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# A Review of Digital Games for Children with Autism Spectrum Disorder

Pavlina – Maria Kellidou

Department of Early Childhood Education, National and Kapodistrian University of Athens  
pavlinoula\_1995@windowslive.com

Iro Voulgari

Department of Early Childhood Education, National and Kapodistrian University of Athens  
voulgari@ecd.uoa.gr

Maria Kotzageorgiou

Department of Early Childhood Education, National and Kapodistrian University of Athens  
kotza2172009@gmail.com

Evdoxia Nteropoulou - Nterou

Department of Early Childhood Education, National and Kapodistrian University of Athens  
ederou@ecd.uoa.gr

## ABSTRACT

In this study, we review existing free digital games for children with Autism Spectrum Disorder (ASD). We examine their features, aim, educational design, and learning theories that underlie them.

Fourteen games were analysed. Based on our analysis, behaviourism seems to be a dominant educational approach for the design of games for ASD, despite the educational advantages of constructivist approaches. Through this review, we link the educational design of digital games for children with ASD to the potential learning outcomes, and we provide some insights for game developers, ASD specialists, and teachers, relevant to the design of more effective games for children with ASD.

## CCS CONCEPTS

• **Social and professional topics** → User characteristics; People with disabilities; User characteristics; Age; Children; • **Applied computing** → Education.

## KEYWORDS

Digital games, learning theories, Autism Spectrum Disorder, behaviourism, constructivism, serious games

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## 1 INTRODUCTION

Information and Communication Technologies (ICTs) and specifically serious games and digital game-based interventions have been widely used for the social and emotional training of children

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with Autism Spectrum Disorder (ASD) [1-3], complementing in most cases the conventional methods of intervention [4, 5]. ASD is a neurodevelopmental disability that affects social communication, and is characterised by the *restricted interests* and *repetitive behaviour* of the individuals [6]. Evidence, though, of the effectiveness of game-based interventions is still limited [3, 7]; most of the studies constitute proof of concept, they are pilot studies, with a limited sample, or they provide limited evidence that the skills trained during the intervention are transferable to real-life.

Information and Communication Technologies (ICTs) and specifically serious games and digital game-based interventions have been widely used for the social and emotional training of children with Autism Spectrum Disorder (ASD) [1-3], complementing in most cases the conventional methods of intervention [4, 5]. ASD is a neurodevelopmental disability that affects social communication, and is characterised by the *restricted interests* and *repetitive behaviour* of the individuals [6]. Evidence, though, of the effectiveness of game-based interventions is still limited [3, 7]; most of the studies constitute proof of concept, they are pilot studies, with a limited sample, or they provide limited evidence that the skills trained during the intervention are transferable to real-life. Digital games are environments integrating structural elements, the mechanics of the game that define the interaction of the player in the game, and narrative elements, the story, the plot, the environment that give context to the players' actions. Players reach goals by accomplishing tasks, solving problems, and making decisions. Digital games have been shown to have a great learning potential by engaging the players, motivating them, and supporting not only content knowledge in various domains but also social and higher order thinking skills such as problem solving, systems thinking, and empathy [8]. The term "serious games" more specifically refers to "the use of digital gaming technology to address a specific set of learning objectives or behavioural goals, games with an agenda of educational design and beyond entertainment" [9, 10].

The use of serious games for creating engaging learning experiences in the field of special education has increased in recent years [7]. Children with ASD seem to commit more to virtual environments as they view them as more predictable and reassuring than a therapeutic centre or even a classroom [11]. Previous studies have shown that children with ASD do enjoy playing video games just as much as the rest of the children do [12]. Considering this increased interest in digital games for children with ASD, it is important to

examine ASD games for getting a better insights of the practices involved.

