

Developing Sensorimotor Art Games for Psoriatic Arthritis using Agile Storyboarding and Game Co-Design Processes

BÁRBARA RAMALHO*, MARTA VICENTE*, and HUGO ESCOBAR, Faculdade de Motricidade Humana/HUMAN Lab, Instituto Superior Técnico, Universidade de Lisboa, Portugal

SANDRA GAMA, HUMAN Lab, Instituto Superior Técnico and INESC-ID, Universidade de Lisboa, Portugal

JOSÉ A. DINIZ, CIPER, Faculdade de Motricidade Humana, Universidade de Lisboa, Portugal

VASILIS CHARISIS, Dept. of Electrical & Computer Engineering, Aristotle University of Thessaloniki, Greece

LEONTIOS J. HAJILEONTIADIS, Dept. of Biomedical Engineering & Biotechnology, Khalifa University/Dept. of Electrical & Computer Engineering, Aristotle University of Thessaloniki, UAE/Greece

SOFIA B. DIAS, CIPER, Faculdade de Motricidade Humana, Universidade de Lisboa, Portugal

Serious Games (SGs) have the potential to provide clinical care and enhance patients' quality of life, while incorporating an element of entertainment. As part of the iPROLEPSIS Horizon Europe project, we introduce two Sensorimotor Art games designed as SGs to assist Psoriatic Arthritis (PsA) patients in managing their symptoms. These SGs provide a platform for self-expression and pain relief through engaging in rhythmic puzzle activities. The co-design process for the proposed Sensorimotor Art games followed an agile methodology, involving 14 experts (including clinicians, researchers, and game developers), to gather feedback on game requirements, storyboards, and mechanics. From the thematic analysis of the transcribed discussion, four main themes emerged, namely: Clinical value (Theme 1), Motor skills and adaptation (Theme 2), Creative engagement (Theme 3), and Feedback and future directions (Theme 4). Clinical value underlines the therapeutic benefits of Sensorimotor Art games for pain distraction and emotional well-being. Motor skills and adaptation focus on hand/finger use and adapting games for older patients. Creative engagement emphasizes fostering creativity, a positive environment, and goal achievement. Finally, Feedback and future directions highlight the importance of continuous feedback and occupational therapists' involvement in coming sessions. The development of Sensorimotor Art games lays the groundwork for digital interventions to alleviate psychological distress and improve fine motor symptoms in PsA patients. At the same time, these SGs can also provide insights to healthcare providers and policymakers for developing future digital solutions tailored to PsA patients.

CCS Concepts: • **Human-centered computing** → **User centered design; HCI design and evaluation methods.**

Additional Key Words and Phrases: Serious Games, Psoriatic Arthritis, Agile methodology, Game Co-design, Storyboarding, Sensorimotor Art Games

ACM Reference Format:

Bárbara Ramalho, Marta Vicente, Hugo Escobar, Sandra Gama, José A. Diniz, Vasilis Charisis, Leontios J. Hajileontiadis, and Sofia B. Dias. 2024. Developing Sensorimotor Art Games for Psoriatic Arthritis using Agile Storyboarding and Game Co-Design Processes. In *Proceedings of 11th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion (DSAI '24)*. ACM, New York, NY, USA, 10 pages. <https://doi.org/XXXXXXX.XXXXXXX>

*Both authors contributed equally to this research.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.

© 2024 Copyright held by the owner/author(s). Publication rights licensed to ACM.

