Requirements Gathering for the Development of a Game for Therapy Sessions with Autistic Children to Encourage Social Communication

HENRIQUE DE OLIVEIRA PEIXOTO, Institute of Computer, Federal University of Mato Grosso, Brazil
GUILHERME BRUN MORAES, Faculty of Engineering, Federal University of Mato Grosso, Brazil
EUNICE P. DOS SANTOS NUNES and LUCIANA CORREIA L. F. BORGES, Institute of Computer, Federal University of Mato Grosso, Brazil
KAMILA RIOS DA HORA RODRIGUES, ICMC, University of São Paulo, Brazil

Children with Autism Spectrum Disorder (ASD) are very sensitive to social situations and have difficulties interacting with their peers. In order to mitigate this difficulty, therapeutic treatment is often used. Games, which can be used for many different purposes, can also be used as an Assistive Technology (AT) in the therapy process, in order to encourage social communication and collaboration, which are very important skills in daily life. A Systematic Review (SR) was conducted using two research questions to gather more information about the theme. In parallel, a survey was applied to support the results of the SR. We found that genres of games that are likely to enhance collaboration are collaborative brain games (such as puzzle or memory games). We also found that games should be very minimalist (with a low number of players) and contain clear language, avoiding figures of speech. The results of this paper will be used as a basis to develop a game as an AT for the therapy of children with ASD in the future.

CCS Concepts: • **Applied computing** → *Consumer health*; • **Human-centered computing** → **Collaborative interaction**; **Accessibility design and evaluation methods**.

Additional Key Words and Phrases: serious game, collaboration virtual environment, social interaction, Children with Autism Spectrum Disorder

ACM Reference Format:
Henrique de Oliveira Peixoto, Guilherme Brun Moraes, Eunice P. dos Santos Nunes, Luciana Correia L. F. Borges, and Kamila Rios da Hora Rodrigues. 2022. Requirements Gathering for the Development of a Game for Therapy Sessions with Autistic Children to Encourage Social Communication. In *LIQUE 2022: Life Improvement in Quality by Ubiquitous Experiences Workshop, together with IMX 2022: ACM International Conference on Interactive Media Experiences, June 22-24, 2022, Aveiro, Portugal*. ACM, New York, NY, USA, 8 pages.

1 INTRODUCTION

Games and virtual environments (VE) are applied in many different fields. In the health field, games are used in applications of healthcare, such as diagnosis, procedure training, therapy and rehabilitation. The scientific literature shows that games are more than entertainment, history and arts, but also allow the improvement of abilities such as interaction and communication, according to Ringland [2019], Zhang et al. [2018] and Zhao et al. [2018].

Children with Autism Spectrum Disorder (ASD) are sensitive to external stimuli, such as communication, interaction, cooperation, physical touch and crowded or unknown places, among others [Wu et al. 2020]. According to Sulkes [2022], they have restrictive and repetitive behavior such as: inflexible adhesion to routines and ritual; narrow and

LIQUE 2022, ACM IMX 2022, June 22-24, 2022, Aveiro, Portugal

specific interests; exaggerated reaction to lack or excess of stimulus and repeated speech; and social interaction and communication deficits (understanding non verbal cues, social and emotional reciprocity and difficulty in maintaining relationships). In this context, we found studies that explored game based VEs, as a means to improve social interaction, verbal engagement and collaboration, such as: Zhang et al. [2018], Ringland [2019] and Crowell and Pares [2018].

Studies have found evidence that experiences lived in 3D VEs have been positive and can contribute to improving the expressiveness of children with autism, as stated by Ringland [2019] and Wu et al. [2020]. However, it is important that a game presents an engaging narrative, but with a minimalist environment and allowing multiplayer, in order to promote collaboration and stimulate social interaction.

In this scenario, by investigating aspects related to games as support to therapy sessions it is possible to bring a reflection about different forms of interaction and the challenges that permeate this study field and game innovation in general. The accelerated innovation production process, makes human aspects, such as of the children with ASD, disregarded or less valued in the conception of game based VEs.

