GAMIFICATION IN AUTISM

Literature review on the use of games for developing social-communicative, cognitive, learning and physical skills in autistic people, as well as their game preferences and interests.

This literature review was conducted by Dr Liam Cross are Dr Gray Atherton, in partnership with GameInLab. This literature review was realised as part of the « Autism and New Technologies » program, supported by the Foundation UEFA pour l'enfance and implemented by FIRAH.

Edge Hill University

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Liam's research is in embodied and social cognition. He is particularly interested in the social consequences of coordination, how moving in time with each other in rhythmic ways leads to pro-group behavior, and understanding the link between autism, anthropomorphism and theory of mind.

Gray's research is centred around understanding how people with autism see the social world. Specifically, exploring individual differences in social processing and how these differences often found in people with autism also exist in the general population. Her research interests also lie more broadly in understanding embodied social processing, and how movement can affect the way we see ourselves and our social partners, and how this applies to special populations.

https://www.edgehill.ac.uk/psychology/people/academic-staff/dr-liam-cross/

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The purpose of this review is to understand the research that has been done on how gamification can improve outcomes for individuals with autism. This review will be of particular interest to professionals who work with autistic clients, special educators, and families of children with autism. Readers will be able to understand the way that certain autism-friendly games are played, and the effect that certain games have had on improving specific skills in autistic samples. This will be particularly useful for those who are looking to introduce games for the purpose of improving a specific skill, or for those interested in introducing gaming more generally to autistic people and would like guidance on strategies for teaching gameplay skills.

This review was translated into French by C Atherton. C. Atherton is a French translator who currently works on the poetry of Édouard Glissant. After receiving a BA in Modern Languages from the University of Oxford, she earned an MFA from Johns Hopkins University, where she also teaches writing seminars.

Game in Lab is a program co-created by Asmodee, board games industry leader, and Innovation Factory, a French non-profit association specialised in collective intelligence-based innovation. Game in Lab's mission is to promote the valorisation and recognition of board games as a source of societal value. We are convinced that academic research on board games and play has an essential role to hold in that endeavour.

Game in Lab supports scientific production and popularisation, as well as community-based research. We animate a network of transdisciplinary scholars and game professionals, and provide financial funding to research projects and PhDs.

To learn more about our actions, please consult our website: https://www.game-in-lab.org/game-in-lab/

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Autism-Europe aisbl (http://www.autismeurope.org/) is an international association whose main objective is to advance the rights of people with autism and their families and to help them improve their quality of life. It ensures effective liaison among almost 90 member autism organisations in from 38 European countries, including 27 Member States of the European Union, governments and European and international institutions. Autism-Europe plays a key role in raising public awareness, and in influencing the European decision-makers on all issues relating to the rights of people with autism. Self-advocates and parents play a central role in our organisation to ensure that the views and interests of persons with autism are adequately reflected in our work. We are also regularly consulted by the World Health Organisation (WHO) and cooperate with the United Nations (UN).

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The goal of this literature review is to report on existing knowledge about applied research on the theme: the use of games for developing social-communicative, cognitive, learning and physical skills in autistic people, as well as their game preferences and interests. It resulted in the selection of relevant research which were each categorised using a set of predetermined criteria. Of these researches, 15 were selected as being particularly relevant or interesting because of their potential for being applied with practical effect, especially with persons with disabilities and their own organisations. This literature review presents a ludography focused on 19 games.

What FIRAH means by the very general terms of applied research is:

- First, it is proper research based on precision and methodologies which allow the implementation of a scientific approach involving teams of one or more researchers or academics whose research is one of the statutory missions.
- Applied research differs from basic research. Its ultimate purpose is to increase independence and social participation of people with disabilities. It is not only aimed at producing theoretical knowledge but also tackling practical issues related to the needs and concerns of people with disabilities and their families. The collaboration between these people, professionals and researchers is a fundamental element to the achievement of this type of research.
- This type of research is designed to produce directly applicable results. In addition to usual publishing (scientific articles, research reports) applied research is also designed to produce other publications called “means of application[1]” which can take various forms: development of good practices, methodological guides, training tools, and are destined to different field stakeholders (people with disabilities, professionals, policies makers).

This work does not intent to be comprehensive but to identify the results and knowledge generated by research that could be useful for field stakeholders in order to improve the quality of life and social participation for people with disabilities.

Each title in the annotated bibliography contains a link with free or paying access to the work in question.

[1] **Means of application**
Shaping of the findings and knowledge gained from applied research into products, services and contents to meet the expectations and needs of people with disabilities. These application supports are adjusted to be used by field stakeholders.

Each reading note contains a link to the relevant research documentary note on the Resource Centre website.

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EDITORIAL

Autism Spectrum Condition (ASC) is a neurodevelopmental condition that affects approximately 2% of the population (Kogan et al., 2018). It is a heterogeneous condition, meaning that autistic people can present with any number of different symptoms in combination with one another. People with autism possess social and communicative differences and restricted interests and repetitive behaviours (American Psychiatric Association, 2013). Additionally, many autistic people have conditions in addition to autism, such as anxiety or ADHD, and it is estimated that half of the autistic population has a co-occurring intellectual disability, meaning they have an IQ below 70 (Matson & Shoemaker, 2009). Throughout this review, we use the term ASC over other labels such as ASD, as well as using identity-first language as these are the terms preferred by the autistic community (Kenny et al., 2016).

Many interventions that target improvements in social communication, as well as other cognitive, learning and physical issues, have been developed to help autistic people. Numerous interventions focus on a training approach which involve teaching autistic people how to adopt neurotypical behaviours. Traditionally, assessments of these behaviours and skills involve determining how autistic individuals perform before and after the treatment in comparison to neurotypicals. Such interventions are often criticised by the autism community as they may increase stigma and inhibit authenticity (Bottema-Beutel et al., 2018). Gamification offers an alternative approach to both foster and assess desired behaviours and cognitions in a more naturalistic and emergent setting.

Through this review, the use of games in intervention and assessment in relation to ASC will be explored. Games used range from analog (cardboard) games, to full body immersive digital augmented reality games, including various levels of equipment form customised research tools and robots, digital touchscreen displays, commercially available consoles such as Nintendo Wii and the Xbox to bespoke programs developed solely for this purpose. The research covered here was chosen as it illustrates the array of gamification strategies employed to target a wide range of outcomes. Lessons learned will be useful for researchers, clinician's therapist, teachers, educators, parents/caregivers and individuals themselves with ASC.

METHODOLOGY

To locate relevant research for the literature review, the following search engines and databases were used:

- Google Scholar
- PubMed
- ScienceDirect

Initial search terms included:

- Board games
- Tabletop games
- Mobile games
- Video games
- Computer games
- Games
- Game play
- Autism
- Autistic
- Autism Spectrum Disorder
- Autism Spectrum Condition
- Developmental Disorder.

These combinations returned a large number of hits, from Google Scholar alone three combinations produced over 1650,000 returns (Autism & Board games - 48,400 returns, Autism & games – 115,000 returns, Autism tabletop games - 1840 returns). The search criteria was therefore restricted to articles published in the last 20 years (from the year 2000 onwards) and the following key, catch-all search terms were used:

- Autism
- Autistic
- Games.

In addition to these searches both Ancestry (earlier articles cited by a given article) and Descendary (subsequent articles citing a given article and further papers by authors/labs of a given article) approaches were utilised in combination with key papers.

Articles that were consistent with the overarching aim of this review were isolated. These consisted of articles which offered pragmatic and applicable solutions to the problems and concerns of autistic individuals and their families. Such articles typically had a focus on interventions utilising gamification

for socio-communicative and cognitive issues faced by autistic individuals. Research that explored the therapeutic use of gamification in ASC was also sought out, alongside work which explored the use of gamification in the assessment of aspects of ASC and research exploring autistic interaction with and preferences for games. While reviewing the literature, another relevant topic became apparent, the use of robots in games and play. The annotated bibliography that follows is made up of 40 papers containing both primary and secondary resources which will be of interest to parents, caregivers, teachers, educators' therapists, and psychologists of those with ASD as well as autistic individuals themselves. Following each section is a brief subsection containing any relevant studies with implications for ASC other areas, such as those exploring gamification towards those with other disorders such as ADHD or developmental delays.

The bibliography is presented in the following sections.

- Analog Gamification
- Digital Gamification
    - socio-communicative outcomes & assessment
    - cognitive-learning-physical outcomes and game preferences
- Robots and Play.

There was less research on analog games compared to digital games, which may be in part understood by the broader scope of digital than analog gamification. For instance, digital games included traditional video and computer games, 2d and 3d, web-based games, and mobile games as well as purpose-built experimental and therapeutic games. Digital games also encompass a wide range of input options using traditional controllers or peripheral keyboard/mouse, touch controls as well as more multimodal movement-based systems. Considering the primary focus of this review concerns the pragmatic outcomes of gamification in ASC research, the presentation of digital gamification was sub sectioned based on this criterion into those concerning socio-communicative outcomes and assessments and, those concerning cognitive learning and physical outcomes and individuals preferences for games.

A selection of key readings were isolated from these articles. An annotated reading list, containing summaries of interest of 15 critical articles alongside the authors' abstracts are also presented here. Additionally, we have provided an annotated ludography containing a selection of the key games used throughout the articles. This ludography includes a description of the key mechanics and theoretical underpinnings of eighteen of the key games presented here. Before the Reading Notes, Annotated Bibliography and Annotated Ludography a summary of the key lessons from the research reviewed is detailed next.

SUMMARY

Introduction

Autism was first formally identified by Kanner (1943) and Asperger (1944) in the mid 20th century through a series of case studies, which described children who showed little interest in social interactions, but high interest in restricted topics. Notably, the children showed atypical interactions during periods of play. For example, rather than build with blocks, a child would use a repetitive motion to move the blocks systematically. When a parent would try and move the block, the child would brush their hand away as if the hand was an object rather than belonging to a social agent (Kanner, 1943).

Early Development and Play

The above example is notable in that the development of early play behaviors are considered pivotal for several reasons. As discussed at length by seminal child psychologist Piaget (1997), play behaviours allow for a child to engage with emerging cognitive skills. Pretend play, for instance, will enable children to learn concepts such as false belief, and more structured turn-taking board games teach reciprocity and strategy. Crucially, when one is playing with another in a competitive or cooperative game, the experience allows them to practice and develop a range of skills including communication, perspective-taking, emotional regulation, emotional recognition and sportsmanship. Also, they are engaging in shared attention and joint action with other social agents, as all players are focused on the same activity and must mutually contribute to the completion of the game.

In this way, while a game is ostensibly an enjoyable, entertaining leisure activity, any game, no matter how 'serious,' is simultaneously teaching players how to behave in a group context. Due to in-built rewards systems that track advancement, games may be particularly motivating over and above other types of educational interventions (Filsecker & Hickey, 2014). For this reason, it is unsurprising that researchers hoping to improve the lives of autistic people have turned to games when designing interventions. Reasons why games may be particularly beneficial when designing interventions for autism are discussed.

Autism and Play

Autistic people have been observed to have differences with regards to social stimulation (Chevallier et al., 2012). While typically developed children may automatically imitate the behaviors of a teacher or peer, autistic children do not as readily imitate other social actors (Gowen, 2012). They may also be less interested in joining in with a shared activity or remaining focused on a joint goal (Wong & Kasari, 2012). For this reason, the built-in reward system involved in most games (i.e. points, levels, progress bars, feedback) may provide positive reinforcement that motivates an autistic person to

continue playing a game, allowing them to either complete an intervention or simply remain socially engaged with other players.

Furthermore, games are in and of themselves teaching cognitive as well as social skills. A multiplayer game for instance teaches joint attention, turn-taking, strategy and appropriate social behaviours in response to other players (Rogerson et al., 2018). Autistic people struggle with these skills and are often late to develop them in line with neurotypicals. Thus, using games, which encourage the development of these skills and behaviours in a naturalistic way could offer a highly effective way to encourage autistic people to practice these concepts.

Learning and playing games are a cornerstone in child development, allowing children to form independent relationships with one another (Piaget, 1997). Autistic children often have difficulty forming peer relationships and can be excluded from social settings (Chamberlain et al., 2007). Developing gameplay skills may serve as an essential tool for autistic children to develop social capital they can use to engage peers. Creating opportunities for autistic and neurotypical children to connect in naturally motivating activities like shared enjoyment of a game could be an incredibly useful way for peers to model socially desirable behaviours for autistic children, and for autistic and neurotypical children to form reciprocal relationships based on shared interests.

Finally, games are particularly well-suited for customization and need not be overly reliant on outside support. Once children learn the rules to a game, they can interact with one another independently through the game without adult oversight (Lancy & Grove, 2017). This may be particularly helpful for autistic children who have been shown to be overly reliant on adult assistance, which may interfere with their ability to interact with peers (Milley & Machalicek, 2012). Additionally, games are built upon fundamental mechanics (i.e. turn-taking, point collection, random dice throws, card matching, bluffing) that can then be modified to fit a specific theme (i.e. fantasy, space, trains, action-adventure). As most autistic people have restricted interests in a specific domain, they may be particularly interested in games that fit a particular theme. The customization of games also makes it possible to design interventions that mainly target specific skills while still providing an enjoyable experience that feels like fun rather than work. As will be discussed, several interventions using games as interventions with autistic children expressly incorporate restricted interests to engage autistic players and include neurotypical children in the autistic child's world.

Skill Building Within Games: Social Communicative

The social aspects of autism are among the most widely researched, and some of the most commonly targeted in interventions. This is also the case with regards to gaming interventions for those with ASC, though the approaches to using games improve social skills are varied.

Behavioural Approaches

Several interventions, particularly with younger children with ASC, use behavioral approaches embedded within gameplay to increase social responsiveness and improve social behaviors. For instance, Daubert et al. (2015) used Power Cards, small cards printed on one side with an autistic child's favourite character and on the other side with how that character would optimally behave, to teach sportsmanship to two autistic children during gameplay with peers. The three specific behaviors of focus were initiating a turn, relinquishing a turn and appropriate commenting. For instance, a child who had an interest in the Ninja Turtles, had Power Cards written from the perspective of one of the turtles behaving appropriately during the game (i.e. Donatello tells his friends 'You did it!' and 'You won!'). Participants reviewed these cards at the beginning of the gameplay session, and when needed, were prompted to view the cards when they forgot to use the appropriate behavior. Results showed that the participants significantly improved in their ability to initiate and relinquish a turn following the intervention.

Several studies also used modelling in combination with behavioural reinforcement within a gaming intervention. Ferguson et al. (2013) used Nintendo Wii Baseball to teach six children with ASC sportsmanship skills over ten sessions in an outpatient clinic. Instructors first modelled appropriate gameplay behaviors such as taking turns and giving a compliment post game and then awarded points to players who engaged in the behaviors. Jung and Sainato (2015) also used modelling in their intervention with slightly younger children with ASC. Borrowing from the Power Card method, children's special interest characters (i.e. a princess) were incorporated into video recordings of adults modelling appropriate gameplay behaviors which the children watched before playing board games like Candyland. The facilitator prompted them to use the appropriate behaviors throughout (i.e. 'play the game with your friend'), and when the children engaged in appropriate behaviors during the game they were rewarded with tokens. Both studies found that the use of behavioural reinforcement and modelling led to increases in appropriate behavior, and Jung and Sainato (2015) also found increased engagement with peers and generalization of learned skills to a novel game.

