Avatar-Mediated Interaction and Collaboration: Perceptions of Individuals with ADHD in the Metaverse Context

Iasmim da Cruz Marinho[1] **, Ailton Ribeiro**[1] **, Vaninha Vieira**[1]
Maria Clara Pestana[1] **, Ana Maria Amorim**[1]

[1]Instituto de Computação, Universidade Federal da Bahia, UFBA

{iasmimcm, ailton.ribeiro, vaninha, mpestana, ana.amorim}@ufba.br

Abstract. *The metaverse consists of a set of virtual spaces that enable interaction between people, regardless of their location. The mediation of this interaction through avatars can present challenges, especially for neurodivergent individuals, such as those with ADHD, which is the focus of this research. We collected data from real users using the focus group methodological approach, conducted on a 3D platform. Our findings highlight opportunities for improving avatars' expressions, gestures, and emotions, as well as the design of virtual environments, aiming to minimize distractions. The insights gathered provide an empirical foundation that underscores the importance of developing more inclusive and diverse immersive virtual environments.*

1. Introduction

Although the literature presents various definitions of the term metaverse [Dionisio et al. 2013, Lee et al. 2024, Meta 2022], this research adopts the concept that characterizes it as a set of dynamic, open, interoperable, shared, persistent, and immersive 3D virtual spaces, as described by [Ismail and Buyya 2023]. These environments serve different purposes and enable interactions between people and avatars, regardless of physical location.

For many years, these environments were primarily used for online gaming, providing immersive and interactive experiences focused on entertainment. However, with advances in virtual and augmented reality technologies, the metaverse has expanded its applications to various contexts, including work, education, socialization, and creativity, extending beyond its strictly recreational use [Dionisio et al. 2013]. In this context, building more meaningful experiences in virtual environments requires adopting effective interaction and collaboration processes among users. However, the usability and accessibility of these platforms remain significant challenges, particularly for neurodivergent individuals, such as those with Attention Deficit Hyperactivity Disorder (ADHD).

Much of the discussion on accessibility and inclusion in the metaverse has taken a broad approach to the topic [Othman et al. 2024, Zallio and Clarkson 2022, Zhang et al. 2025], without focusing on specific groups with distinct characteristics and needs. As a result, there is a gap in research addressing cognitive accessibility, particularly for individuals with executive dysfunctions such as ADHD. This condition is characterized by difficulties with attention and/or hyperactivity [Faraone et al. 2021], requiring additional effort to complete everyday tasks that may be simpler for neurotypical individuals. In this context, how can we support the creation of immersive virtual environments in the metaverse, focusing on avatar-mediated interaction and collaboration to promote inclusion and accessibility for individuals with ADHD?

This study aims to investigate and analyze the perceptions of individuals with ADHD regarding factors that influence avatar-mediated interaction and collaboration in virtual environments. To achieve this overarching objective, the following specific goals have been defined: i) To understand how avatar-mediated interaction and collaboration occur in virtual environments from the perspective of users with ADHD and, ii) To identify the challenges associated with the experiences of individuals with ADHD in interactive and collaborative dynamics within virtual environments.

The remainder of this manuscript is structured as follows: Section 2 covers the background and related works; Section 3, the methodology; Section 4, the user study: participants and procedures; Section 5, the initial results; Section 6, the discussion; Section 7, the limitation and threats to validity; and Section 8, the conclusion and future works.

2. Background and Related Work

2.1. Sensory Load in the Metaverse: Interaction and Collaboration Through Avatars

The metaverse can also be defined as a space that offers "new sensory experiences by incorporating additional tactile, sensory, and cognitive feedback," making interactions distinct from those in non-metaverse environments, such as social media and traditional communication platforms [Zallio and Clarkson 2022]. However, this increased sensory load can present challenges, particularly for neurodivergent individuals, especially those with ADHD, whose sensory processing differs from that of neurotypical individuals [Ghasemi et al. 2024]. The metaverse enables self-representation through avatars, allowing users to navigate social environments and customize their digital identity. Studies suggest that avatars enhance immersion and strengthen the sense of presence in virtual spaces [Ribeiro et al. 2024, Gualano et al. 2024].