Manuscript submitted to ACM

1 INTRODUCTION

Serious games (SGs) are interactive digital applications designed for purposes beyond entertainment [2], combining enjoyment with skills training, social impact, and health improvement. Common types of SGs include educational games [35], training simulations [21], and exergames that incorporate physical activities [6, 24, 29, 31]. SGs enhance healthcare experiences by making them more enjoyable and interactive (game part) while addressing specific health concerns (serious part) [2]. Moreover, effective SG design requires a rigorous iterative development process [20, 40] to ensure usability and efficacy. This study introduces a SG co-design process tailored for individuals with Psoriatic Arthritis (PsA), a chronic autoimmune condition characterized by joint pain, stiffness, and skin inflammation [39]. More specifically, PsA's unpredictable flare-ups pose challenges in daily activities, impacting both physical and emotional well-being [12]. PsA is a degenerative rheumatic disease that severely affects joint mobility and range of motion, and is also characterised by chronic pain and subsequent psychological distress [15]. Patients with PsA deal with various symptoms, ranging from physical impairment due to joint erosion, to depression from dealing with the daily debilitation of the disease and chronic pain. Stress and anxiety are common causes of flare-ups, which can worsen the physical symptoms of PsA [22] and also cause further emotional deregulation. There has been some research into the use of digital solutions for PsA management, but most have involved disease tracking through digital applications, without offering a concrete solution to alleviate symptoms [11]. For instance, the Psorcast project [13] created an app to help clinicians and patients track the progression of PsA and predict future outcomes, but it still does not provide patients with an intervention to relieve symptoms. Other studies focus on the physical aspects of the disease, such as using exercises to practice range of motion in the wrist [3], but fail to address the psychological symptoms which contribute greatly to patients' body inflammation.

Despite extensive research on arthritis and rehabilitation methods, there is a gap in SGs specifically designed for PsA. This study aims to investigate the design process of the proposed Sensorimotor Art games to alleviate PsA symptoms. In particular, sensorimotor art therapies have shown the potential to combine physical movement with creative activities to enhance mental and physical well-being [19, 30]. At the same time, these therapies can improve coordination skills, reduce stress, and provide a creative outlet, benefiting individuals with chronic pain, neurological disorders, and emotional challenges [23, 32]. Inspired by these approaches, we introduce Sensorimotor Art games as part of the Horizon Europe iPROLEPSIS project (<https://www.iprolepsis.eu>). More specifically, by integrating (fine motor) movements and art, the proposed Sensorimotor Art games can potentially help PsA patients focus on the creative process, offering relief from pain/discomfort while fostering a sense of accomplishment and joy. Adopting an agile co-design methodology [37], we present here the design process of the proposed Sensorimotor Art game that integrates input from healthcare professionals, researchers, and technical experts, enabling us to gather essential guidelines for the proposed SG design.

This paper is structured as follows: Section 2 presents related work and existing literature. Section 3 describes the methodology including study context, participants, and data collection. Section 4 presents the results and discussion. Section 5 concludes the article.

2 RELATED WORK

As a degenerative rheumatic disease, the symptomatology of PsA is diverse and diminishes patients' quality of life through both physical and psychological burden [14, 34]. Integrating this mind-body relationship is critical for effective interventions [26] with elevated stress levels contributing to increased inflammation in the nervous system [5], while

low joint mobility results in decreased range of motion and difficulty performing daily activities. Traditionally, stress management has relied on a combination of approaches, including conventional methods such as yoga and meditation [17]. While these methods can provide relief, they do not address the full range of emotional challenges faced by people with PsA. As a result, other alternative therapies have gained attention for their potential to complement traditional interventions and improve the overall well-being of people with similar conditions. As an example, games have emerged as a strategy for managing stress and anxiety, with studies highlighting the positive influence of puzzle-based video games such as Tetris, Angry Birds, and Bejeweled [27]. Puzzle-based games, characterized by short duration and low cognitive load, have been shown to effectively reduce anxiety through the use of stress-reducing components such as neutral themes, to avoid triggering negative emotions, and a progressive nature that promotes a sense of accomplishment [16]. In addition, art therapy offers an alternative solution by providing individuals with a creative avenue to express their emotions, reduce stress, and promote a sense of empowerment and self-discovery [1]. The authors demonstrated the connection between art therapy and stress-relieving mobile games through "Color Me," a puzzle game featuring six key mechanics (i.e., dissociative game themes, progressive challenges, game interactions, relaxing ambiance, self-regulating game pace, and meditative game environments), designed to create a relaxing and meditative digital environment [1]. Du et al. [8] also highlighted the importance of digital art therapy in psychotherapy and identified a gap in research when it comes to applying findings from traditional art therapy to digital environments. To bridge this gap, they collaborated with five professional art therapists and conducted extensive research to understand how digital experiences could be less distressing for users. Their findings revealed that the key needs of participants were to cultivate emotional resilience and to reduce and resolve conflict and distress. In response to these needs, they developed 'DeepThink', an AI-infused art tool designed to lower the threshold for art-making and facilitate self-expression for participants [8]. In addition to addressing the psychological dimension, research on PsA emphasizes the importance of managing joint stiffness through specific movements to enhance fine motor skills [9]. Studies recommend a range of exercises tailored to target these specific areas, including pinch in-out movements, wrist rotations, and finger sliding exercises [10]. These exercises are designed to improve joint flexibility, reduce stiffness, and enhance overall dexterity, thereby mitigating the impact of PsA on patients' daily functioning and quality of life. While not the primary focus of the proposed Sensorimotor Art games, integrating fine motor movements (e.g., finger pinching) through interactive actions on a digital touchscreen while playing the games can potentially help individuals with PsA to maintain/improve finger dexterity, strength, control, and overall mobility.