Embedded Design

The previously discussed projects primarily focused on how to use existing games to teach social skills to children with ASC by supplementing them with behavioral conditioning, modelling and special interests. There are, however, many studies that created new games that explicitly teach social skills within the topic of the game.

Several games used narrative storytelling to teach socio-communicative skills to children with ASC. Tobias in the Zoo (Carvalho et al., 2015), TouchStory (Davis et al., 2007) and Ipad play story (Murdock

et al., 2013) all used mobile gaming technology to teach skill acquisition through a virtual 'storybook.' In Tobias in the Zoo children interacted with an avatar, Tobias, who experienced different scenarios (i.e. a zoo visit, a birthday party) which caused him to experience various emotions. To win the game, the child must have correctly identified Tobias' emotions based on the story. TouchStory consisted of autistic children dragging story panels, which are pictures showing sequential story scenes, into the correct position relative to one another. In the Ipad play story, pairs of autistic children read a story together on an Ipad about various characters experiencing certain events (i.e. firemen in a fire truck going to rescue a girl from a treehouse). The children after reading the story then interacted with toy versions of the story characters and were encouraged to re-enact the story through symbolic play. While Tobias in the Zoo was not formally tested, children's narrative comprehension following TouchStory showed some improvement, and following the Ipad play story children were able to use the narrative from the story to enact pretend play with one another (Murdock et al., 2013).

Several games focused specifically on emotion recognition, an area of delayed development for autsic individuals, to target improvement. In Life is Game (Abirached et al., 2011), autistic children picked a custom avatar and then identified the facial emotions of the avatar with the options of making the game more challenging by hiding the eyes or mouth. Let's Face It (Tanaka et al., 2010) consisted of seven computer games that encouraged the development of different types of facial recognition skills, including recognition of facial identities, emotions and holistic processing of eyes. After twenty weeks, autistic children showed improvement in some aspects of face recognition (such as holistic processing of the eyes) but not others (such as identity recognition).

Rather than explicitly teach socio-communicative skills, some games embedded them within the mechanics of the game. Dell'Angela et al. (2020) modified three existing board games already popular with children in an effort to target certain emotional competence skills. For instance, the researchers changed the game Code Names so that rather than pick any word as a clue to help their team guess the right cards, players instead had to pick an emotion word as their clue. In a large sample of typically developed children, the researchers found that children with higher emotional competence skills were the most successful at the game and found the game most accessible. Bernardini et al. (2014) created the computer game ECHOES in which autistic children interacted with an avatar in a magical garden in a way that supported the use of certain behaviors. For instance, embedded within gameplay were cues that encouraged joint attention and symbol use. While the frequency of these behaviors were not directly assessed, results did indicate that throughout multiple gaming sessions, the children become more socially responsive towards practitioners.

Peer Inclusion

While many games focused on improving socio-communicative abilities in autistic individuals, several took a different approach from those discussed above. Rather than behaviorally reinforce behaviors or explicitly teach individual social skills, some interventions used non-social games to encourage social communication between players. For instance, Wainer et al. (2014) developed an imitation game to be played with two players with ASC and KASPAR the robot, a humanoid animated doll that can verbally and physically interact with humans. Using a digitized version of Simon Says, researchers found that the children spent more time interacting with one another when playing the game with KASPAR than when playing with only each other.

In Pico's Adventure (Malinverni et al., 2017) children interact with an avatar, parents and peers in a virtual environment where they must complete challenges to assist Pico the alien, a virtual character. Exploratory results showed that through engagement with the task, autistic children were more expressive and directive with one another within gameplay. Finally, autistic children were tested on their ability to interact with one another when playing the Collaborative Puzzle Game (Battocchi et al., 2009), which is presented on a digital tabletop and requires players to move digital puzzle pieces simultaneously with a partner. Results showed that players who were required to collaborate in this way were more coordinated and engaged in more complex interactions.

While most of the games reviewed were mainly geared towards children, there are several games that have been shown to be beneficial to autistic adolescents and adults for socio-communication skill development. In an ethnographic study, Fein (2015) spent time at a summer camp for adolescents with ASC where they spend time engaging in Live Action Role Playing and play tabletop role-playing games like Dungeons and Dragons. Fein (2015) found that the games were particularly engaging for campers as it allowed for structured social interactions between players that were specific to the game, and promoted a narrative of inclusion and acceptance within the stories of the games. Katō (2019) tested the effect of tabletop role-playing games on improvements in social speech and changes in quality of life in adolescents with autism following either four or fourteen sessions of tabletop role-playing games. For the four participants who played fourteen sessions, socio-communicative skills improved following the intervention. For the fifty-one children who played four sessions, total scores on a quality of life measure significantly increased.

Qualitative research on online games for autistic adults also suggest that they can help improve socio-communicative skills and quality of life. Mazurek et al. (2015) found that autistic adults spent more time on average playing video games than neurotypicals, and they experienced distinct social rewards from video gameplay including forming friendships with the video gaming community and relief from

social stress. Gallup et al. (2016) also found that in addition to forming friendships with others in massive multiplayer online communities, autistic adolescents reported socio-communicative improvements in online settings as they were able to practice skills in safe spaces and develop competencies in online communication.

Non-Social Skill Building Within Games

Autistic individuals often experience challenges in other areas of life outside of socio-communicative domains including academic and physical difficulties. Several studies target improvements in these specific domains through the use of games.

TeachTown (Whalen et al., 2010) is a computer assisted intervention designed to teach young autistic children social and academic skills through an online curriculum. TeachTown is delivered to children daily and utilizes pivotal response training to reinforce correct responses through verbal praise and graphics. In a randomized control trial children who received TeachTown instruction showed improvement compared to those in the control group on a standardized measure of vocabulary, and significantly improved their scores within the program, with those who spent more time in the program showing more improvement. Satsangi and Bofferding (2017) designed a simple board game to improve numerical knowledge of autistic children by teaching them to roll dice and move tokens along a coloured number line. Results showed that across the ten participants the ability to make numerical estimates significantly improved amongst those for whom the game centred on the numbers not the colours. Finally, many autistic individuals have difficulty with prosody or speech production. Hoque et al. (2009) developed a computerized speech therapy game that focused on improving a player's speech intelligibility. Across a suite of games, results suggested that in eight children, five of whom had an ASC diagnosis, language learning improved.

Many autistic individuals experience motor difficulties including reduced coordination and reduced levels of physical activity compared to those with typical development. In order to improve the physical capabilities of autistic people, several active games have been modified or created to meet the needs of the community. Edwards et al. (2016), for instance, had children with and without ASC engage in a Nintendo Wii activity using several sports-related competitive games for six hours over six weeks. They found that while neither group improved on objective measures of object control (i.e. throwing, kicking and catching a ball), the ASC group significantly improved on their perception of their object control competencies, indicating games like Nintendo Wii can improve sports-related confidence. PuzzleWalk is an intervention created to improve the physical activity levels of autistic adults (Kim et al., 2020). To complete a puzzle, adults must walk in a particular pattern displayed on

their mobile phones. Preliminary results showed that it was seen as user-friendly and engaging and could be a useful way to encourage physical activity in the adult ASC community.

Application: From Research To practice

While many studies offer promising results with regards to improving the lives of autistic children, adolescents and adults, it is clear from this review that more needs to be done to determine how effective these interventions are in naturalistic settings, how they affect skill development over a more extended period of time, and how well easily they can be implemented by educators, professionals and families.

Specifically, there appears to be a disconnect between the engineers who design many of the games and the researchers who test pre-existing games. Engineers who design complex games, often in collaboration with autistic individuals and special educators, benefit from their ability to provide in-depth descriptions of the game development process and the technological innovations that may improve the novelty of the intervention. Very few, however, have tested the effects of the game formally and in-depth, with many of these studies relying instead on anecdotal reports from parents, educators, or researchers. More work needs to be done with regards to testing the behavioural outcomes of those who participate in many of these digital gaming interventions.

On the other side, there are many interventions in which autism researchers have adapted existing games (Wii, Candy Land, Bingo) to study the effects of behavioral modification programs. These studies tend to rely on small samples and use single-case designs. Unlike the papers written about the development of complex programs, these programs are relatively simple in their development and instead have quite involved testing procedures (i.e. video coding of behaviors and complex behavioral reinforcement schedules). While game development and modification may be more straightforward, these studies, in contrast, involve lengthy implementation and testing. The time required to manually code behaviors and individualize existing games for each participant places a heavier burden on professionals wishing to implement these interventions to larger groups.

In order to move from research to practice it is necessary that these two groups of researchers, i.e. those who specialize in game design and those specialize in behavioral testing, collaborate. To invest in a particular gaming intervention these prototypes should be more thoroughly tested. Likewise, in order to understand the effects of the behavioral interventions, larger sample sizes and a way to more efficiently customize the program and track progress, is necessary.

Some of the more achievable gaming interventions discussed thus far may be those that build upon existing games and existing interests and those that encourage collaboration between multiple players. Though it requires further formal testing, the studies focused on role-playing games used pre-

existing games and self-reported interests in autistic adolescents to promote social interaction and provide opportunities to build friendships (Fein, 2015; Katō, 2019). These may be particularly attractive to professionals as they build on existing interests are low cost and encourage social interaction with peers.

Likewise, several researchers used simple well-known boardgames and modified them to reflect a child's restricted interests (Baker, 2000; Jung & Sainato, 2015), or combined them with video modelling (Ferguson et al., 2013), or modified them to teach a specific social skill (Dell'Angela et al., 2020). This approach may also be attractive to professionals as these games are easily accessible (i.e. board games, Wii, Kinect) and with only minor modification the aspects of game play that are already engaging and enjoyable are preserved.

As autistic people reportedly enjoy engaging with digital media, it is not surprising that many game-based interventions rely on computerized technology. Digital games offer several advantages, including performance tracking, more effortless customization and visual engagement that is particularly heightened in people with ASC. For these reasons digital games may also be particularly useful to professionals.

The Collaborative Puzzle Game in Battocchi et al. (2009) and the imitation game with KASPAR the robot (Wainer et al., 2014) are perhaps two of the best examples of how a digital technology can enhance a gaming intervention for ASC. For example, in the Puzzle Game, through a relatively simple game design, players are not able to move a puzzle piece unless it is being touched by another player. This is an excellent example of the tactile element of digital design that is only made possible through a touch-screen format. Furthermore, by having the activity presented digitally the researchers were able to record every movement of the players effortlessly through the program log, which allowed for a fine-grained analysis of time taken to complete the puzzle and the degree of physical coordination between players. Players were also given praise through the program after successfully completing the puzzle. Compared to the video coding of hours of board gameplay, and the need for a practitioner to provide verbal praise, this offers significant advantages for progress tracking and motivating players. Similarly, in the imitation game, KASPAR the robot takes the place of a human practitioner in motivating and guiding two players to interact with one another, reducing the need for professionals and allowing for peer-directed play. Future research will want to understand further the differences and relative advantages with regards to digital and non-digital games, and the effects of these games on behaviours outside of the game setting.

Key Conclusions

What research tells us in 6 key points

- There are many games that have been developed as autism interventions.
- The three key areas that these gamified interventions target are socio-communication skills, academic skills and physical skills.
- While many games have been developed, few have been tested with large samples and many have not shown how skills improved or whether they generalize to other settings.
- Digital games show promise in that they are designed to maximize engagement and reinforcement, but they need to be formally tested to see whether improvements in the game extend to improvements in real life.
- Existing games that have been adapted for autistic players should be tested on larger samples and would benefit from easier data collection processes and more sophisticated ways to customize them to individual players.
- The most effective and accessible interventions reviewed were those that encouraged interactions between players, and used simpler game designs.

READING NOTES

The 15 article summaries presented here are excerpts from the general bibliography. They were selected based on their relevance to the primary aims of this review. They all explore gamification interventions for social-communicative and other cognitive issues relevant to autistic individuals.

Each summary contains the reference for and link to the article in question, the keywords associated with it, an overview of the paper and the original authors abstract

Reading note 1. Incorporating the thematic ritualistic behaviors of children with autism into games: Increasing social play interactions with siblings.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Baker, M. J. (2000). Incorporating the thematic ritualistic behaviors of children with autism into games: Increasing social play interactions with siblings. *Journal of Positive Behavior Interventions*, *2*(2), 66-84.

Keywords

ASD; Family; Siblings; Education; Early childhood/Primary School; Social and psychosocial support

Author Abstract

This study systematically investigated an intervention increasing sibling social play interactions by incorporating the thematic ritualistic activities of children with autism into typical games. Data collected revealed very low levels of sibling play, joint attention, and affect during the baseline condition and high levels of thematic ritualistic behaviors. In contrast, when the children with autism were taught a play interaction based on their thematic ritualistic behavior (e.g., for a child who perseverated on movies, incorporating that theme into a Bingo®-style game), the percentage of social interactions and joint attention increased and maintained in 1- and 3-month follow-up measures. All of the children's affect improved, and the rate of thematic ritualistic behaviors decreased to a minimum or no occurrence. The children's social interactions also generalized to other games and settings. These results imply that children with autism can learn social skills through play and natural interactions in their environment.

Comments

This article focuses on encouraging social interactions with siblings which is often considered one of the earliest forms of peer interaction. Thematic and ritualistic interests (restricted interests) of the autistic sibling were incorporated into games to foster interest and promote interaction with the game and sibling. This study builds upon research that suggests that restricted interests can increase motivation in autistic children. Furthermore, this study was mainly focused on understanding the specificity of the autistic child's interests and how it can be used in games. Restricted interests are specific to the individual, and to account for this, the researchers interviewed parents and teachers, surveyed parents and observed the child, allowing for a bespoke approach based around the Bingo game. Bingo is a standard early educational game for children, in that it introduces the idea of competition and teaches spatial mapping and pattern matching. This study suggests that

incorporating restricted interests into Bingo can not only increase interest in the task, but also the attention paid to the social partner and the understanding of game playing behavior (i.e. turn-taking and shared goals). This article provides a useful guide to how families and professionals can use an autistic child's restricted interests to tailor familiar games and how doing so can socially benefit social to the child.

Reading note 2. Employing Tabletop Role-Playing Games (TRPGs) in Social Communication Support Measures for Children and Youth with Autism Spectrum Disorder (ASD) in Japan.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Katō, K. (2019). Employing Tabletop Role-Playing Games (TRPGs) in Social Communication Support Measures for Children and Youth with Autism Spectrum Disorder (ASD) in Japan. RPG 学研究: *Japanese Journal of Analog Role-Playing Game Studies, 23*-28.110.