2.2. ADHD and Accessibility in the Metaverse

Recent research has addressed accessibility issues in the metaverse, but often from a generalist perspective. Studies such as those by [Lee et al. 2024, Zallio and Clarkson 2022, Othman et al. 2024] provide valuable contributions to solving accessibility problems in these virtual environments. However, these investigations tend to approach accessibility broadly, without a specific focus on the particular needs of neurodivergent individuals. People with ADHD may face unique challenges in virtual environments, such as difficulties with concentration, hyperfocus on distracting elements, or issues with attention regulation across multiple stimuli.

2.3. Related Works

In the literature, some studies have investigated accessibility for neurodivergent individuals in the metaverse. Table 1 provides a comparison of the identified related works and our proposal. In [Alimamy 2024], the author presents a set of propositions for a broader approach to accessibility in services aimed at neurodivergent individuals, including autism, ADHD, dyslexia, and other cognitive variations, through a systematic literature analysis.

In [Collins et al. 2024], the authors present an ongoing study on opportunities to improve accessibility in social virtual reality (VR) environments for individuals with

ADHD and autism. The study involved participants briefly exploring a social VR environment. In [Ribeiro et al. 2024], the authors propose guidelines for creating more inclusive and representative avatars. Data was collected through a survey with 133 participants with distinct profiles. In [Gualano et al. 2024], the study reveals possible self-representation preferences of individuals with invisible disabilities through avatars in VR. The authors conducted interviews with participants who have different types of invisible disabilities.

Our research, however, focuses on the perceptions of individuals with ADHD regarding avatar-mediated interaction and collaboration in virtual environments, without using VR accessories, and collects data through a focus group within virtual environments.

Table 1. Related Works

Reference	Methodology	Neurodivergence	Metaverse	VR
[Alimamy 2024]	Systematic literature review	Not specific to ADHD	Yes	No
[Collins et al. 2024]	Study in a VR environment	ADHD and autism	Yes	Yes
[Ribeiro et al. 2024]	Broad diversity approach	Not specific to neurodivergent individuals	Yes	No
[Gualano et al. 2024]	Semi-structured interviews	Not specific to ADHD	Yes	Yes
Our propose	Focus group in a 3D virtual environment	Specific focus on ADHD	Yes	No

3. Methodology

An exploratory study phase was conducted to identify the theoretical background and relevant literature. A comparative analysis of platforms supporting 3D virtual environments was performed to select a tool for the user study. The study used a focus group session to collect data, chosen for its effectiveness in exploring perceptions, experiences, and challenges through dynamic interaction and real-time observation. The use of this technique was based on reports, such as [Kinalski et al. 2017], emphasizing the importance of focus groups in qualitative data collection.

The fact that the focus group was conducted online and synchronously could be seen as a challenge due to the reduction of social and behavioral cues. However, as highlighted by [Stewart and Williams 2005, Oliveira et al. 2022], the distancing, anonymity, and privacy provided by the virtual environment can offer participants a greater sense of security and reduce inhibition, which can lead to more spontaneous and fruitful discussions. Therefore, the online modality can be seen not only as a limitation but also as an opportunity to promote more authentic and valuable interactions.

In the user study phase, forms, a focus group script, and platform setup were completed. The focus group, held on February 6, 2025, lasted 2 hours, with a test session conducted a week earlier. Participants accessed the session via a WhatsApp link. The resulting documents are available in Appendix A. In the analysis phase, the meeting was transcribed, and a thematic analysis was performed to identify the key discussion topics.

4. User Study: Participants and Procedures

A focus group was conducted in which participants engaged in collaborative activities and discussed the challenges and opportunities of the experience. The group consisted

of four self-identified neurodivergent individuals: three cisgender men and one cisgender woman. Three participants were between the ages of 18 and 28, while one was between 15 and 17, with parental consent obtained for their participation (Appendix A).

In terms of devices used, one participant participated via computer, while three used a cell phone or tablet. Regarding race/ethnicity, one identified as Black and three as Mixed-race. Educational backgrounds varied: one had completed high school, one had not, and two had higher education. None had a formal ADHD diagnosis or took medication, but all reported self-diagnosed symptoms, such as inattention and/or hyperactivity. Additionally, a pilot session was conducted beforehand to refine the methodology and mitigate potential issues. Five participants tested the environment, avatars, features, and dynamics using the same script planned for the main session.