In this study, we examine existing games through the lens of three core learning theories that are prevalent in current educational approaches and methods: behaviourism, cognitive constructivism, and social constructivism. Behaviourism mainly focuses on the study and change of observed behaviour [13, 14]. One of the main concepts of behaviourism is “reinforcement”: behaviours that are reinforced or rewarded are more likely to be repeated and sustained [14]. Skinner, demonstrated how a behaviour could be developed or abandoned through the process of reinforcement or “operant conditioning” [14]. Behaviouristic methods and programs have actually been widely used on autism [15, 16]. Applied Behavioural Analysis (ABA) is a common behaviouristic technique for autistic children; it aims to decrease challenging behaviours through intense interventions and “errorless learning” through feedback [17]. Immediate feedback is a critical aspect of games for autism so that a targeted goal may be achieved and the behaviour of the individuals to be shaped [7, 18]. A similar approach seems to be implemented in serious games as well: they communicate the educational content in an engaging, playful and entertaining way and encourage positive behaviour change by providing encouraging certain activities through elements such as competition or rewards [9]. Nevertheless, behaviourist methods have been criticized for their use in autism and special education [17, 19]. Indeed, the scientific value and ethical aspects of ABA and other behaviouristic techniques have been criticized [19, 20]. Constructivist methods have also heavily impacted education [21, 22]. Blazar & Archer [22] showed how a constructivist technique can be effective for special educational needs students in a general classroom. Cognitive constructivism emphasises the cognitive processes of the individual in order to adapt and refine knowledge [23]. While behaviourism focuses on observed behaviour and the techniques to shape it, cognitive constructivism supports that a child can build new knowledge based on its existing ideas, practices, and mental models [24]. We are currently seeing an emphasis being placed on constructivist approaches to learning in the design of learning technologies [25]. Social constructivism, on the other hand, as an approach to learning, situates the individual within a social and cultural context and views learning as the participation into meaningful social situations and interactions with peers, mentors, and experts [26, 27].

Previous studies addressing the educational design of games for children with ASD identify four main principles that game features should address: i) learning goals that aim at specific targeted skills, ii) feedback and rewards that will shape learning, iii) individualization by evaluating children’s differences, thus offering them the appropriate starting point and level of difficulty and iv) provision of choice to the children in order to raise motivation, enjoyment and the players’ sense of autonomy and control over their learning experience [7, 28, 29]. Through this review, we aim to examine the educational design of existing digital games designed for children with ASD, identify their potential learning outcomes, and provide some insights for game developers and ASD specialists in order to contribute to the design of more effective games for children with ASD.

## 2 METHODOLOGY

### 2.1 Sample selection

Our research took place in June 2020. For identifying the games for our analysis, we used the Google search engine and Playstore, with the search terms “autism”, “games”, and “free”. We used these search platforms as two of the most common platforms, most likely to be used by educators, parents, or children as well. We mainly wanted to focus on free and easily available games as these would also be more accessible to parents, educators, and children. We reviewed the games based on their reported aim, skills addressed, features, and underlying learning approach. We focus not on the implementation of games in the educational practice, but we rather examine the educational design of such games.

We excluded from our review the search results that did not specifically address the education and learning of children with ASD for ensuring the impact of the game; we therefore excluded games with no accompanying context or information clearly documenting the educational aspect of the game, and games that aimed and representing ASD or raising awareness about and empathy for children with ASD. Following these criteria, we identified 19 games which we further reviewed on the basis of their targeted goal, the ASD-related skills they addressed, and the learning theory which seemed prominent in their design. The games were reviewed separately by two coders who were graduates of an education department. Their results were compared and discussed until an agreement was reached for all games.

## 3 RESULTS

The games identified and reviewed were mainly from the following sources:

- Nine games from the WhizKidGames website (<http://www.whizkidgames.com/whizkidgames.php>) also linked to the AutismGames website (<http://www.autismgames.com.au/>). The games are the products of the collaboration of the Swinburne’s University specialists, the Bulleen Heights Specialist School and the National e Therapy Center (NeTC).
- One game from the Do2Learn website (<https://do2learn.com/>). The site was designed by Health Small Business Innovative Research, with the collaboration of teachers and specialists.
- One app from the CARD (Center for Autism & Related Disorders, <https://www.centerforautism.com/>).
- Nine games from the app Autispark (<https://autispark.com/>) which has been approved by special educators as it is indicated by their reviews on the website.