To the best of our knowledge, no SG has been specifically designed to address the multifaceted needs of people with PsA, particularly the connection between psychological health and self-expression. In this context, two Sensorimotor Art games are introduced here for the first time, designed to promote relaxation, distract from pain, encourage creative self-expression, evoke positive emotions, and potentially enhance the quality of life for PsA patients.

3 METHODOLOGY

3.1 Study context

This study is part of the iPROLEPSIS Horizon Europe research project, which aims to explore the transition from health to PsA through multi-source data analysis, leading to a novel personalized digital care ecosystem. Within the iPROLEPSIS framework, the project aims to design, develop, and validate innovative digital biomarkers for assessing and intervening in PsA using an AI-Personalized Game Suite (AI-PGS). The AI-PGS is being collaboratively developed with key stakeholders and has a multi-targeted approach to addressing PsA symptoms. It offers intervention activities

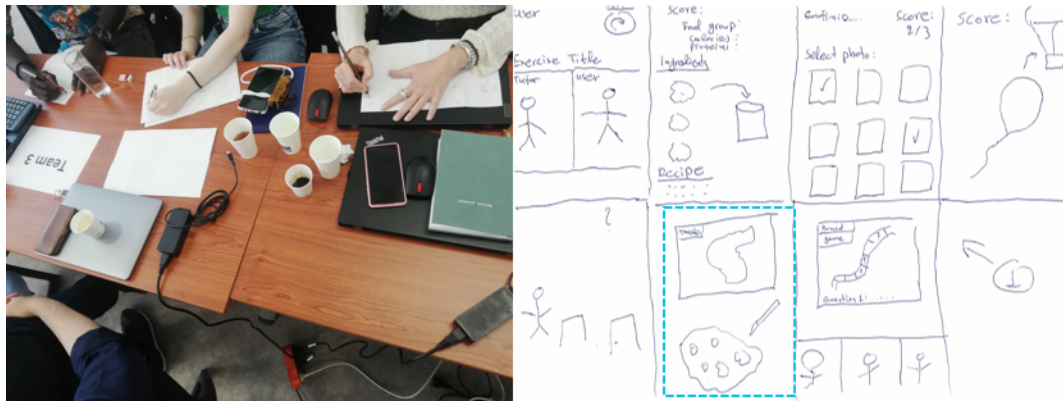


Fig. 1. Co-design session involving PsA patients during the ideation process of the games using Crazy8s methodology. The initial sketch of the Sensorimotor Art game category is marked with dashed blue square.