Keywords

ASD; Middle and High School; Sport / Leisure / Tourism; Social and psychosocial Support; Child and teenager

Author Abstract

This paper presents two studies on promoting social communication and leisure satisfaction of children and youth with through the use of tabletop role-playing games (TRPGs). The first study involved four junior high school students with ASD, and focused on "intentional speech directed to other children" and their "consensu- making" during TRPG play sessions. The results of the analysis suggest that intentional speech as well as the ability to reach consensus increased remarkably between the 14th and the 1st session. The second study investigated the efficacy of leisure activity using TRPGs to enhance the quality of life (QOL) of children and youth with ASD. Fifty-five teenagers with high-functioning ASD participated in the study and responded to the standardized "Questionnaire for Measuring Quality of Life" before and after the TRPG activities. After a total of five sessions once a month significant improvement in the total scores and most of subscales of QOL could be observed. The subscales of "emotional well-being" and "friends" in particular, improved remarkably. These findings suggest that leisure activities using TRPGs have the potential to promote social communication and enhance QOL in children and youth with ASD.

Comments

This article discusses the possibility of introducing autistic adolescents to role-playing games to improve social engagement and quality of life. It suggests that these experiences can enhance interest in peers, evidenced by improvements in other person directed speech following fourteen gaming sessions. It also indicates that role-playing games can improve quality of life outcomes, including increased self-esteem and stronger friendships following as few as five sessions. This is one of the few

studies on autism and gaming, and presents an intervention that is developmentally in line with adolescent interests. As role-playing games have been found to improve creativity and divergent thinking, the game in and of itself can likely be cognitively beneficial.

The authors of this paper specifically discuss role-playing games in contrast to social skills training interventions, the most common type of intervention used to improve social behaviours in ASC. Social skills training relies on instructing autistic people on how and when to use certain behaviors to enhance communication. Many people in the autism community feel that the social skills training approach teaches autistic people to mask their autistic traits and behave in a way that may be at odds with their true identity. Role-playing games offer a naturalistic interaction that can foster social skills in a more natural and emergent way without having autistic players act in a certain way through training.

More research on the efficacy of role-playing games should be done to assess their relationship to quality of life outcomes. Professionals may want to increase the opportunity that autistic teens have for participating in such experiences, including perhaps the creation of autism-friendly role-playing groups. Interestingly, in this article, the groups tested were comprised of entirely autistic cohorts future research should explore the efficacy of role-playing games in mixed cohorts.

Reading note 3. Teaching games to young children with autism spectrum disorder using special interests and video modelling

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Jung, S., & Sainato, D. M. (2015). Teaching games to young children with autism spectrum disorder using special interests and video modelling. *Journal of Intellectual and Developmental Disability, 40*(2), 198-212.

Keywords

ASD; Education; Early childhood/Primary school; Sport / Leisure / Tourism; Social and psychosocial Support; Child and teenager; Technical aids

Author Abstract

Background Children with autism spectrum disorder (ASD) may exhibit delayed play skills or repetitive play and have difficulty engaging in spontaneous play with peers.

Method A multiple-probe design across participants was used to investigate the effectiveness of a video modelling intervention and the use of children's special interests on their engagement with games and with peers for kindergarten children with ASD.

Results results indicated that all three children with ASD demonstrated increased engagement with the games and social engagement with their peers. Inappropriate behaviour decreased with the intervention. The effects were maintained during the follow-up and generalised to a novel game. Social validity data indicated that the study was meaningful and the intervention was feasible and effective.

Conclusion Future research should focus on designing play skills interventions that serve to motivate both children with ASD and their typically developing peers in order to promote more spontaneous and interactive play among them.

Comments

This article discusses how a child's restricted interests could be used to improve engagement with games and engagement with peers. It also used video modelling to teach gameplay behaviors. Teachers and parents were consulted to assess the child's interests which were incorporated to complement the game playing experience (by customizing the appearance of the game and allowing the child and the individuals who modelled the game to dress up in character). This is in line with

Social Learning Theory, which suggests that an observer is more likely to imitate a socially desirable model. This work demonstrated generalizability of using appropriate game-playing and social behaviour following the intervention to novel settings; however, more research should be done with larger samples.

It is important to note that the efforts made in this project first to identify the child's ideal model and to then incorporate that model into a behavioral intervention, is a lengthy process. While it may be useful, it takes significant resources to do this effectively. Future work may want to look into how to increase the accessibility to such a tailored intervention, including the development perhaps of a repertoire of characters that feature more commonly in autistic children's restricted interests. With regards to practitioners, it could be useful to think about utilising this method to foster certain skills, particularly play skills.

Reading note 4. Board Games on Emotional Competences for School-Age Children.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Dell'Angela, L., Zaharia, A., Lobel, A., Vico Begara, O., Sander, D., & Samson, A. C. (2020). Board Games on Emotional Competences for School-Age Children. *Games for Health Journal. 9,3.*

Keywords

Emotional and sexual life; Education; Early childhood/Primary school; Sport / Leisure / Tourism; Social and psychosocial support; Child and teenager

Author Abstract

Objective: Emotional competences (EC) are important for social and academic outcomes and positive life trajectories. Due to their social setting and tendency to stimulate intrinsic motivation, board games may constitute efficient learning tools for promoting socioemotional development in children. The current project therefore aimed at developing and testing three theory-driven board games explicitly targeting EC. First, we explored the quality of these EC games in terms of game experience, compared to off-the-shelf games (without an EC focus). Second, we tested whether targeted EC were linked to game experience in the EC games by measuring associations between children's trait EC and subjective effort and difficulty during gameplay. Materials and Methods: Children (N = 177) aged 8–12 years old were randomly assigned to a four-session protocol that comprised EC board games (experimental group) or off-the-shelf board games (control group). At baseline, participants' trait EC (emotion recognition, differentiation, and cognitive reappraisal) were assessed, while game experience (e.g., positive and negative affect, flow and immersion, difficulty, and effort) was assessed after each game. Results: Both groups perceived the games they played as positive and playable. Furthermore, regression analyses showed that higher trait EC was linked to lower self-reported effort and difficulty in two of the EC board games focusing on emotion recognition and differentiation. Conclusion: The present study shows that the board games on EC designed for children seem to elicit game experiences comparable to off-the-shelf games. Moreover, children's trait EC were linked to subjective game experience in two of the three games. Future interventions should examine the potential of the novel games to promote EC.

Comments

While the study detailed in this article did not assess an autistic sample, it offered an exciting intervention targeting one of the most common issues for autistic people, emotional competency. Autistic people have been shown to have deficits relating to emotion recognition, and understanding the emotional context of social situations, skills that are specifically targeted in this intervention. This study, unfortunately, did not test whether playing these emotional competency games improved emotional competency abilities in the children it tested. Therefore, testing the efficacy of these games, particularly with an autistic sample, would be an essential next step.

This study did, however, show that children with high emotional competency abilities found the games more straightforward, which suggests that it is targeting emotional competency skills within gameplay. It also notably found that children playing the emotional competency modified games enjoyed them as much as the children who played the off the shelf games, which suggests that emotional competency games are engaging and would preserve the playability aspects of games like Codenames that are already popular with children. It is recommended that the emotional competency games described in this paper may make a valuable addition to an emotional competency curriculum for autistic children who are already able to play off the shelf games. These games will offer the same social opportunities for cooperation and strategizing as the originals, with the added ability to possibly enhance emotional competency, though this needs more formal testing to understand fully.

Reading note 5. An inclusive design approach for developing video games for children with Autism Spectrum Disorder.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Malinverni, L., Mora-Guiard, J., Padillo, V., Valero, L., Hervás, A., & Pares, N. (2017). An inclusive design approach for developing video games for children with Autism Spectrum Disorder. *Computers in Human Behavior*, *71*, 535-549.

Keywords

ASD; Education; Early childhood/Primary school; Sport / Leisure / Tourism; Social and psychosocial support; Child and teenager; Technical aids

Author Abstract

The efficacy of therapeutic treatments for Autism Spectrum Disorder is mainly associated with the treatment's intensity in terms of weekly hours. This has led mental health professionals to explore the use of video games to complement traditional treatments. However, major weaknesses have been found due to poor game design, which has failed to fulfill therapeutic objectives or to properly engage children. These weaknesses are typically characterized by the poor integration of knowledge from mental health experts, children's interests and designers' expertise. Starting from this necessity, we propose an in- clusive design approach to develop therapeutic games. The method presents strategies to integrate the expertise of clinicians, contributions of children and experience of designers through a set of elicitation and merging techniques. The goal of this method is to design games that are effective in terms of therapeutic objectives and that are enjoyable for children. To describe this method, we present its application in the design and development of a Kinect-based game for high-functioning children with ASD called "Pico's Adventures". This game aims at promoting social initiation in young children with autism. Findings from a first exploratory study with 10 children with ASD showed the effectiveness of the game in eliciting social initiation behaviors. This provides a first validation of the method. An essential aspect of the game's success was the use of elements and mechanics that were appealing for the children. As a result, we have identified effective design concepts and paths for further research on games for children with ASD.

Comments

Pico's Adventure offers an engaging, narrative-driven adventure game that can be played using the Xbox Kinect. It is a notable intervention in that it was co-designed with autistic children, who advised the creators on all aspects of the program, along with professionals who work with autistic people. This is promising with regards to engagement, as it is likely that these stakeholders offered insight into the development of the game that may have been otherwise unknown.

This full-body intervention engages players physically during gameplay and allows for joint interaction with other real-life players. This offers benefits over controller input digital games that rely on stationary engagement, as they encourage exercise and may improve spatial awareness and physical coordination. As autistic children often experience motor delays in development, this may be a particular advantage over traditional computer game design. This game also encourages children to work together with one another directly through rewards gained through cooperation between players. As children with autism may have atypical social motivation, this may provide a way to enhance engagement with peers. All of these effects must be formally investigated, as this study only offers preliminary observations of game playing efficacy.

Reading note 6. A brief group intervention using video games to teach sportsmanship skills to children with autism spectrum disorders.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Ferguson, B. R., Gillis, J. M., & Sevlever, M. (2013). A brief group intervention using video games to teach sportsmanship skills to children with autism spectrum disorders. *Child & Family Behavior Therapy, 35*(4), 293-306.

Keywords

ASD; Education; Early childhood/Primary school; Sport / Leisure / Tourism; Social and psychosocial support; Child and teenager; Technical aids

Author Abstract

Impaired social skills represent a fundamental deficit for children with Autism Spectrum Disorders (ASD). Despite the potential importance of "good sportsmanship," this social skill has received relatively little attention in the literature. The current study utilized a Behavioral Skills Training (BST) approach to teach three sportsmanship skills (i.e., complimenting, turn taking, and being a good sport) during video game play (Wii Sports). Six children with ASD completed this study. Findings suggest BST can be used effectively to teach sportsmanship skills to children with ASD. The use of video-game technology as part of social skills intervention programs is also discussed.

Comments

This article describes a multiple baseline single-case design framework to investigate the effect of a social skills training program using the Nintendo Wii. The program itself offers several advantages. First, it uses instructor modelling to demonstrate appropriate sportsmanship behaviors before gameplay, which participants then practised with peers. It also relies on a token economy system in which participants earned points for using target behaviors correctly, which could motivate participants with ASC as the prizes offered were in line with restricted interests (i.e. Pokemon cards).

This study also used a readily available gaming console, which offers games suitable for different ages and ability levels, and the option to play with peers, increasing its suitability for social skills practice sessions. As the Wii involves whole-body movement, it could also be a useful tool for increasing physical fitness and improving coordination, though this was not directly assessed. Future work will want to determine how a Wii social skills intervention compares to more traditional social skills

training curriculums. As this approach uses a popular game as the basis for its intervention, it would be useful to compare it not only on efficacy but also on enjoyability and whether parents and educators could use this. It would also be essential to assess whether social skills learned in the context of the Wii games generalized to other skills. This was not directly assessed in the present study.

Reading note 7. Collaborative Puzzle Game: a tabletop interactive game for fostering collaboration in children with Autism Spectrum Disorders (ASD)

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Battocchi, A., Pianesi, F., Tomasini, D., Zancanaro, M., Esposito, G., Venuti, P., ... et Weiss, P. L. (2009, November). Collaborative Puzzle Game: a tabletop interactive game for fostering collaboration in children with Autism Spectrum Disorders (ASD). In *Proceedings of the ACM international conference on interactive tabletops and surfaces* (pp. 197-204).

Keywords

ASD; Education; Early childhood/Primary school; Sport / Leisure / Tourism; Social and psychosocial support; Child and teenager; Technical aids

Author Abstract

We present the design and evaluation of the Collaborative Puzzle Game (CPG), a tabletop interactive activity developed for fostering collaboration in children with Autism Spectrum Disorder (ASD). The CPG was inspired by cardboard jigsaw puzzles and runs on the MERL Diamond Touch table. Digital pieces can be manipulated by direct finger touch. The CPG features a set of interaction rules called Enforced Collaboration (EC); in order to be moved, puzzle pieces must be touched and dragged simultaneously by two players. Two studies were conducted to test whether EC has the potential to serve as an interaction paradigm that would help foster collaborative skills. In Study 1, 70 boys with typical development were tested and in Study 2 16 boys with ASD were tested. Results show that EC has a positive effect on collaboration although it appears to be associated with a more complex interaction. For children with ASD, EC was also related to a higher number of "negotiation" moves, which may reflect their higher need of coordination during the collaborative activity.

Comments

This article presents a game that forces players to interact with one another in order to solve puzzles. In this study, children with and without ASC were shown to improve in their level of peer engagement when they were required to complete a jigsaw puzzle on an interactive tabletop in tandem with another player. A significant limitation to this study is the availability of a digital tabletop to practitioners and educators. Unlike interventions that rely on digital games not dependent upon specialised kit or popular gaming consoles like the Wii and Kinect, or readily available analog games, the tabletop device used for this collaborative puzzle game is a significant investment. It would be of

interest to see whether the mechanism underlying the game, forced collaboration for puzzle completion, could be extended to more readily available platforms such as generic touch screen devices, commercially available gaming consoles, or built into the rules of analog games. The fact that children of varying ages and ability levels showed increased interaction with one another during gameplay is promising. This may be an effective way of improving social motivation in autistic children.

Reading note 8. Using computerized games to teach face recognition skills to children with autism spectrum disorder: the Let's Face It! program.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Tanaka, J. W., Wolf, J. M., Klaiman, C., Koenig, K., Cockburn, J., Herlihy, L., ... et Schultz, R. T. (2010). Using computerized games to teach face recognition skills to children with autism spectrum disorder: the Let's Face It! program. *Journal of Child Psychology and Psychiatry*, *51*(8), 944-952.

Keywords

ASD; Education; Early childhood/Primary school; Social and psychosocial support; Child and teenager; Technical aids

Author Abstract

Background: An emerging body of evidence indicates that relative to typically developing children, children with autism are selectively impaired in their ability to recognize facial identity. A critical question is whether face recognition skills can be enhanced through a direct training intervention.