Therefore, the aim of this study is to present the results of a survey of requirements for the development of a collaborative 3D game with the objective of stimulating the social communication of children with autism during therapy sessions. For this purpose, a Systematic Review (SR) was conducted and a survey was applied to professionals, parents and caregivers that deal with children with autism. The paper is organized as follows: section 2 presents the methodology used to conduct this study. Section 3 presents partial results and discussions of this research and finally section 4 presents its conclusions.

2 METHODOLOGY

This research started with a literature SR, seeking to answer two research questions:

Question 1 (Q1) - "What visual aspects, audio, task timing, interaction resources, immersion, among others that are recommended to develop a customized 3D game for children with ASD?"

Question 2 (Q2) - “What multiplayer collaboration technologies are being applied in games and 3D VE to develop the social interaction and collaboration of children with ASD and what is the context of use of these technologies?”.

The first step was to elaborate the SR protocol. This document contained guidelines on how we needed to conduct the research. Such guidelines established that the research sources that were going to be used were ACM, IEEE and SCOPUS. Preferably, papers in English were considered to the review. No works published before 2018 were included. Inclusion criteria for Q1 were: i) studies that address the development of narratives for 3D games and VEs made for children with ASD; ii) studies that show results of the development of social and daily life activities for children with ASD when using 3D games or VEs. Inclusion criteria for Q2 were: i) studies that address collaborative technologies in games and VEs for children with ASD; ii) studies of collaborative technologies effects on the socialization of children with ASD. Regarding exclusion criteria, any work that didn’t meet these inclusion criteria were excluded. Fig. 1 illustrates a PRISMA diagram containing quantitative information about the SR conduction process.

The following search strings were used for Q1: "children with ASD" AND "3D enviroment"; autism AND collaborative AND "serious game" AND "virtual reality"; autism AND "3D games"; autism AND development AND "3D games"; autism AND "serious game" AND technologies AND "social relationships"; "children with ASD" AND "serious game" AND development; "children with ASD" AND "game 3D"; "children with ASD" AND "3D game"; "children with ASD" AND "serious game" AND "virtual reality". For Q2, these strings were submitted: "children with ASD" AND "collaborative virtual environment"; autism AND collaborative AND games; autism AND multiplayer; "children with ASD" AND games AND "social relationships"; autism AND collaborative AND games AND "social relationships"; autism AND

games AND communication; "children with ASD" AND collaborative AND "3D environment"; "children with ASD" AND "3D games" AND "social skills"; "children with ASD" AND VR AND "collaborative".