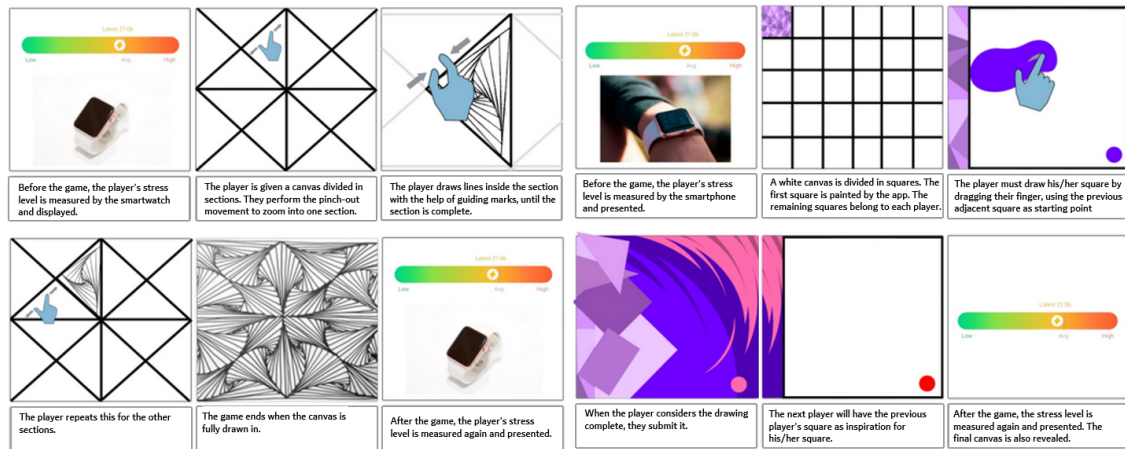


Fig. 2. Left six blocks: Screenshot of the storyboard for the Sensorimotor Art game “Illusion Doodle”, featuring players creating complex patterns by repeatedly using pinch in/out touchscreen movements. Right six blocks: Screenshot of the storyboard for the Sensorimotor Art game “One Art,” where players collaboratively create mosaics by using dragging touchscreen movements based on prompts from previous players. Both storyboards also include displays of smartwatch connection, intended to measure real-time stress levels before and after gameplay.

to improve breathing, mobility, stiffness, balance, coordination, fitness, diet, and mood. The AI-PGS adopts a holistic approach to managing stress, anxiety, fatigue, and pain through various categories of SGs, including Sensorimotor Art Games, Exercise Games, Dietary Games, Emotional Games, No Pain Games, and Breathing Games. The present study’s focus on Sensorimotor Art Games highlights the importance of engaging patients in creative and therapeutic activities that integrate sensorimotor processes with artistic expression to reduce inflammation and manage the discomfort associated with PsA symptoms.

Table 1. Game Design Document including structural characteristics of the proposed Sensorimotor Art games

Title	Game Concept	Game Mechanisms	Visual Design	Clinical Value
Illusion Doodle	The player has a digital canvas with sections drawn in. His/her first action is to select one section to zoom in and work on. After that, a starting and a finishing point appears and the player must draw a line uniting them by using dragging movement. This continues until the section is complete. Afterwards, the player returns to the full canvas and chooses another section, repeating the process until the entire complex pattern is drawn in.	The player taps in a section to zoom it and drags fingers to draw lines. The game ends when the canvas is entirely drawn in.	Minimalist design. Black and white color theme. Patterns reminiscent of oriental-themed vector graphics.	Providing creative output that can distract from pain and discomfort, while also improving and/or maintaining fine motor skills via pinch in/out touchscreen movements, potentially reducing stiffness and enhancing finger dexterity, strength, and control.
One Art	The player is given a square to draw in, adjacent to the edge of the previous players painted square. The player completes their square, using the previous players design as an inspiration. This pattern repeats itself, with the next player always having access to edges of the art the previous one. At the end, the whole canvas is revealed to all users.	The player taps on the touchscreen to pick the color, and drags their fingers along the screen to draw. The player is given a sneak peek of someone else's drawing and his/her drawing will be shared as well, but it never requires synchronous interaction.	The whole colour spectrum is available and at user's choice. Patterns and visual elements are also entirely up to the player's imagination.	Offering creative and collaborative engagement to distract from pain and discomfort, while supporting fine motor skills through dragging touchscreen movements, potentially enhancing finger dexterity, strength, and control.

3.2 Sensorimotor Art games agile design process

The design process of the proposed games followed an Agile approach [37], which prioritizes early feedback to iteratively refine game ideas and prototypes. Initially, the Crazy-8s ideation methodology [18] was adopted, where stakeholders (including patients, clinicians, researchers, and technicians) quickly sketched ideas for different game categories of the AI-PGS, including the Sensorimotor Art games category (Figure 1). From this perspective, initial game ideas were brainstormed and discussed to identify the requirements and expectations of various stakeholders. This session also led to the creation of a Game Design Document (GDD), which outlines several important aspects of the proposed Sensorimotor Art games, such as the game concept, game mechanics, design, controls, and clinical value (see Table 1). Subsequent agile sessions involved healthcare professionals, researchers, and technical experts as co-creators and co-designers (see Section 3.3), using the storyboard technique [4], to discuss the proposed Sensorimotor Art games (see Figure 2).