After the review and analysis of these games, four main categories of games emerged, based on their learning goals: games that aimed at improving social skills, emotional skills, restricted interests, and other skills such as orientation and identification. In the next sections we discuss these four categories of games and their underlying educational design. The results of the review are summarised in Table 1

### 3.1 Social skills

As previously mentioned, ASD affects social communication and interactions of children [6]. Social interaction or *affiliative behaviour*

**Table 1: Games, features and learning theories**

Game	Aim	Targeted Skills	Game Features	Educational Approach
Ted's Ice Cream Adventures	Non-verbal communication, Eye gazing	Social	Correct/Wrong answers, Feedback	Behaviourism
Robbie The Robot	Emotion Regulation	Emotional	Correct/Wrong answers, Feedback	Behaviourism
Feelings Game	Emotion Regulation	Emotional	Correct/wrong answers, feedback	Behaviourism
Rufus Goes to School	Adaptive Behaviour	Restricted interests	Correct/Wrong answers, Feedback	Behaviourism
Ron Gets Dressed	Adaptive Behaviour	Restricted interests	Correct/Wrong answers, Feedback	Behaviourism
Florence the Frog	Find a Route	Orientation, following instructions	Correct/Wrong answers, Feedback	Behaviourism
Marty the Mime	Non-verbal Communication, Emotion Regulation	Emotional	Correct/Wrong answers, Feedback	Behaviourism
Oink Oink	Emotion Regulation	Emotional	Instruction	Behaviourism
Panda Weather!	Adaptive Behaviour	Restricted interests	Correct/Wrong answers, feedback	Behaviourism
Camp Discovery	Numbers, Colours, Locations, Emotion Regulation	Adjustment, Orientation, Emotional	Correct/Wrong answers, Feedback	Behaviourism
Match Foods	Matching	Identification	Correct/Wrong answers, Feedback	Behaviourism
Match the Halves - Vehicles	Matching	Identification	Correct/Wrong answers, Feedback	Behaviourism
Feed By Colour	Sorting	Classification	Correct/Wrong answers, Feedback	Behaviourism
Sort Fruits & Vegetables	Sorting	Classification	Correct/Wrong answers, Feedback	Behaviourism
Sort By Class	Sorting	Classification	Correct/Wrong answers, Feedback	Behaviourism
What-General	Language	Speaking	Correct/Wrong answers, Feedback	Behaviourism
Farm	Language	Speaking	Correct/Wrong answers, Feedback	Behaviourism
City	Language	Speaking	Correct/Wrong answers, Feedback	Behaviourism
Remember The Order	Memory	Memorization	Correct/Wrong answers, Feedback	Behaviourism

is characterized by non-verbal acts of communication such as face to face interaction, eye gaze or joint attention [31]. Specifically, joint attention involves the coordination of attention between self, others, objects or events with the intention of sharing [31, 32]. A number of studies have focused on interventions relevant to the social interactions and joint attention for children with ASD [32, 33], while there is strong evidence that joint attention is associated with latter language development [34-36].

We identified one game situated in this area of skills ("Ted's Ice Cream Adventures"). The game focuses on children with non-verbal acts of communication such as eye gaze. The game encourages children to gaze by integrating features such as bears with large eyes and auditory instructions ("you should look in their eyes"). Ted, the main character, has to look into the bears' eyes and figure out which ice-cream flavour they like, in order to assist them and sell the ice-cream. A wrong answer triggers the negative feedback

which is a disappointed voice (“Please try again”) and a question (“Are you sure?”) A correct answer is encouraged by a positive comment (“That’s correct”) and bonus points (Figure 1).