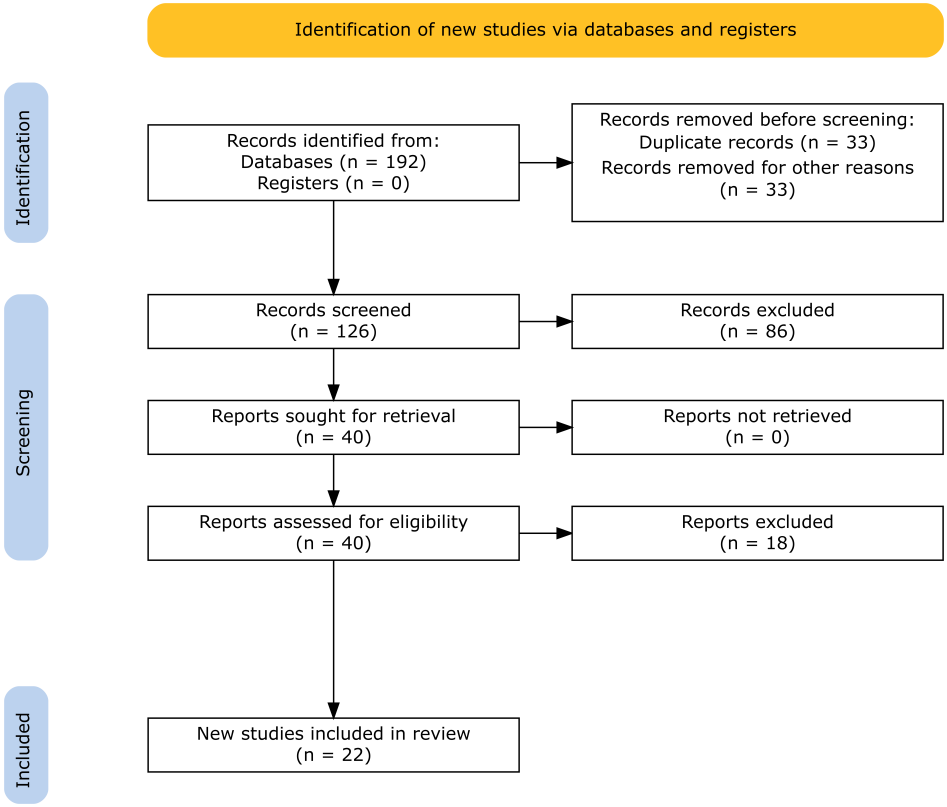

Fig. 1. PRISMA Diagram of the Systematic Review.

Question 1 returned a total of 84 papers, of these, 26 were found to be duplicates. Therefore, 58 papers remained to be analyzed in the preliminary selection. At the end of the preliminary selection, 10 papers remained for the full reading, and 48 were excluded. All 10 papers were included at the end of the SR. Regarding Question 2, in total 112 papers were retrieved on the initial search. Out of these, 11 duplicates were found and 33 did not meet the inclusion criteria. Therefore, 68 papers remained for the screening process (title and abstract reading).

The number of papers that did not make it through the screening process was 55, leaving 13 articles for a full text review. Finally, one did not meet the inclusion criteria and 12 articles were included in the review. For each one, a summary was made and a few key points were gathered in a spreadsheet, such as : methodology, collaborative technologies, implementation technologies, stored data, VE control, proxemics (personal space in a social environment), devices, public, experiments, approach and session time.

A survey was also made to help us gather more information and support the results of the SR. We used the “snowball” sampling method. Such a method is non-probabilistic and involves a participant sending the survey to someone known. The new participant receives the survey then does the same. The process repeats until the end of the survey or if the sharing process keeps going [Vinuto 2014].

The survey targeted professionals working with therapeutic treatment of children with ASD. Currently, it has 14 answers and is online since December of 2021. It is divided into two sections, the first being: “Identification of the requirements for a collaborative 3D game to be used in therapy sessions with children with autism”, which is closely tied to Question 1. The second section was: “Recommendations for the use of collaborative technologies in a 3D serious game to encourage social interaction of children with autism”, which gathers information for Question 2. Since the research is still in progress, the survey is still accepting answers.

3 RESULTS AND DISCUSSIONS

In the Question 1 research, it was noted that the development of games to assist in the treatment of people with autism is an efficient way and many times more attractive than a common activity, with all the papers presenting positive results in the acceptance and improvement of the children.

Of the 10 papers read, 6 presented a 3D VE (about 60%): [Rahmadiva et al. 2019], [Abdelmohsen and Arafa 2021], [Terlouw et al. 2021], [Lu et al. 2018], [Wang et al. 2018] and [Mota et al. 2020]. Even with 4 of the papers not presenting 3D worlds it was important to see that some development resources were maintained in all 10 papers. The main genres presented in the papers were puzzle and memory games, such as: [Abdelmohsen and Arafa 2021], [Gomez et al. 2018], [Rahmadiva et al. 2019], [Mota et al. 2020], [Lu et al. 2018] and [Terlouw et al. 2021], with the purpose of accomplishing or facilitating the accomplishment of children’s daily tasks.

The customization of the environment was not well explored by the researchers, with only 2 games being customizable: [Mota et al. 2020] and [Gomez et al. 2018], and 1 of them did not implement it from the start, but only when health professionals suggested it.

Finally, the main development technology used in the production of these games was the Unity graphics engine. Other technologies explored were motion controls through Leap Motion: [Rahmadiva et al. 2019], Augmented Reality cards: [Mota et al. 2020], and facial recognition using a database: [Dapogny et al. 2018].