3.3 Study Participants and Data collection

The participants were selected through purposive sampling, by intentionally inviting individuals of relevant knowledge-field to participate. The involvement of researchers and clinical/technical experts from the iPROLEPSIS Consortium brought relevant multidisciplinary perspectives and expertise enriching the discussions. The participation in the session was entirely voluntary, and participants were not offered any compensation for their involvement. Participants provided verbal informed consent before participating in the study. The co-creation session took place on October 2023 and was

Table 2. Demographic characteristics of the study participants

Profile	Participants (n)	Age (yrs) (mean \pm std)	Sex (n of females)	Years of experience (mean \pm std)	Tech literacy (n of participants)
Rheumatologist	6	36.3 \pm 7.2	6	10.1 \pm 7.0	Basic=4 Intermediate=2 Advanced= 0
Technical Experts	4	44.8 \pm 7.9	0	15.6 \pm 4.3	Basic=0 Intermediate=0 Advanced= 4
Researchers	4	28.5 \pm 7.0	3	4.75 \pm 4.9	Basic=0 Intermediate=0 Advanced= 4

conducted online, using the Microsoft Teams platform. The session had a group size of 14 experts (from three different countries, i.e., UK, Greece, and Portugal), including partners from research (n=4), healthcare (n=6) and technology (n=4) sectors within the iPROLEPSIS Consortium (see Table 2). Audio recordings were made during the session, which were later transcribed to verbatim and pseudo-anonymized to preserve confidentiality. The online setting ensured that all participants could actively engage in the discussions. The session was guided by a female researcher with expertise in qualitative research (last author SD), primarily posing questions and encouraging group discussions to elicit participants' opinions and experiences. Transcriptions were pseudonymized to maintain anonymity. To enhance the participants' comprehension of the session topics, relevant storyboards related with each Sensorimotor Art game were presented (see Figure 2). The session followed a script with main questions designed to explore the opinions of participants regarding the design of the proposed Sensorimotor Art games. A dedicated time frame of 90 minutes was allocated for this session, allowing for in-depth discussions and exploration of main topics.

3.4 Proposed Sensorimotor Art games

Two different Sensorimotor Art games were designed, i.e., the "Illusion Doodle" and the "One Art" games, both sharing a similar genre that follows a puzzle game logic. At the beginning of each Sensorimotor Art game, the option of a smartwatch connection is displayed on the screen to measure real-time stress levels before and after each play session (see Figure 2). In the "Illusion Doodle" Sensorimotor Art game, the player/patient has a digital canvas on the smartphone's screen, divided into different sections from which the PsA patient selects one to start with. Once the game starts, two dots appear, and the player/patient promptly connects them, drawing a line on the canvas. This process repeats consecutively until the entire section is finished. As the player/patient progresses and closes all the sections, a complex pattern gradually emerges, providing a sense of satisfaction and beauty upon completion (see Figure 2-Left). In the "One Art" Sensorimotor Art, the player/patient is invited to paint a square canvas, adjacent to the edge of a previous players' square. The objective is for players/patients to engage their creativity in creating a painting, starting with a small section of another player's drawing as a cue. After completing their square, the process repeats, allowing the next player/patient to access the edges of the previous player's artwork. In the end, the whole canvas is revealed to the players/patients, showcasing how each drawing influenced the next and how the entire painting fits together (see Figure 2-Right). Designed for both iOS and Android operating systems, the Sensorimotor Art games do not include a scoring system; instead, game progression is based on the collection and sharing of completed artworks. The proposed games present similar interaction controls, with players/patients using a touchscreen to draw on the digital canvas. Both games incorporate physiological feedback (i.e., before and after the session, the player's stress level is measured by

the smartwatch and shown to the player). In general, the audio design consists of simple and relaxing background music. Both Sensorimotor Art games provide a psychologically soothing experience by offering continuous and methodical tasks that establish a relaxing rhythm. Simultaneously, players/patients are encouraged to express their creativity through visually satisfying artwork. Furthermore, these games encourage the practice of fine motor skills (such as finger sliding, dragging, pinching in/out, and zooming), which are crucial for individuals with PsA who may encounter joint stiffness and limited (finger/hand) mobility.