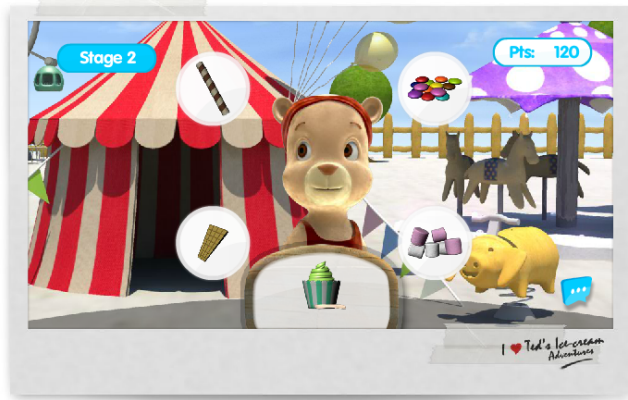


Figure 1: Ted’s Ice Cream Adventures

The game reinforces eye gazing, since it encourages the children to look into the virtual characters’ eyes in order to communicate. It provides an immediate feedback (negative or positive) to the users. Despite the attractive graphics though, the game repeats the same sequence of events and children may lose interest.

### 3.2 Emotional skills

Lack of emotional intelligence, emotional awareness, and empathy are considered as trademarks of autism; a number of studies have focused on the emotion regulation of children with ASD [37-39]. Emotional intelligence is the ability to detect one’s own and others’ emotions [40]. For children with ASD, lack of emotional intelligence is correlated with further symptoms such as anxiety and depression [41].

“Robbie the Robot” is designed to encourage the emotional awareness of children with ASD (Figure 2). The main character, Robbie, is a robot. The game integrates 3D animations and photographs of real human faces depicting different emotions such as happy, sad, angry, and surprised. The children have to identify and match the correct emotions through a series of puzzles. A wrong answer is discouraged through a negative shaking of Robbie’s head and a corrective intervention (“That’s sad”). A correct answer is encouraged with a cheering sound effect and a “well done.”

The use of a robot instead of a human as the main character seems interesting, although the designers justify their choice explaining that many autistic children find mechanical objects “engaging”<sup>1</sup>. All the WizKidGames, including “Robbie the Robot” were designed with the participation of students, lectures and autism specialists.

Similarly, the “Feelings Game”, a game from the Do2Learn website, encourages the user to choose among happy, angry, sad, interested, and afraid facial expressions of real human faces as well. During our review of the game though it was hard even for us to distinguish between the expressions and find the correct one (Figure 3). The game encourages the user with a “Correct!” sign,

<sup>1</sup>See also [http://www.autismgames.com.au/game\\_memotion.html](http://www.autismgames.com.au/game_memotion.html)



Figure 2: Robbie the Robot

after a successful try and a “Try again” after a wrong one. The absence, though, of auditory instructions can be a barrier for children without reading skills.



Figure 3: Feelings Game

“Marty the Mime” also introduces children to non-verbal communication and the recognition of emotions through facial expressions. The players have to select the emotions that correspond to Marty’s facial expressions. The game responds with positive feedback for correct answers or lack of feedback for wrong ones.

In “Oink Oink”, which also aims at emotion regulation, players choose an emotion by throwing a dice (mainly happy and sad) and watch animations of the main character, a pig, in happy or sad situations, with no further interaction required by the players.

### 3.3 Restricted interests

Restricted interests is one of the core symptoms of autism (for a definition see also [42]). It has been addressed in a number of studies as an activity that differs from ordinary hobbies [43-45]. There is a debate though on whether or not this is a symptom that should be treated; on one hand, restricted interests have been positive correlated with anxiety symptoms in studies on ASD [46], and on the other hand, research has emphasized the positive impact of restricted interests as an adaptive factor for the individuals and as an anxiety coping strategy [44, 45]. Mercier, Mottron & Belleville [44] addressed the beneficial impact of the restricted interests on the lives of adults with ASD, while Smerbeck [45] argues that if an interest has more positive than negative effects there is no need for

intervention, and further suggests that there is a difference between “helping” and “normalizing” a person. Nevertheless, a number of intervention programs have targeted the management of restrictive interests and repetitive behaviour of children with ASD [47].

