting noticeable changes, along with the lack of follow-up assessments.

Overall, there are several methodological features to improve on, such as having more effective high-quality study designs (RCTs), larger sample sizes with randomized sampling techniques and multiple recruitment sources, multiple testing scenarios similar to real-life social settings to better generalize gains, and longer-term follow-ups to evaluate the persistence of gains.

Even with these study limitations, there has been a range of both neutral and positive results in improving social deficits. Additionally, majority of the children and parents were receptive of these gaming interventions.

Conclusions

There were positive intervention effects reported on particular aspects of social skills for children with ASD across the world. However, there were limitations and risks of bias that must be taken into consideration for these studies in focus. Nevertheless, they have shown virtually no negative intervention effects and, as such, these treatment gains can and should be further explored.

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