4.1. Focus Group: Creating Immersive Environments with Spatial.io

This section examines the use of the Spatial.io [1] platform for creating immersive environments to host the focus group session. For the execution of the focus group, the Spatial.io platform was used, where two distinct virtual spaces were configured. The room shown in Figure 1 was designed to host participants and facilitate a collaborative activity. The space simulates a conventional classroom, featuring chairs, tables, screen-sharing equipment, and visual elements such as wall-mounted boards. Additionally, random objects were scattered throughout the environment to encourage reflections on the presence of out-of-context elements in the space.

Figure 1. Screenshot of Room 1 - collaborative task

In the collaborative task, participants worked in pairs to generate an image using Generative AI after watching a video. They used both platform resources and external tools, interacting via voice and text with avatars. The session explored usability, communication challenges, interaction, and accessibility. Spatial.io was chosen for its easy access, multiplatform support, and features for communication, space, and avatar customization, enhancing the immersive experience.

[1] Available at: https://spatial.io/ Accessed on: February 10, 2025

4.2. Focus Group Session: Execution in the Spatial.io Environment

As illustrated in Figure 2, the second room was set up for the session so that participants and moderators could sit in a circle with their avatars, clearly seeing one another and sharing the same field of view, as proposed by [Kinalski et al. 2017].

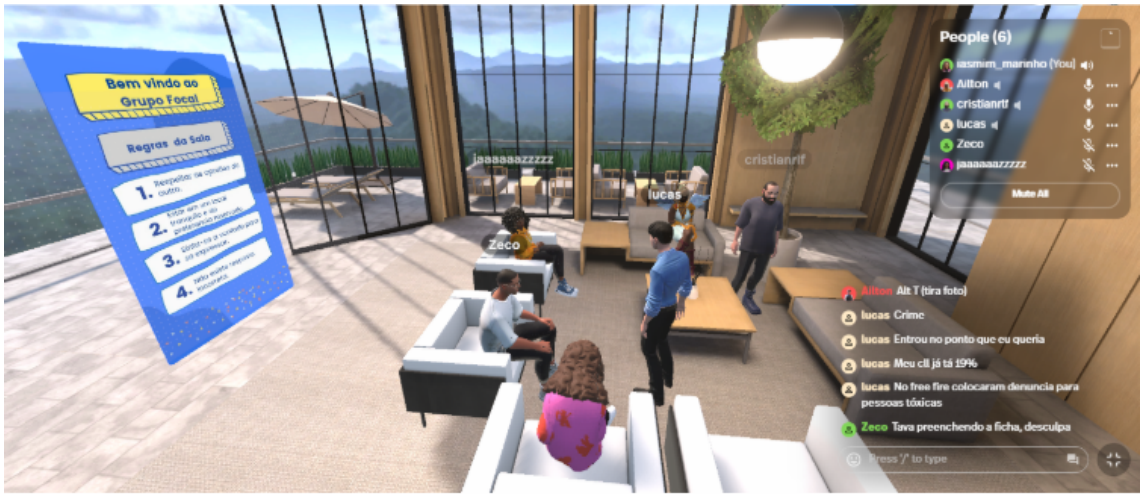

Figure 2. Screenshot of Room 2 - During the Focus Group Discussion

The focus group followed the planned steps, including questions designed to understand participants' perceptions of interaction, communication, teamwork, attention and focus, environmental features, and experiences with avatars. At the end of the session, a feedback form was administered to allow participants to evaluate the methodology, provide suggestions, or share any comments they may not have expressed during the discussion. Full details of the methodology, informed consent forms, and questionnaires used can be found in Appendix A.

5. Initial Results

According to the participants, the preference for using a 3D virtual environment for everyday tasks depends on the context and the goal of the activity. It was mentioned that for brief meetings, a conventional videoconferencing tool, such as Google Meet[2], would be more suitable. However, for more interactive activities, 3D virtual environments were considered more engaging. As P4 highlighted, "I think it ends up being a more fun experience".