Methods: In a randomized clinical trial, children diagnosed with autism spectrum disorder were pre-screened with a battery of subtests (the *Let's Face It!* Skills battery) examining face and object processing abilities. Participants who were significantly impaired in their face processing abilities were assigned to either a treatment or a waitlist group. Children in the treatment group (N = 42) received 20 hours of face training with the *Let's Face It!* (*LFI!*) computer-based intervention. The *LFI!* program is comprised of seven interactive computer games that target the specific face impairments associated with autism, including the recognition of identity across image changes in expression, viewpoint and features, analytic and holistic face processing strategies and attention to information in the eye region. Time 1 and Time 2 performance for the treatment and waitlist groups was assessed with the *Let's Face It!* Skills battery.

Results: The main finding was that relative to the control group (N = 37), children in the face training group demonstrated reliable improvements in their analytic recognition of mouth features and holistic recognition of a face based on its eyes features.

Conclusion: These results indicate that a relatively short-term intervention program can produce measurable improvements in the face recognition skills of children with autism. As a treatment for

face processing deficits, the *Let's Face It!* program has advantages of being cost-free, adaptable to the specific learning needs of the individual child and suitable for home and school applications.

Comments

This article describes a gamified intervention for holistic face processing. A deficit in holistic face processing, particularly with regards to the eye regions, is a common deficit in the autistic population that has been linked to impairments in emotion recognition. Following the gaming intervention, autistic participants showed improvements in only two of the seven skills assessed, which may mean that the program only has a narrow application. This may mean that the training itself could be shortened or expanded to focus on only specific skills shown to be affected by the game. A game that can improve the holistic processing of the eyes would be a useful addition to an existing social skills curriculum. More research, however, is needed to understand the efficacy of Let's Face It, as the generalizability of the game has not been tested. Future work will want to test whether gains made in the game generalise to real-life face processing situations (i.e. during peer interactions), as well as how feasible such a program is with regards to participant motivation. This study did not assess user enjoyment and engagement, an important area to understand as the program is lengthy. It is available for free and could be easily implemented at school or home.

Reading note 9. Efficacy of TeachTown: Basics computer-assisted intervention for the intensive comprehensive autism program in Los Angeles unified school district.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Whalen, C., Moss, D., Ilan, A. B., Vaupel, M., Fielding, P., Macdonald, K., ... et Symon, J. (2010). Efficacy of TeachTown: Basics computer-assisted intervention for the intensive comprehensive autism program in Los Angeles unified school district. *Autism, 14*(3), 179-197.

Keywords

ASD; Education; Early childhood/Primary school; Social and psychosocial support; Child and teenager; Technical aids

Author Abstract

Computer Assisted Instruction (CAI) has shown increased popularity recently and there are many studies showing promise for this approach for children with Autism Spectrum Disorders (ASD). However, there are no between-subject studies to date assessing the efficacy of CAI with this population. In this study, 47 preschool and K-1 students in ASD classrooms participated from Los Angeles Unified School District. *TeachTown: Basics*, a CAI program which also includes supplementary off-computer activities, was implemented over 3 months for approximately 20 minutes per day on the computer and 20 minutes per day in supplementary *TeachTown: Basics* activities. Compared to the students in the control group, the *TeachTown: Basics* students showed more improvement overall on language and cognitive outcome measures. In addition, students who used *TeachTown: Basics* demonstrated significant progress overall in the software and those students who used the program for more time demonstrated larger gains within the software and in outcome measures. Although not conclusive, these findings offer possibilities for the use of CAI for remediating many deficits for children with ASD and other special needs. In addition, CAI may offer solutions to schools and parents with insufficient funds for more expensive treatments.

Comments

TeachTown offers an applied behavioural analysis based computer-delivered educational curriculum, focusing on improving academic and social skills for young autistic children. Results suggested that the children who received TeachTown did not show significantly different performance on a cognitive battery or autism symptom scale than those who did not complete the training. Children in the

experimental condition did, however, show significant improvement on the in-game mini-assessments. Those who spent longer playing TeachTown showed more improvement. This suggests that while in-game performance is improved, TeachTown may not generalize to improving other skills outside of the game.

Young children with ASD were able to develop computer-based skills in TeachTown, which allows them to demonstrate learning gains when assessed within the application. This suggests that the game is influencing learning. Future work may want to expand the type of assessment given to children to test gains following TeachTown. As this curriculum taught children on topics of life skills and social understanding, two skills not assessed formally, it may be that these are areas of improvement following the TeachTown curriculum.

Additionally, TeachTown offers enrichment to typical classroom instruction. Not only did children spend twenty minutes of their day on computers interacting with TeachTown, but teachers had an additional twenty minutes spent doing connection activities in small groups or with the whole classroom about TeachTown. It may be that this structured daily time spent on TeachTown and in the connection activities is beneficial students and teachers by allowing for differentiated learning and social engagement by discussing the shared experiences of TeachTown. More research should be done on how autistic children can improve their technological skills by engaging in computer-assisted instruction through TeachTown, and how teachers feel that TeachTown connection activities contribute to curriculum design.

As mentioned in the study, a more detailed understanding of TeachTown connection fidelity would be helpful in future research. Teachers and parents with young children with ASD may want to incorporate TeachTown into a curriculum, as it offers a short and engaging opportunity to improve in-game skills using the principles of applied behavioural analysis, and the program provides tracking of skill improvement.

Reading note 10. Does playing a sports active video game improve object control skills of children with autism spectrum disorder ?

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Edwards, J., Jeffrey, S., May, T., Rinehart, N. J., & Barnett, L. M. (2017). Does playing a sports active video game improve object control skills of children with autism spectrum disorder? *Journal of Sport and Health Science, 6*(1), 17-24.

Keywords

ASD; Early childhood/Primary school; Sport / Leisure / Tourism; Social and psychosocial support; Child and teenager; Technical aids

Author Abstract

Active video games (AVGs) encourage whole-body movements to interact or control the gaming system, allowing the opportunity for skill development. Children with autism spectrum disorder (ASD) show decreased fundamental movement skills in comparison with their typically developing (TD) peers and might benefit from this approach. This pilot study investigates whether playing sports AVGs can increase the actual and perceived object control (OC) skills of 11 children with ASD aged 6–10 years in comparison to 19 TD children of a similar age. Feasibility was a secondary aim.

Actual (Test of Gross Motor Development) and perceived OC skills (Pictorial Scale of Perceived Movement Skill Competence for Young Children) were assessed before and after the intervention (6 × 45 min). Actual skill scores were not improved in either group. The ASD group improved in perceived skill. All children completed the required dose and parents reported the intervention was feasible. The use of AVGs as a play-based intervention may not provide enough opportunity for children to perform the correct movement patterns to influence skill. However, play of such games may influence perceptions of skill ability in children with ASD, which could improve motivation to participate in physical activities.

Comments

This article explored the use of active video games in fostering improved object control. While results did not show actual improvement on object control skills (i.e. hitting, kicking or throwing a ball), autistic children who participated in the program showed increased self-perception of object control skills. This is notable given that many autistic children are often excluded socially and may experience

low self-esteem. This study also showed that children with and without ASC did not have differences in measures of object control. This is contrary in many ways to research that shows that children with ASC have poor motor control relative to neurotypicals. More research should test how this relates to object control skills. It may be that games like Xbox Kinect are suitable for mixed groups of children (i.e. children with and without ASC) as they are matched in skills. Furthermore, it may be helpful with regards to improving self-esteem in those with disabilities.

As this study only utilised six sessions of Kinect, it may be that longer interventions using Kinect games could improve actual object control. This study also tested this intervention at homes and at schools, demonstrating the feasibility of such a program in multiple settings. Parents of autistic children reported that the children enjoyed the experience and were interested in trying more games and sports following the intervention. As autistic people are at an increased risk for obesity, it may be that the increases in perceived physical competence and enjoyability of the Kinect games act as a gateway to playing these games in real life.

Reading note 11. Video games from the perspective of adults with autism spectrum disorder.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Mazurek, M. O., Engelhardt, C. R., & Clark, K. E. (2015). Video games from the perspective of adults with autism spectrum disorder. *Computers in Human Behavior*, *51*, 122-130.

Keywords

ASD; Sport / Leisure / Tourism; Social and psychosocial support; Emotional and sexual life; Social perception / Raising Awareness

Author Abstract

Individuals with autism spectrum disorder (ASD) experience significant challenges in community engagement and social activities, yet they have strong interests in video games. Thus, there has been increasing interest in understanding potentially positive and negative effects of video games in this population. However, research has not yet examined the perspectives of individuals with ASD themselves on this topic. The purpose of this study was to use qualitative methods to examine the preferences and motivations for video game play among adults with ASD. Individual interviews were conducted with 58 adults with ASD, and responses were coded through an iterative and collaborative process. Several themes were identified, including perceived benefits of video game use (e.g., social connection, stress reduction) as well as perceived negative effects (e.g., time use, addictive potential). Participants also noted both positive and negative aspects of game design that affect their overall enjoyment. The most frequent all-time favorite video game genres were Role-Playing (31%) and Action-Adventure (19%). These qualitative findings enhance our understanding of video game use from the direct perspectives of individuals with ASD, and suggest a need for incorporating these perspectives in future quantitative studies on positive and negative aspects of game use in this population.

Comments

This article utilised qualitative interviews with autistic adults providing constructive insights into what kind of video games appeal to autistic users, how they benefit from video game use and the positive and negative aspects of game design for autistic users.

With regards to optimal game design, participants discussed their appreciation of the challenges within games play, such as trying to hit certain milestones, receive in-game rewards and competing against other players. Participants also enjoyed the autonomy and creativity inherent to games like

Minecraft, and others like the story aspects of some games, particularly with regards to adventures and fantasy. Some of the negative aspects of game design included disliking first-person games and the negative aspects of online gaming interactions where people use aggressive language and unhealthy competition. The two favourite game genres were role-playing games like World of Warcraft and action-adventure games like Zelda.

Some of the main themes that emerged indicated that autistic people relied on games to relieve stress and fill their time. Some also used games to form social connections with others in the gaming community. Some also discussed the negative aspects of over usage, in that video game use can become compulsive, with participants discussing worries about becoming addicted. This study is helpful to game developers who may want to understand video game usage in autistic people. Video game usage is heightened in the autistic population compared to those who are neurotypical, with higher average game use per day and higher risk for addiction. Understanding what autistic people enjoy with regards to gaming can help clinicians, and other professionals, connect with clients and understand more about this part of their lives. It may also be helpful for professionals to understand what drives overuse of video games and how to encourage a healthier relationship with this pastime. One clear finding in this study is that autistic people use video games to relieve stress, which may be linked to autistic symptomology (social anxiety and sensory stressors). It would be of interest to think about developing interventions for autistic adults using videogames, as rates of anxiety and depression are heightened in adulthood. It may be that stress-relieving and entertaining experiences such as video games help relieve these symptoms. As many also reported building relationships within gaming communities, it may be that video games could serve as a tool for developing social skills in the context of online gaming communities.

Reading note 12. Strategies for enhancing play skills for children with autism spectrum disorder.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Brown, J., & Murray, D. (2001). Strategies for enhancing play skills for children with autism spectrum disorder. *Education and Training in Mental Retardation and Developmental Disabilities*, 312-317.

Keywords

ASD; Education; Early childhood/Primary school; Sport / Leisure / Tourism; Social and psychosocial support; Child and teenager; Needs assessment; Adaptation and Rehabilitation

Author Abstract

Children with autism spectrum disorder (ASD) do not develop play in the same way that child typical development do (Libby, Powell, Messer, & Jordan, 1997; Murray-Slutsky & Paris, 2000; W 1999). This article describes play differences in children with ASD. It also suggests strategies for develop intervention plan including assessment, goal setting, and teaching play skills.

Comments

This review article gives a very useful overview of the differences in play related behaviours in autistic children and how professionals can help children develop crucial play behaviours. Developing play behaviors is considered a milestone in early childhood. Several essential cognitive skills are developed in conjunction with play. Symbolic play, for instance, emerges around the same time as language, and both are thought to be supported by the ability to form mental representations. Pretend play is a product of the cognitive ability to understand that objects can be used for creative purposes. Pretend play also teaches children about perspective taking, specifically that people can suspend their disbelief to engage in a fantasy. More generally, children develop social skills in the context of play, and engage in reciprocal, peer-directed activity that helps form relationships.

For these reasons, it is critical that autistic children develop play related skills as these skills develop in tandem with others, and aid in the development and maintaining of friendships. However, there are specific areas of need with regards to the development of play skills in autistic children. Among the main areas of difference mentioned in this paper are those relating to reduced motivation to engage in play, difficulties transitioning from one play activity to the next, problems with the symbolic

aspects of play, and struggles concerning restricted interests and repetitive behaviors. Reduced affect may also make it difficult for a child to express enjoyment during play.

The authors suggest several strategies to improve play skills in autistic children. They suggest that first professionals must observe the play of the child, specifically noting how the child handles play materials, whether they symbolically use play items and whether they share a common focus when playing with other children. Videorecording play sessions may be particularly useful. After this observation, the professional should individualize the intervention and introduce goals specific to improving play skills. For instance, it may be that the child needs to be more socialized during play. If so, it could be that the intervention uses a toy or activity that will attract peers to play with the child, and in a way that encourages reciprocal interactions (for instance a puppet or a board game). This paper is a handy tool for early educators and professionals who wish to develop an individualized intervention to improve play in autistic children.

Reading note 13. Using the humanoid robot KASPAR to autonomously play triadic games and facilitate collaborative play among children with autism.

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Wainer, J., Robins, B., Amirabdollahian, F., & Dautenhahn, K. (2014). Using the humanoid robot KASPAR to autonomously play triadic games and facilitate collaborative play among children with autism. *IEEE Transactions on Autonomous Mental Development*, *6*(3), 183-199.

Keywords

ASD; Education; Early childhood/Primary school; Social and psychosocial support; Child and teenager; Technical aids; Sport / Leisure / Tourism; Adaptation and Rehabilitation

Author Abstract

This paper presents a novel design, implementation, and first evaluation of a triadic, collaborative game involving the humanoid robot, kinesics and synchronization in personal assistant robotics (KASPAR), playing games with pairs of children with autism. Children with autism have impaired social communication and social interaction skills which make it difficult for them to participate in many different forms of social and collaborative play. Our proof-of-concept 10-week, long term study demonstrates how a humanoid robot can be used to foster and support collaborative play among children with autism. In this work, KASPAR operates fully autonomously, and uses information on the state of the game and behavior of the children to engage, motivate, encourage, and advise pairs of children playing an imitation game. Results are presented from a first evaluation study which examined whether having pairs of children with autism play an imitative, collaborative game with a humanoid robot affected the way these children would play the same game without the robot. Our initial evaluation involved six children with autism who each participated in 23 controlled play sessions both with and without the robot, using a specially designed imitation-based collaborative game. In total 78 play sessions were run. Detailed observational analyses of the children's behaviors indicated that different pairs of children with autism showed improved social behaviors in playing with each other after they played as pairs with the robot KASPAR compared to before they did so. These results are encouraging and provide a proof-of-concept of using an autonomously operating robot to encourage collaborative skills among children with autism.