The game “Rufus goes to school” is designed to help children with ASD cope with change. The main character, Rufus, has to cope with changes during his drive to school, such as driving with different people, interacting with his classmates or taking the bus. The game encourages changes through positive feedback (“Well done for choosing someone different”, “Changes are fun”). The players are guided by the virtual figure of a man with a “doctor’s” outfit, generating a “therapeutic” atmosphere in the game (Figure 4).



Figure 4: Rufus goes to school

“Ron Gets Dressed” is designed to help children with ASD cope with changes in clothing. Furthermore, the outfit that the player chooses for Ron has to match the weather conditions. A warm outfit in a sunny day is discouraged with a negative comment (“It’s too hot to wear that”), while an appropriate outfit is reinforced through a happy face of the character and a positive comment from the game (“Nice work”). On the next day, the player has to pick another outfit for Ron as the previous day’s clothes appear dirty. If the player selects the same clothes again, the game moves the clothes into the washing basket (Figure 5). “Panda Weather!” also addresses change through the selection of the appropriate clothes for each day, integrating positive and negative feedback for correct and wrong answers.

### 3.4 Other skills

The games included in this category mainly target basic life skills such as classification, language and memorization. “Florence the Frog” aims to help children follow instructions. The players take the role of a frog and guide it by following the auditory instructions. It could also help support orientation skills since the children become

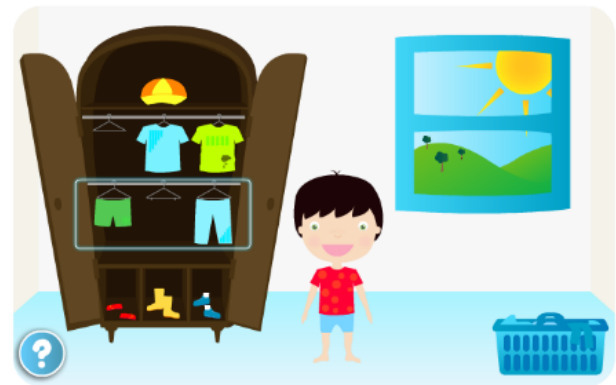


Figure 5: Ron gets Dressed

familiar with the concepts of left, right, shorter and longer path. The game guides the players and only accepts correct answers, with no possibility for exploration or experimentation.

The game “Camp Discovery” from the CARD centre is designed to train the children on numbers, colours, locations, emotions and other skills. It provides the opportunity to the player to choose his/her favourite reward from a list. A correct answer is awarded with the player’s preferred reward, while a wrong one is discouraged with a comment (“That’s not it, try again”) and an animation (the system makes the correct answer bigger). The game allows the players to choose a level of difficulty and personalizes the game by saving their performance. Elements such as the linear progression (levels), predefined options, and the reinforcement of correct answers are linked to behaviourism. “Match Foods” and “Match the Halves – Vehicles” aim to train identification and matching skills. In the first case (Figure 6), a kitten is sitting on a park for a picnic requesting a specific food. The player has to select the food that has been requested through a variety of foods and place it on top of the blanket. If the answer is right, kitty jumps in delight, the narrator announces the food and little stars appear. If the answer is wrong, kitten gets sad and the narrator gives a motivational feedback (“Keep going”, “Try Again”, “Good Try”) and the wrong choice is not available for selection again. Once the game is over, balloons and stars fill the screen and the narrator exclaims “Marvellous”. The same feedback is given in “Match the Halves – Vehicles” with the exception of the removal of the wrong choice. In both cases, if the player is taking too long to reply, a moving arrow will guide the player towards the direction of the correct answer.