4 RESULTS AND DISCUSSION

The co-creation session included six healthcare professionals, four technical experts, three observers and one facilitator (14 participants in total, see Table 2). The mean age of Rheumatologists was 36.3 ± 7.2 years. All were females with over ten years of experience, and the majority had a basic level of technology literacy. The mean age of the technical experts was 44.8 ± 7.9 years. All were males with over 15 years of experience, and all possessed advanced-level technology literacy. The mean age of researchers was 28.5 ± 7.0 years, including three females, with over four years of experience, and all possessed advanced-level technology literacy (see Table 2).

Four main themes emerged from the thematic analysis, namely: Clinical value (Theme 1), Motor skills and adaptation (Theme 2), Creative engagement (Theme 3), and Feedback and future directions (Theme 4). Various subthemes were derived from the main themes identified in the session to explore the discussions further. The level of agreement between the two researchers (first and last authors) in identifying these subthemes was assessed using the Kappa statistic. The obtained score of 0.92 indicates an almost perfect agreement between the two researchers. At the points of doubt, a discussion between the researchers resulted in a reworked text, arriving at a 100% final agreement across all subthemes. Overall, the co-creation session highlighted several key findings. Clinical value, with subthemes of pain distraction and emotional well-being, underlined the therapeutic benefits of the Sensorimotor Art games. Motor skills and adaptation focused on using hands and the need for game adaptations for older patients. Creative engagement emphasized promoting creativity, fostering a positive environment, and providing a sense of achievement. Lastly, feedback and future directions highlighted the importance of continuous feedback, involving specialists such as occupational therapists, and planning future development meetings. The main findings for each identified theme are briefly presented.

Clinical Value (Theme 1). The discussion frequently highlighted the importance of the games' clinical value. A significant focus was on using the Sensorimotor Art games for pain distraction and promoting emotional well-being. For instance, *"We want to understand from the clinical value if this game can be used for pain distraction; the idea behind is to promote the emotional well-being during the game and to create a positive environment"* (Researcher #1). In fact, some studies have already successfully explored the use of mobile apps and games for pain distraction, suggesting significant potential for these digital solutions to improve patients' emotional health [36, 38].

Motor Skills and Adaptation (Theme 2). A recurring topic during the session was related with the physical interaction required by the Sensorimotor Art games, particularly concerning fine motor skills and the use of hands/fingers, such as the pinching movement. There was also an emphasis on the need to adapt the proposed games for different patient profiles. For example, one Rheumatologist mentioned: *"Some patients are dependent on very small motricity of the hands...especially older patients even if they don't have active psoriatic arthritis, they may have osteoarthritis and this might be a little bit difficult for them. So we might have to adapt the games to the profile."* (Rheumatologist #4). In addition, one technical expert added, *"The patients have to play the game, then we analyze their scores and use an AI algorithm to determine the best level of difficulty for the patient."* (Technical expert #1). This is in line with other research that

has explored game adaptations to patient profiles in various contexts [28], from physical personalization to emotion-adapting neurogames that change according to the player's emotions [7]. Such adaptations would allow the games to adjust to individual patient profiles, increasing their effectiveness through personalization of the movements required during interaction with the interface. This idea could be further supported by the data collected from the smartwatch, potentially turning the proposed personalized games into multimodal digital biomarkers for health monitoring.

Creative Engagement (Theme 3). The Sensorimotor Art games aim to enhance creative skills and provide a positive and engaging environment for the patients. One of the positive aspects highlighted by the participants was the sensibility and beauty of the Sensorimotor Art games, potentially triggering positive emotions. One participant underlined: *"I think the creative aspects of these games are very good and there is a sense... of achievement at the end and you're looking at something beautiful"* (Rheumatologist #4). The mention of the sense of accomplishment indicates that the Sensorimotor Art games can eventually sustain player engagement over time, making them less likely to be perceived as uninteresting or boring [25], encouraging the sustainability of the clinical intervention. The positive effect of adopting a calming aesthetic is also highlighted in other studies that link visual stimuli to emotional responses [1].