Comments

This is an exciting study that shows some improvements in play stemming from exposure to social robots. Specifically, children who played an imitative game with KASPAR, a humanoid robot, showed

more reciprocal eye gaze towards one another during and after the intervention, and they showed an improved positive affect. This suggests that KASPAR encourages shared attention between autistic children and is found to be socially rewarding. As these are two critical areas of delay for autistic children, these results are quite promising. It is also important to note that retention for this study was high. As this was an intervention involving over seventy sessions, a high retention rate in and of itself shows that the program is engaging and promotes play activity. Unfortunately, current access to a robot like KASPAR will be limited. However, such technology is developing at a rapid pace. It will be of interest in the future to see the application of robots to enhancing experiences for people with disabilities, and the role of robots in special education and intervention. For now, professionals may want to explore gaming interventions that make use of technology such as computer and video games that have a virtual character that guides multiple players to work with one another in a game.

Reading note 14. Serious games to teach social interactions and emotions to individuals with autism spectrum disorders (ASD)

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Grossard, C., Grynspan, O., Serret, S., Jouen, A. L., Bailly, K., & Cohen, D. (2017). Serious games to teach social interactions and emotions to individuals with autism spectrum disorders (ASD). *Computers & Education*, *113*, 195-211.

Keywords

ASD; Education; Early childhood/Primary school; Sport / Leisure / Tourism; Social and psychosocial support; Child and teenager; Adaptation and Rehabilitation; Technical aids; Emotional and sexual life

Author Abstract

The use of information communication technologies (ICTs) in therapy offers new perspectives for treating many domains in individuals with autism spectrum disorders (ASD) because they can be used in many different ways and settings and they are attractive to the patients. We reviewed the available literature on serious games that are used to teach social interactions to individuals with ASD. After screening the Medline, Science Direct and ACM Digital Library databases, we found a total of 31 serious games: 16 that targeted emotion recognition or production and 15 that targeted social skills. There was a significant correlation between the number of reports per year and the year of publication. Serious games appeared promising because they can support training on many different skills and they favour interactions in diverse contexts and situations, some of which may resemble real life. However, the currently available serious games exhibit some limitations: (i) most of them are developed for High-Functioning individuals; (ii) their clinical validation has rarely met the evidence-based medicine standards; (iii) the game design is not usually described; and, (iv) in many cases, the clinical validation and playability/game design are not compatible.

Future research agendas should encompass (i) more robust studies in terms of methodology (large samples, control groups, longer treatment periods, follow-up to assess whether changes remain stable, etc.) to assess serious game efficacy; (ii) more collaboration between clinical and computer/game design experts; and (iii) more serious games that are adapted to Low-Functioning ASD individuals.

Comments

This paper presents a comprehensive review of the games that have been used to improve social skills in autistic individuals. This review paper is particularly useful with regards to identifying gaps in this area of research. One of the gaps identified relates to sample size and experimental design; few studies had more than thirty participants, and only two of the 31 games included a control group. Another issue identified related to age. Though autism is a lifelong condition, and autistic adults also experience social difficulties, none of the gaming interventions in this review targeted an adult age group. The studies targeted in this review also predominantly focused on individuals without intellectual disability. Exceptionally few games are designed to assist autistic people who are non-verbal to develop social skills, though this is an area of distinct need for those with a co-occurring intellectual disability.

The authors suggest several areas of improvement for future studies. They recommend larger sample sizes and longitudinal designs to assess progress throughout multiple time points. They also identify the need to understand how the effects of serious games generalize to real-life behaviours. Finally, they identify a disconnect between the clinicians testing the efficacy of gameplay and the engineers who design the games. Specifically, the clinicians seeking to establish the effectiveness of the interventions are not always adequately describing the gaming procedure or focusing on the usability of the game. At the same time, the engineers who are seeking to design a new gaming paradigm and enhance the gaming experience for autistic people are not always testing the effect that the game has on social skills, and how this can affect real-life social performance. Future work should involve collaborations between game designers, behavioural researchers and clinicians who can collectively design suitable programs that can be tested in a sophisticated manner.

Reading note 15. A review of serious games for children with autism spectrum disorders (ASD)

Access to the reading note and to complete documents in the documentary database on FIRAH's website

Reference

Zakari, H. M., Ma, M., & Simmons, D. (2014, October). A review of serious games for children with autism spectrum disorders (asd). In *International conference on serious games development and applications* (pp. 93-106). Springer, Cham.

Keywords

ASD; Education; Early childhood/Primary school; Sport / Leisure / Tourism; Social and psychosocial support; Child and teenager; Adaptation and Rehabilitation; Technical aids; Emotional and sexual life

Author Abstract

This paper reviews 40 serious games designed for children with autism spectrum disorders (ASD), and these games/studies are classified into four categories; technology platform, computer graphics, gaming aspect and user interaction. Moreover, the paper discusses serious games designed for the improvement of communication skills and social behavior, social conversation, imaginative skills, sensory integration and learning accounts in ASD children. The children usually interact with these games by ordinary IO (input/output), e.g. keyboard and mouse or touchscreen tools. Previous researches show the effectiveness of playing serious games on mobiles or tablet devices in helping ASD children to express their feelings and improve the level of engagement with others. However, there are limitations in designing games for helping autistic children with sensory processing disorder (SPD), improving imaginative play, and teaching first aid. Further, there is not much research that addresses repetitive behavior in ASD children.

Comments

This paper provides a comprehensive list of serious games that have been used with participants with ASC. This study is mainly focused on systematically identifying common themes and trends in ASC related games. The paper in and of itself doesn't necessarily advance our understanding of ASC and gaming. It does, however, offer an accessible reading of possible interventions.

This paper is particularly helpful as it focuses on the technology that each of the suggested interventions requires. For instance in Table 2 of the paper the authors detail the way that the game is delivered (i.e. desktop/laptop), whether it is 2 or 3D, the topic that the game purportedly targets

(i.e. imaginative skills) and whether this requires a camera or ordinary computer interface. A paper like this is particularly useful for professionals who may be thinking of incorporating a number of computer-based gaming interventions into their practice in order to see what would be most compatible with their existing technology. This paper however does not evaluate the efficacy of the interventions, but rather the focus of computer gaming interventions and the technology necessary. It would be best to use this paper to identify the various programs that may be useful, and then to explore the efficacy of these games on the targeted skill.

ANNOTATED LUDOGRAPHY

GAME: Bingo

Bingo involves children having a board that is delineated by rows and columns, and a player wins Bingo by having a complete row/column that contains items announced by the Bingo caller. In this version, the Bingo game is modified to reflect an autistic child's restricted interests. For instance, a child who is interested in model cars, the bingo item is 'called' by having the children launch cars off a track and note what car picture the model car lands upon following the jump. This picture must then match the picture on the Bingo card in order to be covered up.

- Broad Application: Autistic children may be more receptive to learning games and playing with peers if games are centred around their preferred area of interest. In order to do this effectively, it is helpful for practitioners to learn about the child's interests from parents, and to create modifications in existing games for ease of access.
- Relevant Article: Baker, M. J. (2000). Incorporating the thematic ritualistic behaviors of children with autism into games: Increasing social play interactions with siblings. *Journal of positive behavior interventions*, *2*(2), 66-84.

GAME: Recognition Game (i.e. Mimtoo)

The Recognition Game is a variant on the game Mimtoo, a pantomime game in which children select at random a slip of paper with a sentence that they must act out for their team to guess. In this emotional competence version, the child who is set to pantomime will choose both a sentence AND an emotion word which may or may not be congruent with the sentence (e.g. 'My mother forgot my birthday' and one of the six emotions: happy, sad, frustrated etc). Taking turns each team will send a player to pantomime the sentence and act out the emotion, and the goal is to guess as many correct emotions as possible in a given time.

- Broad Application: This game could be a particularly engaging way to improve emotion recognition. The challenge is that the emotion may not match the sentence. However, it presents an interesting way about learning emotional context, as many sentences could be spoken in a different way to convey a different meaning. As children with ASC have difficulty both interpreting emotions and understanding context in communication could be a particularly beneficial game to learn these two skills. Additionally, this game is played in a

group setting which could in and of itself improve peer relationships. Very little materials are needed to implement this game, making it very easy to adapt for a variety of settings.

- Relevant Article: Dell'Angela, L., Zaharia, A., Lobel, A., Vico Begara, O., Sander, D., & Samson, A. C. (2020). Board Games on Emotional Competences for School-Age Children. *Games for Health Journal. 9,3.*

GAME: Differentiation Game (i.e. Codenames)

The Differentiation Game is a variant on the game Codenames, in which children in teams try to help their group guess a certain combination of word cards laid out on a grid based on a card identifying which words are safe and which are off limits. Players should only give clues that help identify certain words, and avoid words that identify the words that give the other team points. In this version, rather than choose any word as a clue, the player must use an emotion word.

- Broad Application: In this version of Codenames, the skill being used is emotion recognition and the ability to perspective take. The team that is guessing the words using their team members emotional word clue must think about what the player likely feels about certain words on the board (i.e. 'Do they get scared on roller coasters? Or maybe they find certain types of movies scary?') This type of emotional reasoning is building on perspective taking, and also teaching children to think more broadly about emotions. This game allows for the adaptation of an existing game that is readily available, and refines it to target a specific emotional competency skill. It could also be used to help build relationships between team members, as they learn about one another by understanding what emotions a team member associates with certain words. This would be an excellent game to test on autistic children who are looking to build skills in this area.
- Relevant Article: Dell'Angela, L., Zaharia, A., Lobel, A., Vico Begara, O., Sander, D., & Samson, A. C. (2020). Board Games on Emotional Competences for School-Age Children. *Games for Health Journal. 9,3.*

GAME: Reappraisal Game (i.e. once upon a time)

The Reappraisal Game is a cooperative storytelling game in which children must incorporate randomly drawn story cards into a single narrative in a sequential order. This game is based on the cooperative storytelling game Once Upon a Time. In this version of the game, there is an added layer to build emotional competencies. In this version, towards the end of the story one of the players draws a 'complicator' card that introduces a negative element into the story. The player must then describe the emotions that the characters would experience following this complication. Another player,

designated to be the 'optimist' must then roll a dice which matches a reappraisal strategy. They must then use that reappraisal strategy to see the 'bright side' of the complication. The other players then guess which reappraisal strategy had been used.

- Broad Application: This game builds on several important cognitive skills. In line with the original version, the Reappraisal Game allows children to practice building a cohesive narrative and doing so with an audience in mind, a form of theory of mind. The Reappraisal game builds on this by requiring players to also focus on the emotional arc of the story, first describing a complication and then a resolution. The children will be focusing on the emotional effects of the resolution by identifying how the resolution was presented using cognitive reappraisal. This game may be particularly helpful for autistic children who experience difficulties in emotion recognition, narrative comprehension and emotional regulation. Learning techniques for seeing the 'bright side' of a negative event may be particularly helpful with regards to this last skill. Similar to the last two games discussed in this study, this game would be easy to implement and suitable for a number of settings.
- Relevant Article: Dell'Angela, L., Zaharia, A., Lobel, A., Vico Begara, O., Sander, D., & Samson, A. C. (2020). Board Games on Emotional Competences for School-Age Children. *Games for Health Journal. 9,3.*

GAME: Linear Board Game

In this game designed to build numerical competencies, the board the children played upon was designed to form a number path, with ten tiles numbered 1-10 displayed horizontally. The tiles alternated in color (red blue and green). To play the game, the children rolled a six sided die, with half of the die faces numbered '1' and the other half '2.' The children then moved across the number line the number of spaces they had rolled, and verbally stated the numbers that they moved across on the board.

- Broad Application: The results of the study found that the children who played the game significantly improved in their numerical knowledge compared to those who had done a control condition using colors instead of numbers to advance across the board. This game is certainly useful for children with autism who struggle with numerical understanding. It is however rather rudimentary, and there doesn't appear to be a scoring system in place which adds an element of competition or a reward for completion. If adapted by a professional it would be beneficial to add more complexities to the game in this way, especially for older children. This is however an easy game to create and run for groups.

- Relevant Article: Satsangi, R., & Bofferding, L. (2017). Improving the numerical knowledge of children with autism spectrum disorder: The benefits of linear board games. *Journal of Research in Special Educational Needs*, *17*(3), 218-226.

GAME: Power Card Games

The Power Cards are behavioral reinforcement tools in which a child has a character related to their restricted interest model appropriate behaviours that are depicted on cards. These cards are then presented to the child during activities to remind the child of appropriate behaviors and to motivate them to emulate their favorite character. In the study cited below, Power Cards were used to guide children through gameplay, specifically the games Topple, Operation and Honey Bee Tree. All three of these games require players to use a similar motion, grasping, to reach a certain gaming goal. For instance, in the game Topple, players have to build the tallest structure they can without having the structure topple after placing a piece on the top. In these games, Power Cards were used to guide appropriate gameplay behavior, specifically initiating a turn, relinquishing a turn and speaking encouragingly to other players.

- Broad Application: Power Card techniques have been tested in other domains, and have improved behaviors in autistic children in a number of activities. This study suggests that they are particularly useful when introducing autistic children to gaming, and helping them play effectively with others. Power Cards are easy to adopt, as they require few materials, and are easy to adapt, as they follow a broad template that is designed to be customized to a child's favorite character. As autistic children may struggle with emotional regulation and reciprocity, it is likely that they will need additional help when learning about good sportsmanship in gameplay. Using Power Cards within a gaming intervention may be particularly useful for those children who show particular difficulties with regards to these gaming skills.
- Relevant Article: Daubert, A., Hornstein, S., & Tincani, M. (2015). Effects of a modified power card strategy on turn taking and social commenting of children with autism spectrum disorder playing board games. *Journal of Developmental and Physical Disabilities*, *27*(1), 93-110.

GAME: LARPing

Live Action Role Playing Games (LARP) are games in which a group of participants create and enact a different story. In the LARPing activities discussed in the article below, the quest narratives were created by the Journeyfolk, who run a summer camp tailored for autistic adolescents in the United

States. In LARPing the game is begun using a broad theme drawn from a number of different narratives. Each player then adds their own element to the story and their subsequent decisions within the game change the plot. Players develop characters that they embody within the game. These characters have back stories, personality traits and customized costumes so that players can fully realize their characters within the game.

- Broad Application: In this qualitative study, the researcher found that autistic LARPers were empowered within the gaming event. They created meaning out of the quests that often appeared to express something about how they felt about themselves as an autistic person, including the challenges and the pride they felt in their autistic identity. Within the LARPing environment campers had more structured social encounters that were made more clear by the constraints of the game. They were also able to engage with each other in creative ways by changing the narrative and personalizing their characters. Finally, campers formed a community with one another where they shared common interests and the autistic identity. Creating opportunities for LARPing among autistic adolescents may be a valuable endeavour. Such an intervention would be time consuming with regards to gaging interest and organizing the materials (i.e. scripts, costumes). However, if it stimulated excitement among participants it could lead to the formation of an autistic adolescent community where shared interests and acceptance of differences led to friendships and increased self-esteem.