“Feed by Color”, “Sort Fruits & Vegetables” and “Sort by Class” (Figure 7) require the sorting of items based on characteristics such as colours, fruits, vegetables and class. Following a similar concept as the previous games in the same app, the first two games depict little children and a dinosaur respectively. The little children have to eat the food that is of the same colour as their outfit. On the other hand, the dinosaur needs help with sorting vegetables and fruits into the correct basket. In both cases the heroes makes a happy face when the answer is correct, with the children eating the food and the dinosaur dancing around. In “Sort by Class” there are no characters represented and the player has to distinguish toys and

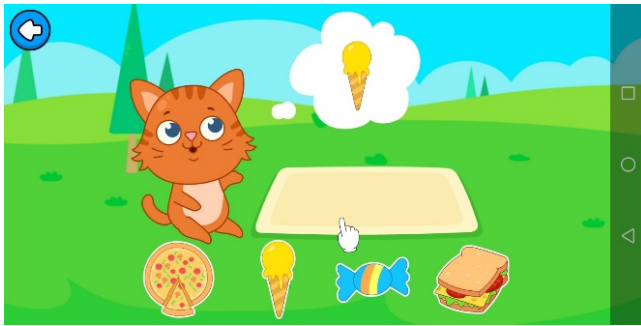


Figure 6: Match Foods

school supplies. In all cases, the narrator announces the name of the answer when it is given correctly. When the answer is wrong, the narrator gives again motivational feedback as in the games “Match Foods” and “Match the Halves – Vehicles”. Once the game is completed, the players are rewarded with balloons and stars that fill the screen.

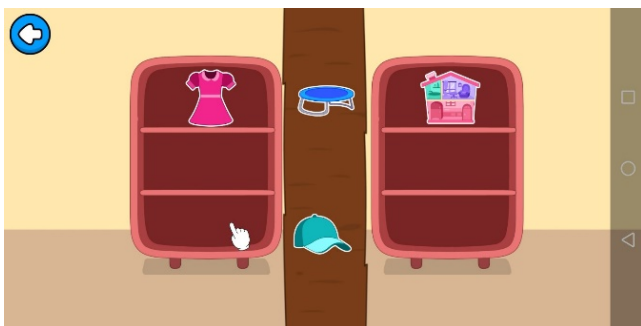


Figure 7: Sort by Class

“What-General”, “Farm” and “City” (Figure 8) are all language games with the user in the first one searching for the appropriate answer to “what” questions. A small chicken accompany the user by dancing and sending kisses when the answer is right and getting confused or starts crying when the answer is wrong. In the games “Farm” and “City” however, the concept of game is different, resembling a puzzle. There are two scenes, one of a city and one of a farm, where objects of the landscape are missing. The player has to fill the dark spot in the scene with the correct puzzle piece. However, the feedback on all these games follows the exact same model as the one we have encountered in all AutiSpark games.

Lastly, the game “Remember the Order” (Figure 9) aims at practicing memorization skills. The players are given limited time to memorize the order of the objects presented, the objects are then randomised, and the players has to put them back in the correct order. Feedback is given by the character of a dinosaur who dances when the answer is correct and cries when it is wrong. In this case, the feedback differs; no informative feedback is given but this time feedback is slightly different. No informative feedback is given but rather the narrator exclaims “Good job” and “Amazing” when the answer is correct.

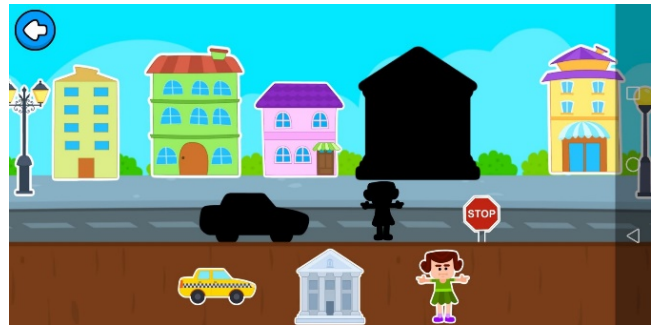


Figure 8: City



Figure 9: Remember the Order

Again, behaviourism emerges as the main educational approach of the games. Feedback is similar in all games and the players have limited time to respond before the correct answer is indicated by the game. There is no personalisation of the content such as increasing levels of difficulty or different starting points.