Regarding focus and attention, all participants reported loss of concentration at some point during the initial dynamic. In addition to internal distractions, managing external distractions also proved challenging. It has been suggested that experiences using VR (Virtual Reality) headsets may yield better results in maintaining focus and attention throughout the activity, as the feeling of immersion is greater and external distractions tend to decrease.

Regarding design preferences, all participants favored the room in Figure 1, noting that despite its vibrant colors and visual elements, it did not cause sensory overload. In

[2]Available at: https://meet.google.com/ Accessed on: February 10, 2025

contrast, the second room was described as “suffocating” and lacking natural elements that could offer comfort, as noted by P1. Participants preferred larger, more open spaces, as P4 highlighted: “It gives the impression that this one is a spacious, free environment, whereas here it feels more limited”.

In terms of usability, participants found navigation easy and intuitive. Likely, their previous experience with other platforms contributed to their smooth interaction without usability issues. However, it was suggested that the avatar could perform a wider variety of movements, beyond walking, running, jumping, and dancing. For instance, the inclusion of actions like crouching or lying down was mentioned as a potential improvement that could enhance the experience and expand the possibilities for interaction within the virtual environment.

Participants were satisfied with the platform’s communication tools, noting that the chat and voice functionalities effectively facilitated interaction. They highlighted the usefulness of spatial audio for private communication, with P3 and P4 using this feature during the paired dynamic. As one participant stated: “I thought it was perfect because we can communicate through chat, we can talk via audio, and our mouth moves as we speak, it felt very realistic”.

Most participants felt represented by the avatar customization options, especially the ability to use a user’s photo. Initially, P1 felt less represented but was satisfied after exploring the features. However, the lack of avatars representing individuals with special needs, such as those using wheelchairs or crutches, was seen as an area for improvement, highlighting a need to enhance inclusivity.

Participants found the available expressions and actions insufficient for emotional communication. While bodily movements were varied, expressions for emotions like anger and sadness were lacking. P4 highlighted the need for real-time emotional reflection in avatars, and P3 suggested enabling dynamic facial expressions to enhance social interactions. Another suggestion put forward was the introduction of a “thought cloud,” where users could display their thoughts, including floating emojis visible above the avatar. As P4 explained, “You could choose an emoji that would appear next to your head. To place a sad or happy emoji. It’s a good way to mark it”.

There was disagreement about the impact of harassment in virtual environments, particularly when avatars invade personal space. P1 spoke about the effect of physical actions not being as impactful to the user, highlighting discomfort in audio and chat interactions, while P4 argued that immersion increases emotional sensitivity. One proposed solution was to restrict overlapping avatars while preserving personal space.

5.1. Thematic Analysis: Perceptions and Implications

Based on the initial results, a thematic analysis was conducted following the guidelines described by [Braun and Clarke 2006], as shown in Table 2. According to participants’ reports, it is important to create new forms of expression for avatars, so that each individual can express themselves in the way they wish. Among the suggestions raised, the creation of more realistic and diverse gestures that can express a variety of feelings, such as sadness, fear, anxiety, boredom and others, stands out.

Additionally, a proposal was made to create a feature that would allow avatars to

Table 2. Thematic Analysis

Step	Process	Outcome
1	Understanding the data	Transcription of the focus group, reading, and note-taking.
2	Initial coding	Expressing emotions, avatars, interaction challenges, attention and focus, usage contexts, and ethical challenges.
3	Themes	(1) Comparison with Traditional Videoconferencing; (2) Focus and Attention; (3) Environment Design and Sensory Overload; (4) Communication and Emotional Expression; (5) Avatar Customization; (6) Collaboration and Interaction; (7) Privacy and Security
4	Reviewing themes	Refinement based on the relevance to the research problem.
5	Defining and naming themes	Consolidation of the main themes.
6	Writing the paper	Analysis based on the defined themes.

express feelings and reactions through facial expressions. This tool would be especially useful for conveying emotions in real time during social interactions, providing a more immersive and realistic experience. Complementing this idea, participants suggested implementing a feature called "thought cloud", which would allow users to type thoughts and add emojis that would float above the avatar, promoting clearer communication.