- Relevant Article: Fein, E. (2015). Making meaningful worlds: role-playing subcultures and the autism spectrum. *Culture, Medicine, and Psychiatry, 39*(2), 299-321

GAME: Tabletop Role Playing Games

Tabletop role playing games are interactive games in which a small group of players interact with one another through a fictional story setting. Using pencils, paper and dice, TRPG players explore their character's personality, background and goals to construct the story with other players in a form of in-game role playing. Their choices within the game will affect the outcome of the group. TRPGs have been found to enhance creativity and divergent thinking, and have been used therapeutically to build social skills and self esteem in teens and young adults.

- Broad Application: For autistic teens with typically developed verbal ability, training based communication support which teaches routine methods for conversation may not provide naturalistic opportunities for communication. They also rely heavily on professional support rather than learning through everyday interactions with peers. Creating opportunities for autistic teens to interact with peers in an engaging environment may teach communication

skills that are absent from stricter communication training programs. The games themselves may be intrinsically motivating as they allow for creativity, character development and immersion in the game.

- Relevant Article: Katō, K. (2019). Employing Tabletop Role-Playing Games (TRPGs) in Social Communication Support Measures for Children and Youth with Autism Spectrum Disorder (ASD) in Japan. RPG 学研究: *Japanese Journal of Analog Role-Playing Game Studies, 23*-28.110.

GAME: Speech Therapy Game

In this game players are completing traditional speech therapy activities in the context of a computer game. For instance, in the game a participant would be required to modulate the volume of their speech, or the rate of their speech, to control objects in the game. The authors provide limited information about this game, and therefore the description above is brief.

- Broad Application: There is not enough information about the game to say whether it offers definitive improvements over traditional speech therapy with a speech and language specialist, though the preliminary results suggested that this was more engaging to students than the traditional delivery. The program appears to be easy to implement as the only necessary equipment would be a computer and a microphone headset. However, it is not clear whether this program is readily available for use or purchase. Professionals who wish to explore this option can contact the authors for more information.
- Relevant Article: Hoque, M. E., Lane, J. K., El Kaliouby, R., Goodwin, M., & Picard, R. W. (2009). Exploring speech therapy games with children on the autism spectrum.

GAME: Candy Land

Candy Land is a board game in which players draw cards that have either colors or characters. Players then move their game pieces along the Candy Land board using the cards as guidance. There are various challenges within the game that allow some players to advance a greater distance at certain points, or get stuck. Players win when they reach the end of the board. There are special editions of Candy Land. In this study, a young autistic girl who was interested in princesses played the Candy Land: Disney Princesses version of the game.

- Broad Application: In this study, the game Candy Land was supplemented by a video modelling program in which instructors recorded videos of themselves playing the game dressed as a princess. The child then dressed up as the princess to play the game. This was

done to encourage the child to model their behavior after the video, and to maintain interest in the game theme. The behaviors targeted related to engagement, social reciprocity and reducing inappropriate behavior. Results suggested that not only did behaviors improve in the game, but they generalized to a new game without the embedded character. This intervention would be somewhat lengthy to implement as it would involve video recording behaviors as certain characters. However, this may be necessary for children with ASC who would not otherwise be motivated to participate. That this technique led to some generalization to novel games is encouraging. Though the process of recording the videos for each child may be time consuming, it is something that would be readily accessible i.e. no specialist tools are required.

- Relevant Article: Jung, S., & Sainato, D. M. (2015). Teaching games to young children with autism spectrum disorder using special interests and video modelling. *Journal of Intellectual and Developmental Disability, 40*(2), 198-212.

GAME: Make n Break

Make n Break is a game in which players must follow a blueprint to build a certain structure using ten colorful wooden blocks. Players must complete as many of the sixty structures as they can in the allotted time indicated on the dice, which they roll prior to beginning construction. In this study cited below, Make N Break was combined with the video modelling approach described in the previous game.

- Broad Application: Similar to the previous discussion of the game Candy Land and how it is combined with video modelling, this seems to be a valuable tool to increase engagement and appropriate gaming behavior in autistic children. While it is not a ready made intervention in that a professional will need to create customized videos demonstrating gaming behavior in line with the child's interests, it does appear to significantly increase motivation to play games. Professionals may want to explore this option to improve social functioning in autistic children.
- Relevant Article: Jung, S., & Sainato, D. M. (2015). Teaching games to young children with autism spectrum disorder using special interests and video modelling. *Journal of Intellectual and Developmental Disability, 40*(2), 198-212.

GAME: Picos Adventure

Pico's Adventure is a Kinect based game in which children played a whole-body video game over four sessions. In the game, children go on a series of adventures to help Pico, an alien, complete different missions (i.e. fixing his spaceship). In the four sessions the children work on basic social initiation, cooperation, joint attention and turn-taking. In the first session the child meets the character and familiarizes themselves with the environment, and in the subsequent sessions the child plays in tandem with a parent/professional, and finally another autistic child. While the effects of the intervention were not formally tested with regards to improvements on the target behaviors, an exploratory study found that the children readily engaged in the task and were eager to explore the digital environment.

- Broad Application: Pico's Adventure would be a fun addition to a social skills curriculum for ASC children, either at school or at home. Kinect equipment is needed, but this is readily available for purchase. One of the strengths of Pico's Adventure is that it was designed with the help of ASC professionals and children, making it particularly appealing to its target demographic. As it encourages whole body movement and encourages social interaction between two players, it could be a stimulating way to improve reciprocal interactions between peers, though this needs more formal testing. Pico's Adventure also includes a narrative, in that children are learning about Pico throughout the game and helping him return to his planet after accidentally landing on earth. It would be interesting to explore whether narrative comprehension is also positively affected following the intervention. Professionals or parents looking to engage children with ASC in a social intervention that may also improve narrative comprehension may want to include this game in a curriculum.
- Relevant Article: Malinverni, L., Mora-Guiard, J., Padillo, V., Valero, L., Hervás, A., & Pares, N. (2017). An inclusive design approach for developing video games for children with Autism Spectrum Disorder. *Computers in Human Behavior*, *71*, 535-549.

GAME: Wii (i.e. baseball / wiffle / sports) and Kinect

Nintendo Wii is a video game console that allows for motion controlled gaming. Wii has motion sensing technologies and a Wii remote, which can be used as a pointing device or as a means to detect whole body or arm motion. The Wii console is readily available, and has games suitable for all ages.

Xbox Kinect is also a motion sensing video game console. Unlike the Wii which uses a handheld remote, the Kinect uses cameras and microphones to allow the device to recognize speech and detect

the bodies of up to four players. The Kinect camera sits at the top of the user's display and operates like a webcam.

Both consoles allow users to play games that allow the user to interact within the gaming environment using whole-body motion in a way that mimics real life gameplay (i.e. hitting a virtual tennis ball by swinging the arm in real time).

- Broad Application: In the two papers listed below, Wii and Kinect were used to encourage autistic children to play virtual sports games and, in the process, improve their sportsmanship or their object control abilities. Both interventions showed improvement, either in certain sportsmanship behaviors or in perceived sports abilities. This suggests that both gaming platforms can teach new behaviors and improve self-perception regarding physical competence. More broadly, both platforms allow for autistic children to interact with other players through an engaging virtual environment. As both platforms allow for multiple users, they would be a useful addition to curriculums aiming to improve social skills and/or physical activity as they encourage whole body movement and social interaction, either competitively or cooperatively. Both consoles are similarly priced. Wii games do though require an additional remote for each player, and motion tracking is only done through the handheld remote. The Kinect can track whole body movement (i.e. arms legs head) and has voice recognition. As it does not require a remote up to four players can be involved without any additional equipment. The Kinect however requires the Xbox console in addition to the Kinect, so it is more expensive. If it is possible however, the Kinect may be more suitable for autistic children who have more significant needs as it does not require holding a remote and is more sensitive with regards to movement tracking. For interventions in which practitioners want to understand motor differences in autistic children the Kinect will offer a more fine-grained analysis. The Kinect can also project the user's image into the game which may be particularly engaging for players.
- Relevant Articles:
    - Ferguson, B. R., Gillis, J. M., & Sevlever, M. (2013). A brief group intervention using video games to teach sportsmanship skills to children with autism spectrum disorders. *Child & Family Behavior Therapy, 35*(4), 293-306.
    - Edwards, J., Jeffrey, S., May, T., Rinehart, N. J., & Barnett, L. M. (2017). Does playing a sports active video game improve object control skills of children with autism spectrum disorder?. *Journal of Sport and Health Science, 6*(1), 17-24.

GAME: Collaborative Puzzle Game

The Collaborative Puzzle Game (CPG) is a two-player puzzle game played on a touch screen tabletop. In the game, players must complete jigsaw puzzles in tandem with one another. Specifically, in order to have a piece move both players must be dragging it together at the same time with their fingertips. During the puzzle completion phase and after successfully completing a puzzle the users are given visual and auditory feedback that alerts them if a mistake is made and gives them praise for having finished the puzzle. The equipment needed for the game is an interactive touch screen tabletop.

- Broad Application: Research on the CPG showed that while the interactions with players who had to move the puzzle pieces in tandem with one another were more complex and completion time was longer, collaboration was higher than if the puzzle was completed independently. Players were also more coordinated with one another in this condition. Thus, it appears that the CPG is a useful tool for encouraging social interactions between children with ASC and may even lead to higher degrees of problem solving as the puzzle was more difficult and communication more complex. The CPG and its delivery using a touch screen table clearly offers several benefits due to its unique format. The touch screen allows for a more naturalistic and intuitive way to complete a puzzle, in line with real life jigsaw puzzle motions. The fact that it is delivered on a table top rather than a tablet for instance means that players have to coordinate with their bodies (i.e. leaning over the table, moving around the table) which could be helpful for autistic children who have motor difficulties. As this is a digitized puzzle, it can be programmed to deliver prompting and reinforcement, and can change the level of difficulty and the requirements for success (not allowing puzzle piece movement unless two children are touching the piece). This offers advantages over non-computerized tasks of a similar nature. However, the ability to purchase a digital tabletop will not be feasible for everyone. It may however be a useful addition to a school or larger facility with more resources. However, unlike more popular consoles like the Kinect or Wii it is not clear how many programs are available on the digital touch table, and activities for the device may be more limited.
- Relevant Article: Battocchi, A., Pianesi, F., Tomasini, D., Zancanaro, M., Esposito, G., Venuti, P., ... & Weiss, P. L. (2009, November). Collaborative Puzzle Game: a tabletop interactive game for fostering collaboration in children with Autism Spectrum Disorders (ASD). In *Proceedings of the ACM international conference on interactive tabletops and surfaces* (pp. 197-204).

GAME: Lets Face It

Lets Face It (LFI) is a computer game intervention in which children practice a variety of face recognition skills. Specifically, LFI comprises seven games that target aspects of facial identification including holistic face processing, memory for faces, facial expression and face dimensions. The intervention takes 20 hours to complete, with a recommended time of 100 minutes spent playing LFI per week. LFI has built-in rewards and incentives, including a high score table and animated graphics. Children are also able to select the mode and level of game play. The LFI also has a face recognition battery test that is also delivered over the computer, allowing for an understanding of baseline and post-treatment face recognition abilities. This program only requires a computer, as the program is available for free.

- Broad Application: Results from the study listed below showed that LFI was able to improve some aspects of face recognition in children with ASC, including recognition of the eyes and the mouth. However, most subtests did not see substantial improvement following the intervention. Additionally, this program did not assess whether real life improvements in face recognition occurred following the intervention. As this program is available free of charge and requires little equipment it may be a viable option for parents or professionals interested in targeting facial recognition skills in autistic children. However, this intervention only allows for independent game play. As many of the other games target specific skills while also allowing for peer directed play, LFI may not be as effective in simultaneously teaching children about reciprocal social interactions or help with relationships development with peers. It may be that LFI is most useful in conjunction with a real life peer activity (i.e. a role-playing game or a board game) where children can practice the facial recognition skills they learned in the game in real life situations.
- Relevant Article: Tanaka, J. W., Wolf, J. M., Klaiman, C., Koenig, K., Cockburn, J., Herlihy, L., ... & Schultz, R. T. (2010). Using computerized games to teach face recognition skills to children with autism spectrum disorder: the Let's Face It! program. *Journal of Child Psychology and Psychiatry*, *51*(8), 944-952.

GAME: TeachTown

TeachTown is a computer delivered intervention targeting academic and social skills. Specifically, the program targets skills related to receptive language, social understanding, life skills and cognition/academics. TeachTown is delivered through twenty minute sessions over the computer, and with an educator everyday for 3 months. The program uses the basic principles of ABA. Specifically, children are encouraged to supply correct responses by receiving the opportunity to play games after they correctly complete a task. Children progress through at their own pace. After they master a lesson they move onto new material; if they do not progress on a pre-test then they are given training on the material until they master the content. In the in-person lessons provided by their instructor to the whole class, the teacher implements activities that target skills not included in the TeachTown curriculum (i.e. imaginative play, daily living skills).

- Broad Application: Children who completed Teach Town showed significant improvement on the program's lessons, and though not significant, they had higher scores than waitlisted children on standardized assessments of the four TeachTown skill categories. This curriculum may be of interest to special educators interested in incorporating a computer-based intervention. TeachTown uses ABA principles, it may be particularly effective for classrooms that already use these techniques. More research is needed on the real life effects of TeachTown and the long term effects of the intervention. As this is delivered to young children, it may be that improvements following Teach Town are more obvious in following years, though this has yet to be tested. As the intervention must be completed daily, it may be most feasible for schools with multiple available computers so that several children can complete the tasks at the same time. This may not be suitable for all children as it does require the ability to use a mouse and attend to the computer for twenty minutes at a time.
- Relevant Article: Whalen, C., Moss, D., Ilan, A. B., Vaupel, M., Fielding, P., Macdonald, K., ... & Symon, J. (2010). Efficacy of TeachTown: Basics computer-assisted intervention for the intensive comprehensive autism program in Los Angeles unified school district. *Autism, 14*(3), 179-197.

GAME: KASPAR

In this intervention, two children interact with a humanoid robot, KASPAR, while playing an imitation game. KASPAR appears similar to a baby doll, with realistic skin and hair, and has an animated face and free moving arms. KASPAR is able to speak and change his facial expressions. In the game, two children use Nintendo Wii controllers to complete a mimicry challenge similar to the game Simon Says.

Specifically, one child would pose in a specific way by following a screen in front of them showing a specific pose depicted by a stick figure. The child would then strike that pose and communicate to their partner how to copy the pose. KASPAR's role in the game was to provide verbal encouragement, reminders and to be a third player in the imitation game. The equipment needed for this intervention is an animated robot doll and a digitized version of Simon Says.