### 3.5 Excluded games

During our research we found three commercial games, not specifically targeting children with ASD and therefore excluded on the basis of our exclusion criteria. We, nevertheless, include them in this study, since they seem to have the potential to support children with ASD and they integrate a different learning approach. These games were discussed in blog posts and online fora of parents, caregivers, or developers discussing the games’ effectiveness and positive impact on the social skills and flexible thinking of children with ASD. These games were “Angry birds”, “Pokémon Go”, and “My talking Tom” [48-50]. “Angry Birds” and “Pokémon Go” allow for more cognitive and social constructivist approaches to learning; children can explore, experiment, they can select the appropriate strategy, they solve problems [51], they construct their knowledge through their interaction with the game, with their environment, and with others. In general, by blending the virtual and the real world, augmented reality applications such as “Pokémon Go” give the opportunity to the players to interact with their environment and with others and may become an excellent constructivist tool [52, 53]. In addition, “Angry Birds”, has the potential to support spatial intelligence [54]. In “My talking Tom”, players take care of a virtual pet and can also talk to it. Players became familiar with

everyday routines such as eating, toilet, sleeping, and playing and are rewarded with positive feedback (e.g. points, increased levels) when accomplishing the tasks. The game integrates a “talk back” feature where the virtual pet repeats back any sound or words the players say, which may encourage verbal communication of the children, as also discussed by the designer of the game [50]. However, there are no studies referring to the impact of these games on children with ASD.

#### 4 DISCUSSION AND CONCLUSIONS

The games examined target a wide range of emotional, social, and other life skills for children with ASD. One of the main patterns in their educational design is the prevalence of behaviourism; with features such as linear progression in the game, correct or wrong answers, goal targeted learning, and positive or negative feedback and rewards, the children have limited control over their game experience, and very limited opportunities of exploration, experimentation, and problem solving, with the exception of the games discussed in the section “Excluded games”.

Transferability of skills acquired in the games is also another issue that emerged. Although a number of games focus on essential real-life skills such as everyday routines, following instructions, and coping with change, there is little evidence that these skills are transferred to the real life of the child as well. The gap between game interventions and real life impact has also been highlighted by Grossard et al. [2]. The “unpredictability” and complexity of real life makes it difficult to generalize skills such as flexibility or tolerance to changes.

At certain points, a more therapeutic approach seemed to emerge, limiting the fun and engaging aspect of the games. The doctor’s outfit and the repetitive narration in “Ted’s Ice-cream Adventures” are indicative examples. Grossard et al. [2] also noted that the majority of games for ASD focused more on the therapeutic objects of the games and less on their enjoyability. The design of games for individuals with disabilities under the “rhetoric of compassion” has already been heavily criticized [3, 30].

Another issue identified was the absence of the children’s voice and perspective in the design of the games. There were no reports in the accompanying documentation of the games that the children’s opinions and interests were considered during the design process, except of generalisations (e.g. in the case of the “Robbie the Robot” game). Malinverni et al. [3] at their work for ASD, discuss the neglect of children’s opinion or interests at the design process of a game. Approaches such as the Participatory Design (PD) [56] of games for autism with the active participation of children with ASD, where they could influence the designing of the games could be a solution for the design of games relevant to the interests of the children, and consequently increase their engagement and the effectiveness of the games. To this end, the active involvement and cooperation of experts, teachers, children with ASD, and game designers is needed during the design and development phase of the games

In this study, we identified trends and issues that could be further considered for the design of games that are educationally effective. There seems to be gap, in our sample, in the design of games for

addressing cognitive skills or games integrating appropriate learning approaches for higher order thinking skills such as problem solving and decision making.

Future studies are certainly needed examining commercial games as well, or the impact of entertainment games that do not specifically target children with ASD but could, nevertheless promote the inclusion of the children. The implementation of augmented reality could also be considered for the design of games that allow children to interact with their environment in a playful way.

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