Participants agreed that interacting through avatars felt more comfortable than conventional videoconferencing, especially with unfamiliar people. Avatars foster a sense of belonging and ease, encouraging open and relaxed communication—as P3 noted, "This environment really helped me to just open up, relax, and feel at ease with you all, as if I already knew you".

Participants also raised concerns about social issues like harassment and violations of personal integrity in virtual environments. They emphasized the need for preventive mechanisms, suggesting features such as reporting and banning tools, similar to those on gaming platforms, adapted for 3D spaces.

The participants expressed a preference for larger virtual environments with visual elements that promote comfort and security. This preference was evident in their choice of the first room, which was described as more spacious and open. In contrast, the second room was considered "suffocating" and lacking natural elements, reinforcing the importance of a user-centered design that balances visual and sensory stimuli to prevent discomfort [Othman et al. 2024].

On the other hand, excessive interactive elements were seen as distracting. For focus-driven tasks like meetings or learning, a minimalist design with spacious areas is preferred. As P4 noted, "If the video were a one-hour documentary, I would already be getting distracted (...) I wouldn't be able to pay attention to anything anymore", highlighting the need to reduce information overload for better concentration.

6. Discussion

The results highlight that individuals with ADHD have distinct needs compared to neurotypical users in the metaverse context, aligning with findings in the literature [Gualano et al. 2024]. This underscores the importance of enhancing existing features and developing new functionalities in platforms aiming to create the metaverse.

In the work of [Dionisio et al. 2013], the authors describe the metaverse as a promising space for avatar-mediated interactions in various contexts, such as the collaborative environment utilized in this study. However, the challenges identified in our research, such as focus loss in environments with too many interactive elements, support the observations of [Collins et al. 2024], which call for more minimalist designs tailored to the sensory needs of neurodivergent individuals.

On the other hand, reports of increased attention and focus by some participants align with the results found by [Meliande et al. 2024] in their study on the use of the metaverse in education. These findings complement those of [Lee et al. 2024], which highlight the potential of the metaverse to transform social and educational practices. It was noted that focus loss or gain may be linked to individual characteristics, as each participant reported specific challenges regarding focus and attention.

The suggestions for incorporating more diverse facial expressions and gestures for avatars are in line with proposals from [Gualano et al. 2024, Ribeiro et al. 2024, Zhang et al. 2025, Hatada et al. 2024], who advocate for avatar customization as a way to enhance self-expression and immersion in virtual environments. Additionally, the idea of a "thought cloud" as a tool for expressing emotions and mental states mirrors studies such as that of [Ghasemi et al. 2024], which emphasize the importance of visual and interactive resources to facilitate communication for individuals with ADHD.

7. Limitation and Threats to Validity

The study provides significant and novel initial results but has limitations. Expanding the sample to include a broader range of ages, genders, and metaverse experience would enhance representativeness. Including participants with a clinical ADHD diagnosis and adding a neurotypical control group would help mitigate biases and enable comparisons between cognitive profiles. Lastly, participants' limited familiarity with the platform may have influenced their perceptions.

8. Conclusion and Future Work

This research contributes to the understanding of avatar-mediated interaction and collaboration in the metaverse, with a focus on the perceptions of neurodivergent individuals, especially those with ADHD. Through a focus group conducted directly within the metaverse environment, we collected data from real users. Insights were gained and improvements were discussed for the development of more inclusive and accessible environments, aiming to support interaction and collaboration among diverse user profiles. Our study also contributes to the fields of collaborative systems and human-computer interaction by providing empirical data and practical recommendations. Future work includes: i) extending the familiarization period with the platform; ii) including a control group composed of neurotypical individuals; iii) conducting studies in collaboration with mental health professionals.

Acknowledgments

We thank all participants for their valuable contributions to this research. This study was partially supported by the Fundação de Amparo à Pesquisa do Estado da Bahia (FAPESB), under TIC Notice 013/2015, project TO 0008/2015.

References

Alimamy, S. (2024). Neurodiversity in the metaverse: Advancing customer augmentation and service accessibility. In *SaudiCIS 2024 Proceedings*, number 43.

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3:77–101.

Collins, J., Ko, W., Shende, T., Lin, S. Y., Jiang, L., Stevenson Won, A., and Azenkot, S. (2024). Exploring the accessibility of social virtual reality for people with adhd and autism: Preliminary insights. In *Proceedings of the 26th International ACM SIGACCESS Conference on Computers and Accessibility*, ASSETS '24, New York, NY, USA. Association for Computing Machinery.