- Broad Application: The researchers found that children who played together alongside KASPAR were more animated and showed more positive affect towards one another. At the same time, when playing with KASPAR participants were less successful at the imitation task. Nonetheless, it appears that KASPAR improves social interactions between children with ASC and is an engaging addition to game play. KASPAR is not readily available for purchase, so the usability of this intervention is limited. Additionally, though Wii remotes were used in the imitation game tested in this project, the imitation game is also not readily available. Specialists wishing to include a robot intervention may want to explore other more readily available options. For instance, many games have on-screen avatars which provide reinforcement similar to KASPAR. Researchers may want to test whether the inclusion of an avatar and the creation of an imitation game on a console like Wii or Kinect can produce similar effects.
- Relevant Article: Wainer, J., Robins, B., Amirabdollahian, F., & Dautenhahn, K. (2014). Using the humanoid robot KASPAR to autonomously play triadic games and facilitate collaborative play among children with autism. *IEEE Transactions on Autonomous Mental Development*, *6*(3), 183-199.

GAME: ADDventourous Rhythmic Planet

In this virtual reality (VR) game, players use a drum to create a rhythm. This drumming is then turned into a gaming action that is visually represented in the VR space. In the game the hero is an alien who only progresses if a player reproduces a rhythm correctly, allowing the alien to continue its journey into the next stage of the game. The levels become increasingly difficult. The game comes with two modes, single and multi user. The game plot encourages children to play with one another and move from single to multiplayer mode. When playing in multiplayer mode, the rhythm is created collaboratively. This game requires VR headsets, a drum that can transmit to the VR system, and computing systems that are able to run the VR platform Unity.

- Broad Application: This game offers an engaging, multi-sensory digital environment in which children are encouraged to create music with one another and, in doing so, receive in-game rewards and complete a narrative quest. This program uses state of the art VR technology to

create a 3-d visual game, thus providing a highly immersive gaming experience. Though originally designed with children with ADHD in mind, this would likely be beneficial to autistic children as well, as it encourages joint action between peers and helps build rhythmic competencies, which are often found to be disrupted. One of the limitations to this program is the feasibility and lack of formal testing. VR systems are expensive and highly technical. They require training with regards to set-up and testing, and may not be suitable for professionals, educators or parents. Additionally, while the VR systems are available for purchase, the drum used in the intervention to guide game play is not. Those wishing to use this intervention would have to create a similar instrument on their own. Researchers may want to investigate ways to recreate this game using less expensive, more readily available equipment, and perhaps use an alternative to the physical drum (i.e. using a remote that simulates a drumstick to provide a similar movement). Finally, the effects of the intervention were not tested. More research is needed to determine how this improves skills in children with disabilities.

- Relevant Article: Giannaraki, M., Moumoutzis, N., Kourkoutas, E., & Mania, K. (2019, October). ADDventurous Rhythmical Planet: A 3D Rhythm-Based Serious Game for Social Skills Development of Children with ADHD. In *Interactive Mobile*

GAME: Magic Mat

In this video game, users stand on a mat that is able to track movement and thus guide on screen actions. Magic Mat is analogous to a large keyboard on the floor; it has arrows that the user steps on that guide the on-screen movements. For instance, in the game Tetris a user must guide falling blocks to angle them into gaps with a similar shape on the bottom of the screen. Using Magic Mat, the user does this by stepping on the appropriate arrow rather than sitting on a computer and doing this on the keyboard. This format encourages the user to use whole body movement to play traditional computer games. This requires a Magic Mat and compatible games in order to be used.

- Broad Application: Though this was not designed specifically for ASC, it is relevant in that autistic children show an interest in computer games and struggle with coordination. The Magic Mat approach to video games may encourage more whole body movement, improved spatial awareness and even collaboration between multiple players. Magic Mat is a gaming prototype and is thus not readily available. It is however a rather simplistic device that could likely be created by individuals with computer programming ability. It would be interesting for future research to test the effects of Magic Mat on autistic children with regards to physical

coordination and peer collaboration. At present however it needs more testing and development in order to be used by professionals and families.

- Relevant Article: Politopoulos, N., Stylianidis, P., Apostolidis, I., Chaldogeridis, A., Mavropoulou, A., & Tsiatsos, T. (2019, October). Creating Magic-Matt, An Interface to Transform Video Games to a Sports Experience. In *Interactive Mobile Communication, Technologies and Learning* (pp. 629-637). Springer, Cham.

ANNOTATED BIBLIOGRAPHY

Analog gamification

- Baker, M. J. (2000). Incorporating the thematic ritualistic behaviors of children with autism into games: Increasing social play interactions with siblings. *Journal of positive behavior interventions*, *2*(2), 66-84.

This article details an intervention based on a 'Bingo' game aimed at increasing sibling play amongst three autistic children aged five and six by incorporating ritualistic activities into gameplay. When taught a play intervention utilising this ritualistic behaviour, joint attention and social interaction of autistic children was increased as was positive affect, thematic behaviour also decreased. The effect was maintained across one to three months. Effects also generalised to other settings. This study presented an interesting, strength-based use of thematic behaviours, and showed promise in terms of longevity and generalisability of effect. However, results are difficult to generalise due to the small number of participants.

- Daubert, A., Hornstein, S., & Tincani, M. (2015). Effects of a modified power card strategy on turn taking and social commenting of children with autism spectrum disorder playing board games. *Journal of Developmental and Physical Disabilities*, *27*(1), 93-110.

This article details an intervention based on power cards, a visual technique capitalising on an individual's motivation and interests to teach skills or encourage behaviours. Power cards were used to develop social initiations and pro-social behaviour during three games (Topple Operation and Honey Bee Tree). Two autistic children aged nine and ten took part, power cards depicted appropriate behaviour in problematic situations capitalising on individuals restricted interests to foster social communication and turn-taking. Results showed that turn initiation and relinquishing (but not commenting) were increased using these methods. This project has an interesting use of restricted interests, although it is again difficult to generalise the results due to the small number of participants.

- Oppenheim-Leaf, M. L., Leaf, J. B., & Call, N. A. (2012). Teaching board games to two children with an autism spectrum disorder. *Journal of Developmental and Physical Disabilities*, *24*(4), 347-358.

This article details an intervention utilising three different structured board and card games (Go Fish, Yahtzee junior and Uno) with two autistic children aged five and seven. Both participants successfully learned all three games and could generalise gameplay behaviours to other opponents and different situations in less structured sessions in the future. This approach focused more on autistic children's

ability to actually learn a game and generalise that learning to other situations than any benefits of actually doing so. Again, it is difficult to generalise the efficacy due to the small number of participants.

- Satsangi, R., & Bofferding, L. (2017). Improving the numerical knowledge of children with autism spectrum disorder: The benefits of linear board games. *Journal of Research in Special Educational Needs*, *17*(3), 218-226.

This article details a replication of earlier research showing linear board games can improve numerical skills in autistic children. Ten autistic children aged four to ten, played a board game involving rolling a die to progress on a track, half with a focus on numbers of tiles on the track, the other half on the colour of tiles. A greater understanding of numerical relationships was demonstrated by those who had played the game with a focus on numbers rather than shapes. This study represents a well-controlled demonstration of a simple, novel board game utilised to improve numerical math ability in children of varying ages.

- Katō, K. (2019). Employing Tabletop Role-Playing Games (TRPGs) in Social Communication Support Measures for Children and Youth with Autism Spectrum Disorder (ASD) in Japan. RPG 学研究: *Japanese Journal of Analog Role-Playing Game Studies, 23*-28.110.

This article details two studies in which 59 autistic adolescents aged around fourteen participated in tabletop role-playing games. Researchers found that following the intervention improvement on almost all outcomes, most notably emotional well-being and friendship. This study is a well powered example of role-playing games ability to foster various quality of life outcomes.

- Jung, S., & Sainato, D. M. (2015). Teaching games to young children with autism spectrum disorder using special interests and video modelling. *Journal of Intellectual and Developmental Disability, 40*(2), 198-212.

This article details a single-case design study with nine (three autistic, six neurotypical) children in kindergarten, aged five and six. Games to be studied during play were chosen for each child and included Candy Land and Make n Break. Using video coding, researchers assessed whether social engagement with peers, nonverbal engagement and inappropriate behaviour changed during the course of the intervention. Results showed a significant increase in positive behaviour and a decrease in negative behaviour following the intervention. This study describes an interesting approach focusing on the use of special interests of children, which shows promise.

- Klopotova, E. E., & Krupnova, I. Y. (2020). Possibilities of Using Board Games to Develop Communication Skills in Children with Autism Spectrum Disorder. *Bulletin of Psychological Practice in Education*, *17*(1), 41-50.

This article details an experiment utilising board game intervention to foster social skills in six autistic children aged four to eight using two board games 'Walker & Memory'. Attention to partner and reciprocal communication improved over a ten-week period across 40 gaming sessions.This study is difficult to generalise due to the small number of participants.

- Fein, E. (2015). Making meaningful worlds: role-playing subcultures and the autism spectrum. *Culture, Medicine, and Psychiatry, 39*(2), 299-321.

This article details an ethnographic exploration of autistic adolescents at a summer camp dedicated to live-action role-playing games and table-top roleplaying games like Dungeons and Dragons. Using observations from fieldwork, the author concludes that these escapist games allowed the campers to construct narratives about their autism diagnosis that were shared and valued and that the shared interests in the games were sources of power, strength, and motivating acceptance.

- Carvalho, V. H., Brandão, J., Cunha, P., Vasconcelos, J., & Soares, F. (2015). Tobias in the Zoo–A Serious Game for Children with Autism Spectrum Disorders. *International Journal of Advanced Corporate Learning (iJAC), 8*(3), 23-29.

This article details the development of a mobile phone game for autistic children to strengthen their emotion recognition abilities. In the game, which operated through a digital picture book, children interact with a boy named Tobias, who has various experiences like going to a zoo or a party. Within the game, children have to match which facial expression Tobias would display based on the context of the story. The intervention was not formally evaluated.

Contributions from outside of ASD research

- Dell'Angela, L., Zaharia, A., Lobel, A., Vico Begara, O., Sander, D., & Samson, A. C. (2020). Board Games on Emotional Competences for School-Age Children. *Games for Health Journal. 9,3.*

This article details an experimental study in which one hundred and seventy even neurotypical children aged eight to twelve, were randomly assigned to play four sessions of either board games developed to help bootstrap emotional recognition and differentiation, or off the shelf control games (such as Codenames). Results showed that children with higher emotional competency found the emotional recognition and differentiation games less difficult, and all children reported equal enjoyment of these games as the off the shelf games. Though not directly focusing on ASC, this paper showcases how to develop board games to develop emotional competency and provides an

adequately powered and controlled experiment showing these games can be just as enjoyable as commercially available off the shelf games.

- Davis-Temple, J., Jung, S., & Sainato, D. M. (2014). Teaching young children with special needs and their peers to play board games: Effects of a least to most prompting procedure to increase independent performance. *Behavior Analysis in Practice, 7*(1), 21-30.

This article details a single-case design study with three children with developmental delays and three neurotypical children aged four and five on the effect of prompts on gameplay performance. Games required participants to roll die, match colours and move pieces. The experimenter used prompt in line with applied behavioural analysis to assist the children in learning the steps to the game and having appropriate social responses to gaming partners. Results showed a significant increase in independent board gameplay following the intervention. Though not directly focusing on ASC this paper showcases how to break down steps of games and teach them to those with developmental delays.

Digital gamification

Socio-Communicative outcomes

- Silva-Calpa, G. F. M., Raposo, A. B., & Suplino, M. (2018, May). CoASD: A tabletop game to support the collaborative work of users with autism spectrum disorder. In *2018 IEEE 6th International Conference on Serious Games and Applications for Health (SeGAH)* (pp. 1-8). IEEE.

This article details the development and evaluation of 'CoASD' a collaborative game using a touch screen interface for autistic children. The game was developed to encourage engagement in collaborative tasks. Seven autistic boys aged five to fourteen participated in the study. Results showed the game had positive effects on motivating individuals to act with partners, as well as increasing individuals' attention to the partner. Results are difficult to generalise due to the small number of participants.

- Malinverni, L., Mora-Guiard, J., Padillo, V., Valero, L., Hervás, A., & Pares, N. (2017). An inclusive design approach for developing video games for children with Autism Spectrum Disorder. *Computers in Human Behavior*, *71*, 535-549.

This article details 'Picos adventure,' a motion-controlled therapeutic computer game designed to increase foster social initiation, turn-taking, imitation, cooperation and emotion recognition. With a focus on an inclusive user and clinician led design, ten autistic children aged four to six took part. Results showed that the game was effective in promoting pro-social behaviours. An interesting

application of a user and clinician led approach to developing a motion-controlled game which successfully promoted pro-social behaviour in autistic children.

- Ferguson, B. R., Gillis, J. M., & Sevlever, M. (2013). A brief group intervention using video games to teach sportsmanship skills to children with autism spectrum disorders. *Child & Family Behavior Therapy, 35*(4), 293-306.

This article details a single-case design study in which eight autistic children aged seven to eleven played Nintendo Wii games. Researchers found significant improvements in sportsmanship following the ten-week program.

- Abirached, B., Zhang, Y., Aggarwal, J. K., Tamersoy, B., Fernandes, T., Miranda, J. C., & Orvalho, V. (2011, November). Improving communication skills of children with ASDs through interaction with virtual characters. In *2011 IEEE 1st international conference on serious games and applications for health (SeGAH)* (pp. 1-4). IEEE.

This article details the development and evaluation of LIFEisGAME, an intervention to help with emotion recognition. Nine autistic children aged four to eleven played the narrative-driven game involving creating and becoming an avatar. Results showed that while the children did correctly identify emotions post game, this was possibly due to matching instead of recognising emotions.

- Bernardini, S., Porayska-Pomsta, K., & Smith, T. J. (2014). ECHOES: An intelligent serious game for fostering social communication in children with autism. *Information Sciences, 264*, 41-60.

This article details an experimental study that explores the design and implementation of ECHOES, a serious game, built to help autistic children develop socio-communicative skills. Twenty-nine autistic children aged 8 to fourteen interacted with an intelligent virtual agent who is both a peer and a tutor and accompanies them while they virtually explore a sensory garden where there are learning activities. While this was a well powered and controlled evaluation, results showed no consistent increase in social behaviours, although there was some evidence of partial improvements of some individuals.

- Grossard, C., Grynspan, O., Serret, S., Jouen, A. L., Bailly, K., & Cohen, D. (2017). Serious games to teach social interactions and emotions to individuals with autism spectrum disorders (ASD). *Computers & Education*, *113*, 195-211.

This review article focuses on elements inherent to game design and playability for autistic players. It reviews 31 serious games designed to foster better social abilities (split into emotion recognition and social skills) in children with ASC. This review highlights a promising body of findings but with the need

for games targeting those with more severe needs / lower functioning and the need for better evaluation of games.

- Battocchi, A., Pianesi, F., Tomasini, D., Zancanaro, M., Esposito, G., Venuti, P., ... & Weiss, P. L. (2009, November). Collaborative Puzzle Game: a tabletop interactive game for fostering collaboration in children with Autism Spectrum Disorders (ASD). In *Proceedings of the ACM international conference on interactive tabletops and surfaces* (pp. 197-204).