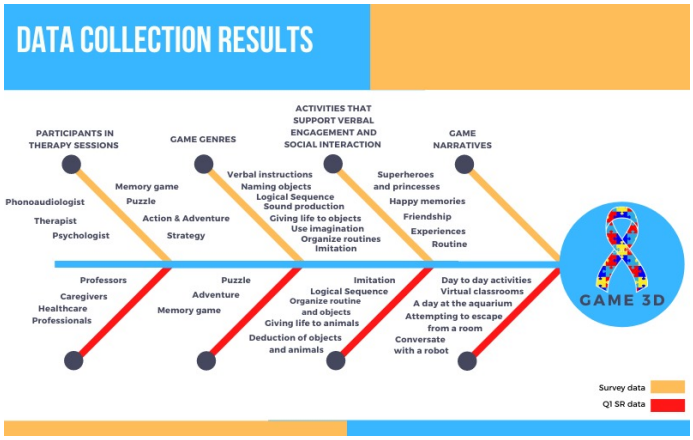

Fig. 2. Summarization of the results from Q1 of the SR and the survey.

Regarding Question 2 research, the most used collaborative technology were collaborative puzzle games, which appeared in 4 out of 12 papers (about 33%): [Zhang et al. 2018], [Zhao et al. 2018], [Zhang et al. 2021] and [Amat et al. 2021]. Other 3 papers focused on body interaction for training both motor abilities and social skills, such as: [Zhao et al.

2021], [Giraud et al. 2021], [Crowell 2018]. The remaining papers had more specific implementations for a collaborative VE (CVE), such as: [Babu et al. 2019], [Crowell and Pares 2018], [ling Wu et al. 2019] and [Babu and Lahiri 2020]. A SR was made by Baykal et al. [2020].

In order to evaluate the efficiency of the VE it is required to establish metrics that can serve for such a purpose. It is notable how data collection was not consensual between papers, 10 of which collected at least one of the following: the game state, audio and video conversation, user interactions, playing efficiency (e.g. time elapsed and points acquired), proxemics in VEs, gaze direction and the heart rate.

Regarding VEs, the most recurrent setting was to give players full control of the VE (7 papers). Proxemics is also an important detail to pay attention to, as children with ASD are sensitive to high levels of proximity [Crowell and Pares 2018]. 6 works had a research enviroment that involved no physical contact, either by placing children in different rooms or putting them to play against an intelligent agent (2 papers). Crowell and Pares [2018] mentions that children with ASD are sensitive to proximity even in virtual spaces.

Many devices were used in the studies, such as: Leap Motion Controller, headsets and webcams, Tobii EyeX Tracker (for eye gaze tracking), Microsoft Kinect and VR headsets. The approach consisted mostly of 3D VEs, appearing in 6 papers. 2D VEs were used in 3 papers. In other works, the approach was not specified. Unity Engine was cited in 4 papers. We also found an average of 38 minutes spent on each play session. The average was calculated by summing all the session times specified on the papers and dividing by the quantity of session times (some papers had more than one).

About the survey, we received answers from 14 participants (with 11 of them identifying themselves as therapists). When asked if the participant had already used games in therapeutic treatment, 9 responded “yes” and 5 said “no”. We also asked about the names of the games used and we got 9 different responses: CTS Play apps, Imimic, Fofuuuu and Coelho Sabido were among them. When asked about which game genres were recommended for therapeutic treatment of children with ASD, the 5 most recurring answers were: Memory, Puzzle, Action/Adventure, Board games and Strategy.

Seven participants out of 13 (53,85%) mentioned that daily life activities should be the focus of the game narrative. Regarding what we should be aware of when developing a game for children with ASD, keeping a simple language was mentioned the most (6 responses).

Survey data shows the number of simultaneous players should be: **two** according to 8 respondents; **three** according to 4 respondents; **four** according to 2 respondents . All 14 respondents said that it is interesting for the therapist to participate in the game. In 50% of 14 answers it was recommended for children with ASD to play remotely with their peers. 35,7% (or 5 answers) suggest for the children to play with a computer simulating real human interaction. Other participants propose playing in proximity with peers.

Regarding communication, out of 14 respondents, 10 proposed that the children should have the option to choose the communication method to be used for the collaborative game (text, audio and/or video). 4 of them mentioned that the communication should be set to video and audio. Finally, 12 respondents recommended that the therapist should be able to intervene in the CVE and 2 proposed that the children should play without intervention.

In general, it can be said that 3D VEs are effective in terms of improving engagement and social interaction. It is notable how Puzzle and Memory games seem to be the game genre that had the best results among other types. This could be related to the narrow and specific interests and inflexible adhesion to routines children with ASD tend to have, both mentioned by Sulkes [2022]. The genre is predictable (rules don’t change midplay).