Dionisio, J. D. N., III, W. G. B., and Gilbert, R. (2013). 3d virtual worlds and the metaverse: Current status and future possibilities. *ACM Comput. Surv.*, 45(3).

Faraone, S. V., Banaschewski, T., Coghill, D., Zheng, Y., Biederman, J., Bellgrove, M. A., Newcorn, J. H., Gignac, M., Al Saud, N. M., Manor, I., et al. (2021). The world federation of adhd international consensus statement: 208 evidence-based conclusions about the disorder. *Neuroscience & biobehavioral reviews*, 128:789–818.

Ghasemi, S., Behravan, M., Ubur, S. D., and Gračanin, D. (2024). Attention and sensory processing in augmented reality: Empowering adhd population. In *International Conference on Human-Computer Interaction*, pages 301–320. Springer.

Gualano, R. J., Jiang, L., Zhang, K., Shende, T., Won, A. S., and Azenkot, S. (2024). "i try to represent myself as i am": Self-presentation preferences of people with invisible disabilities through embodied social vr avatars. In *The 26th International ACM SIGACCESS Conference on Computers and Accessibility*, ASSETS '24, page 1–15. ACM.

Hatada, Y., Barbareschi, G., Takeuchi, K., Kato, H., Yoshifuji, K., Minamizawa, K., and Narumi, T. (2024). People with disabilities redefining identity through robotic and virtual avatars: A case study in avatar robot cafe. In *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*, CHI '24, New York, NY, USA. Association for Computing Machinery.

Ismail, L. and Buyya, R. (2023). Metaverse: A vision, architectural elements, and future directions for scalable and realtime virtual worlds. *arXiv preprint arXiv:2308.10559*.

Kinalski, D. D. F., Paula, C. C., Schnitzler, P. H., and et al. (2017). Focus group on qualitative research: experience report. *Revista Brasileira de Enfermagem*, 70(2):424–429.

Lee, L.-H., Braud, T., Zhou, P. Y., Wang, L., Xu, D., Lin, Z., Kumar, A., Bermejo, C., Hui, P., et al. (2024). All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda. *Foundations and trends® in human-computer interaction*, 18(2–3):100–337.

Meliande, R., Ribeiro, A., Arouca, M., Amorim, A., Pestana, M. C., and Vieira, V. (2024). Meta-education: A case study in academic events in the metaverse.

Meta (2022). What is the metaverse? Accessed: January 12, 2025.

Oliveira, J., Penido, C., Franco, A., Santos, T., and Silva, B. (2022). Especificidades do grupo focal on-line: uma revisão integrativa. *Ciência e Saúde Coletiva*, 27:1813–1826.

Othman, A., Chemnad, K., Hassanien, A. E., Tlili, A., Zhang, C. Y., Al-Thani, D., Altınay, F., Chalghoumi, H., S. Al-Khalifa, H., Obeid, M., Jemni, M., Al-Hadhrami, T., and Altınay, Z. (2024). Accessible metaverse: A theoretical framework for accessibility and inclusion in the metaverse. *Multimodal Technologies and Interaction*, 8(3).

Ribeiro, A., Vieira, V., Alves, L., and Maciel, C. (2024). Vishnu: An approach to support the personalization of self-expressive avatars using context-awareness. *International Journal of Human-Computer Studies*, 185:103243.

Stewart, K. and Williams, M. (2005). Researching online populations: the use of online focus groups for social research. *Qualitative Research*, 5(4):395–416.

Zallio, M. and Clarkson, P. J. (2022). Designing the metaverse: A study on inclusion, diversity, equity, accessibility and safety for digital immersive environments. *Telematics and Informatics*, 75:101909.

Zhang, K., Spencer, E. G. S., Manikandan, A., Li, A., Li, A., Yao, Y., and Zhao, Y. (2025). Inclusive avatar guidelines for people with disabilities: Supporting disability representation in social virtual reality.

A. Supplementary Data

The Supplementary Data are available online.[3]

[3]Supplementary Data - (Available URL)