This article details the development and evaluation of 'CPG' a collaborative puzzle game for fostering collaboration amongst children with and without ASC. This game was based on traditional jigsaw puzzles and utilised a touch screen interface. Across two studies, sixteen autistic children and seventy neurotypical children aged eight to eighteen were tested. Results showed more significant negotiation and coordination amongst those with ASC when the game enforced collaboration. This study was well powered and provided an interesting example of a puzzle game being utilised to enforce collaboration.

- Tanaka, J. W., Wolf, J. M., Klaiman, C., Koenig, K., Cockburn, J., Herlihy, L., ... & Schultz, R. T. (2010). Using computerized games to teach face recognition skills to children with autism spectrum disorder: the Let's Face It! program. *Journal of Child Psychology and Psychiatry*, *51*(8), 944-952.

This article details an assessment of the 'Let's Face It' intervention for face recognition, comprising a suite of seven computer games. Randomised clinical trials of 79 children aged around eight to fifteen, most of whom had a diagnosis of ASC. The result showed that those who completed the intervention showed reliable improvements in analytic and holistic recognition of faces and features compared to a waitlist group. This study was well powered and consisted of controlled randomised clinical trials demonstrating advances in facial recognition in autistic children as a result of a gamified intervention.

- Murdock, L. C., Ganz, J., & Crittendon, J. (2013). Use of an iPad play story to increase play dialogue of preschoolers with autism spectrum disorders. *Journal of autism and developmental disorders, 43*(9), 2174-2189.

This article details a single-case design study utilising a tablet story game to improve pretend play skills. Four autistic children aged four and five were recruited. In the game children touched a computer tablet to generate dialogue from the characters, like a digital picture book. Children were then presented with physical toys identical to the characters shown in the story. The intervention showed that following the game, children had a significant increase in their level of play dialogue and play behaviour with the toys

- Kim, B., Lee, D., Min, A., Paik, S., Frey, G., Bellini, S., & Shih, P. C. (2020). PuzzleWalk: A theory-driven iterative design inquiry of a mobile game for promoting physical activity in adults with autism spectrum disorder. *PLoS One, 15*(9), e0237966.

This article details an intervention for autistic adults using a mobile game to increase physical activity. Within the app, users navigate a walk displayed on the screen, and after they follow the correct route, they can solve a puzzle. Scores for users are then shared on leaderboards, allowing in-game competition. This app was developed with autistic adults and practitioners, and surveys and focus groups suggested that adult users enjoyed the app and that it promoted physical activity and, through the leaderboard, enhanced the feeling of kinship to other players.

- Gallup, J., Serianni, B., Duff, C., & Gallup, A. (2016). An exploration of friendships and socialization for adolescents with autism engaged in massively multiplayer online role-playing games (MMORPG). *Education and Training in Autism and Developmental Disabilities*, 223-237

This article details a qualitative investigation of mass Multiplayer online role-playing games with three male autistic players aged 16-21 in an attempt to understand their popularity with autistic online players. Results suggested that autistic players felt that the online environment allowed them to practice skills that generalized to real-life settings, that it gave them a way to connect with other players socially. They also felt it was helpful to have more transparent social rules in the online environment. The implications for this exploratory study are that the popularity of such games with autistic adults may allow targeted interventions within the gaming environment.

- Zakari, H. M., Ma, M., & Simmons, D. (2014, October). A review of serious games for children with autism spectrum disorders (asd). In *International conference on serious games development and applications* (pp. 93-106). Springer, Cham.

This review article details findings of 40 serious games designed for improving social behaviour, communication imagination, learning and sensory integration for children with ASD. The article did not formally evaluate the interventions described in the paper. It did, however, supply an extensive list of computer games developed for autistic children, and the type of equipment that would be needed to run the program in an educational setting. This paper is helpful for professionals looking perhaps to add computer games into an existing program as it mentions what skills are targeted and what resources would be needed.

Contributions from outside of ASD research.

- Narimani, A., Khaleghi, A., Haedar, H., & Semnani, F. (2019, October). The Use of Gamification in Evaluating Children's Emotional Intelligence. In *Interactive Mobile Communication, Technologies and Learning* (pp. 806-813). Springer, Cham

This article explores the use of 'MSCEIT' a gamified assessment of emotional intelligence for children. The game was developed using machine learning algorithms to improve the speed and accuracy when assessing children's emotional intelligence. Although an interesting account of the development of gamified assessment of emotional intelligence with clear links to ASC is included, this work was not directly exploring ASC and offered no evaluation of the assessment.

- Giannaraki, M., Moumoutzis, N., Kourkoutas, E., & Mania, K. (2019, October). ADDventurous Rhythmical Planet: A 3D Rhythm-Based Serious Game for Social Skills Development of Children with ADHD. In *Interactive Mobile Communication, Technologies and Learning* (pp. 582-593). Springer, Cham.

This article details the development of 'Adventurous Rhythmical planet' a 3d multimodal game designed to address social and emotional issues in children with ADHD. Though it focuses on ADHD, it uses both methods and looks at outcomes that could have overlap with ASC. No evaluation of the games is given, only its theoretical underpinnings and development are discussed.

Non-Social (cognitive/learning) outcomes & game preferences

- Hoque, M. E., Lane, J. K., El Kaliouby, R., Goodwin, M., & Picard, R. W. (2009). Exploring speech therapy games with children on the autism spectrum.

This article details a suite of games designed to help speech production. Various assessments are reported across eight children (five of which had an ASC diagnosis) aged eight to nineteen. Results suggested the games provided an effective and engaging language learning platform.

- Hiniker, A., Daniels, J. W., & Williamson, H. (2013, June). Go go games: therapeutic video games for children with autism spectrum disorders. In *Proceedings of the 12th international conference on interaction design and children* (pp. 463-466).

This article details 'Go Go Games' a suite of therapeutic games for young children with ASC. It was designed to complement existing practitioner lead therapy to increase total therapy time for those who needed it. The suite of games is based on pivotal response treatment, focusing on key behaviours which have wide-ranging implications, such as responding to cues. Thirty autistic children (ages not reported) were involved in the design of the three games in this suite. This study provides an

interesting, evidence-led approach, although released on the app store, very little evaluation of the game is given.

- Whalen, C., Moss, D., Ilan, A. B., Vaupel, M., Fielding, P., Macdonald, K., ... & Symon, J. (2010). Efficacy of TeachTown: Basics computer-assisted intervention for the intensive comprehensive autism program in Los Angeles unified school district. *Autism, 14*(3), 179-197.

This article details an experimental study of TeachTown, a computerised game developed to improve language and cognitive abilities. During normal school hours, 47 autistic children aged three to six took part for twenty minutes a day over three months. Compared to controls, participants who used TeachTown improved on language and cognitive measures and those who used it more had more considerable gains. This study presents a well powered and controlled example of a digital game bootstrapping language and cognitive abilities in those with ASC.

- Davis, M., Otero, N., Dautenhahn, K., Nehaniv, C. L., & Powell, S. D. (2007, July). Creating a software to promote understanding about narrative in children with autism: Reflecting on the design of feedback and opportunities to reason. In *2007 IEEE 6th International Conference on Development and Learning (pp. 64-69). IEEE.*

This article details a within-subjects study evaluating TouchStory, a computer game involving ordering different parts of a story into the correct position developed to aid with the understanding of narrative. Six autistic children, aged five to seven, participated. Results suggested that the children significantly improved their ability to construct narratives. It is difficult to generalise these results due to the small number of participants.

- Edwards, J., Jeffrey, S., May, T., Rinehart, N. J., & Barnett, L. M. (2017). Does playing a sports active video game improve object control skills of children with autism spectrum disorder?. *Journal of Sport and Health Science, 6*(1), 17-24.

This article details a within-subjects design study in which eleven autistic children and nineteen neurotypical children, aged six to ten played a sport active video game. Improvement in both perceived and actual movement skills were assessed. Results showed that real skills didn't improve in either group, but in the ASC group, perceived skills improved. This study is particularly interesting as indicated that amongst autistic children, movement-based games may bolster more confidence in physical abilities.

- Gaudi, G., Kapralos, B., Uribe-Quevedo, A., Hall, G., & Parvinchi, D. (2019, October). Autism Serious Game Framework (ASGF) for Developing Games for Children with Autism. *In Interactive Mobile Communication, Technologies and Learning* (pp. 3-12). Springer, Cham.

This master's thesis discusses the development of a serious game framework to help clinicians develop games for children with ASD. As children with ASC may have particular sensory needs or specific restricted interests, it can be helpful to individualize an intervention to reflect these preferences. In this paper, the author discusses the creation of a serious game and how therapists can use the simple interface to create more gaming interventions for specific clients.

- Li, B., Atyabi, A., Kim, M., Barney, E., Ahn, A. Y., Luo, Y., & Mademtzi, M. (2018, April). Social Influences on Executive Functioning in Autism: Design of a Mobile Gaming Platform. In Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (pp. 1-13).

This article details the creation and validation of a mobile gaming app used to assess executive functioning in autistic children. Thirty three autistic children and thirty two neurotypical children aged between two and seventeen were recruited. Three games were developed for use with a tablet, and they tested the executive functioning constructs shifting, short term memory and inhibition. Results showed that children played the game in different ways, revealing core differences in executive functioning across groups. Game results also showed that performance on all three games correlated with age, and shifting specifically correlated with IQ.

- Mazurek, M. O., Engelhardt, C. R., & Clark, K. E. (2015). Video games from the perspective of adults with autism spectrum disorder. *Computers in Human Behavior*, *51*, 122-130.

This article explores the video game preferences and outcomes of 58 autistic adults. Findings highlighted stress relief, immersion and social connection as positive outcomes to playing video games in the population, though addiction and negative social interactions were also highlighted. In terms of motivations and preferences in games achievement, graphics, story and creativity were found to be essential elements. This study presents interesting observations for likes and dislikes and preferences of video gaming in autistic people as well as highlighting the positive effects of videogame play.

- Brown, J., & Murray, D. (2001). Strategies for enhancing play skills for children with autism spectrum disorder. *Education and Training in Mental Retardation and Developmental Disabilities*, 312-317.

This article details a useful summary of differences in the ways children with and without an ASC diagnosis engage in play and highlights some of the key lessons to be replicated through an intervention. The paper gives a good overview of the importance of play and suggests strategies for successfully incorporating play into interventions and interactions.

- Mercado, J., Espinosa-Curiel, I., Escobedo, L., & Tentori, M. (2019). Developing and evaluating a BCI video game for neurofeedback training: the case of autism. *Multimedia Tools and Applications, 78*(10), 13675-13712.

This article details the development and testing of a neurofeedback brain training game using EEG called FarmKeeper. Sixty autistic children participated in a collaborative development process to develop the game, designed to stimulate sustained attention. The game was tested using a within-sample design with twelve autistic children aged between four and eleven. Results showed following the sessions that participants improved attention and found the game fun and user friendly.

Contributions from outside of ASD research.

- Behnamghader, M., Khaleghi, A., Izadpanah, P., & Rahmani, F. (2019, October). Using Gamification Based on Mobile Platform in Therapeutic Interventions for Children with Dyslexia. In *Interactive Mobile Communication, Technologies and Learning* (pp. 814-824). Springer, Cham.

This article describes a gamified reading intervention for children with dyslexia based on a modified version of 'Mario'. This game was developed for children (aged six to eight) with dyslexia to increase motivation and participation in reading and has not been used with ASC, though it may offer an interesting tool for the development of reading skills in the population.

- Khaleghi, A., Heydari, F., Takhttavani, M., Haedar, H., & Soltaninezhad, A. (2019, October). Combined Approach to Diagnose ADHD: Gamifying Conners Rating Scale. In *Interactive Mobile Communication, Technologies and Learning* (pp. 825-835). Springer, Cham.

This article details the development of the gamification of an assessment tool for ADHD. While not focusing on ASC, there is relevant overlap between ADHD and ASD as well as a considerable degree of comorbidity. Therefore this work offers valuable insights, though this development is yet to be evaluated.

- Politopoulos, N., Stylianidis, P., Apostolidis, I., Chaldogeridis, A., Mavropoulou, A., & Tsiatsos, T. (2019, October). Creating Magic-Matt, An Interface to Transform Video Games to a Sports Experience. In *Interactive Mobile Communication, Technologies and Learning* (pp. 629-637). Springer, Cham.

This article details the development and initial evaluation of 'Magic-Matt' a movement-based games intervention to aid the development of motor skills. This paper offers a theoretical overview of exergames, natural user interfaces and serious games in the context of interventions. Though not focusing specifically on ASC, there are clear overlaps and cross over considering motor aspects of ASC.

Play with robots

- Wainer, J., Robins, B., Amirabdollahian, F., & Dautenhahn, K. (2014). Using the humanoid robot KASPAR to autonomously play triadic games and facilitate collaborative play among children with autism. *IEEE Transactions on Autonomous Mental Development*, *6*(3), 183-199.

This article details the development and evaluation of a social robot (KASPAR) designed to engage autistic children in social and collaborative play. Over this ten-week proof of concept study, three pairs of autistic children aged eight and nine played imitative and collaborative games with KASPAR. Improvement was seen in both social behaviour and collaborative skills. This study presented an interesting use of a robot partner in studying imitative games to improve social behaviour. It is difficult to generalise the findings due to the small number of participants.

- Pliasa, S., & Fachantidis, N. (2019, October). Mobile Technologies Serious Games for the Development of Social Skills in Children with Autism Spectrum Disorders, in Enhanced with Socially Assistive Robots Interventions. In *Interactive Mobile Communication, Technologies and Learning*(pp. 618-628). Springer, Cham.

This article details an evaluation of 'Daisy' , a socially assistive robot in serious games interventions for collaborative play. The intervention was tested on twelve children aged six and seven, six of which had a diagnosis of ASD. Autistic individuals presented more socially acceptable behaviours when playing games supported by Daisy.

- Dautenhahn, K., & Billard, A. (2002). Games children with autism can play with Robota, a humanoid robotic doll. In *Universal access and assistive technology* (pp. 179-190). Springer, London.

This article details the use of 'Robota' a humanoid robot doll designed for imitative interaction games in autism interventions and therapy. A theoretical and applied background on the use of interactive robots in autism therapy is discussed, particularly in the development of social skills.

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The purpose of this review is to understand the research that has been done on how gamification can improve outcomes for individuals with autism. This review will be of particular interest to professionals who work with autistic clients, special educators, and families of children with autism. Readers will be able to understand the way that certain autism-friendly games are played, and the effect that certain games have had on improving specific skills in autistic samples. This will be particularly useful for those who are looking to introduce games for the purpose of improving a specific skill, or for those interested in introducing gaming more generally to autistic people and would like guidance on strategies for teaching gameplay skills.

This review was translated into French by C Atherton. C. Atherton is a French translator who currently works on the poetry of Édouard Glissant. After receiving a BA in Modern Languages from the University of Oxford, she earned an MFA from Johns Hopkins University, where she also teaches writing seminars.