Regarding the virtual environment, the recommended number of simultaneous players was 2. It is likely due to the fact that children with ASD feel uncomfortable in social situations. Also, having too many players makes it difficult to manage the therapy/study session.

Children with ASD have also difficulties in developing relationships. In the studies of Zhao et al. [2018], strategies used to encourage communication were audiovisual triggers: the game would stop for a few moments and ask the participants to communicate and it would also be able to detect if they were communicating, by analyzing audio input. Note that predictability and routine take place here.

The use of intelligent agents [Zhang et al. 2021], collaboration from the perspective of the partner [Babu and Lahiri 2020] and shared attention [Amat et al. 2021] were methods used due to ASD leading to deficits in social or emotional reciprocity. Intelligent agents were accepted well as collaborative partners by children with ASD.

Three forms of communication were used across studies, however there is no prevalence of one of them, even in the survey. Voice [Zhang et al. 2021], video [Zhang et al. 2018] or face-to-face communication [Babu and Lahiri 2020] were used as ways to deal with overreaction or lack of reaction to sensory stimulus or non-verbal communication deficits.

Fig. 2 illustrates a summarization of the results from Q1 and the survey, highlighting the convergence between the results. Some notable common points include some game genre and narratives and recommended activities that support verbal engagement and social interaction.

Fig. 3 illustrates ASD symptons and the corresponding CVEs initiatives found in Q2. Some noteworthy common points between the results of the Q2 and the survey include number of simultaneous players, communication methods and the recommendation for remote play over using a shared device.

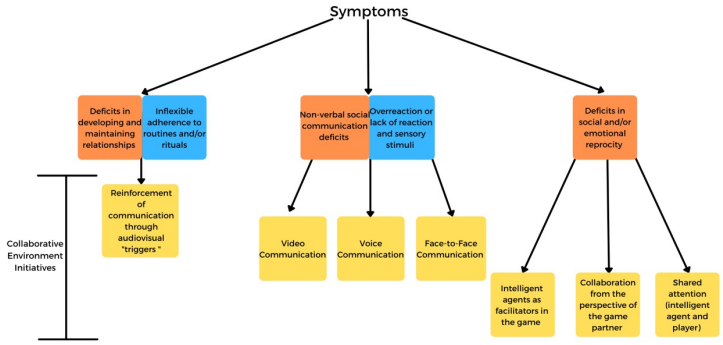

Fig. 3. ASD symptons and the corresponding collaborative VEs initiatives found in Q2 of the SR.

4 CONCLUSION

In this paper, our goal was to identify information about serious games being used as Assistive Technologies (AT) in therapeutic treatment of children with ASD, as a means of facilitating social interaction and collaboration. We also wanted to find out if the abilities acquired during play are transferred to real life. In other words, we wanted to verify the effectiveness of serious games in the treatment process. This study could help support therapy sessions with children

with ASD, as games have are an accessible and effective AT in therapy, according to: Zhang et al. [2018] and Zhao et al. [2018].

For this a SR was conducted using two different research questions. The first one aimed to study the design and implementation of 3D games to encourage social communication of children with autism while the second one assessed collaborative technologies in games for children with ASD. This separation of research questions allowed us to gather more information for the SR. Specifically, by being able to study both as separate components, we were able to find more articles for the SR and reach more consistent results regarding, for instance, the game genre and VE type, broadening the possibilities of using games as support for therapy sessions.

Studies show that serious games can be applied as a therapeutic alternative, but there are considerations to be made, such as: proxemics and number of players. Both the SR and the survey made it clear that brain games (puzzle or memory), seems to be the genre that leads to better results.

The results also show that it is important to communicate clearly the game's objectives, without resorting to figures of speech. Keeping a clean and minimalist display and VE is also key, as children with ASD are prone to distracting themselves when too much stimulus is present.

Requirements gathering for the game from the SR and survey results is under development. In future works, we intend to develop a serious game to support the therapeutic treatment of children with ASD, even considering the age group, with no gender distinction and level 1 or 2 of the autism spectrum.

ACKNOWLEDGMENTS

The authors thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) institution and the Pro-Rectorate of Research of Federal University of Mato Grosso (UFMT). We also thank the survey respondents.

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