Feedback and Future Directions (Theme 4). The importance of feedback from occupational therapists and the involvement of a broader range of healthcare professionals was also discussed, as one Rheumatologist noted, *"this maybe is not our usual kind of focus clinically and whether it's worthless also asking some occupational therapists or somebody else to be involved to have some additional representation to get their input as well."* (Rheumatologist #2). This emphasizes the need to engage with a multidisciplinary team with a wide range of expertise. In particular, occupational therapists can offer insights into the impact of game mechanics on joint health and disease progression, ensuring that the games support rather than hinder physical rehabilitation [33].

The main findings described here will inform the next steps in the iPROLEPSIS project's game design process. Overall, the collected feedback from researchers and clinical/technical experts revealed several concerns and suggestions regarding the proposed Sensorimotor Art games. To address these issues and improve the Sensorimotor Art games, the following actions will be implemented:

- **Including Patients in Co-Design Sessions:** Although the initial ideation process during the first co-creation session (Figure 1) included patients, the results of the session presented here involved only clinical and technical experts. In future sessions, it is our intention to include patients as their feedback is crucial to the development of the games, ensuring they meet user preferences and needs, as well as maintaining clinical relevance.
- **Validating Clinical Relevance:** The Sensorimotor Art games will need to undergo implementation and rigorous testing to understand their impact on patient well-being. Future metrics for user research testing include data collection from smartwatches (stress levels), game interactions, and patient reports.
- **Identifying Digital Biomarker Opportunities:** From the data collected by the games, smartwatch biosignals, and touchscreen interactions, it would be valuable to identify patterns that could be translated into biomarkers of patient health. For example, we could attempt to find patterns in the player's stress levels and cardiac rhythms and provide patient alerts and health status updates.
- **Maintaining Aesthetic Balance:** The Sensorimotor Art games have been very well received for their aesthetics. Considering the importance of design in user experience and emotion regulation, we aim to continuously refine this aspect of the games.
- **Combining Entertainment with Clinical Relevance:** In addition to serving as clinical tools, the goal is for the proposed Sensorimotor Art games to be fun and engaging for PsA patients. To achieve this, we focus on

balancing these two aspects, ensuring that the games not only provide pain relief to patients (serious part) but are also enjoyable and intuitive to play (game part).

5 CONCLUSION

Sensorimotor Art games show potential for enhancing the well-being of individuals with PsA by promoting creative engagement and serving as a distraction from pain and discomfort. This study introduces two Sensorimotor Art serious games developed using agile methodology and co-design principles, with the involvement of researchers and clinical/technical experts. The research explores the co-creation process, presenting initial results through storyboards and game visualizations. Future steps involve collecting more patient feedback and conducting real-world user testing to assess feasibility, acceptability, and user satisfaction.

ACKNOWLEDGMENTS

The authors would like to thank and acknowledge all members of the iPROLEPSIS Consortium for their valuable contributions. This work received funding from the European Union under the Horizon Europe Grant agreement no. 101095697 (iPROLEPSIS: Psoriatic Arthritis Inflammation Explained through Multi-Source Data Analysis guiding a Novel Personalised Digital Care Ecosystem). Disclaimer: Views and opinions expressed are, however, those of the authors only and do not necessarily reflect those of the European Union or European Health and Digital Executive Agency. Neither the European Union nor the European Health and Digital Executive Agency can be held responsible for them.

REFERENCES

- [1] Vasundhara Agrawal, Varnika Naik, Mayuri Duggirala, and Sandeep Athavale. 2020. Color Me: A Game based on art therapy for mental health. In *Extended Abstracts of the 2020 Annual Symposium on Computer-Human Interaction in Play*. 158–162.
- [2] Polona Caserman, Katrin Hoffmann, Philipp Müller, Marcel Schaub, Katharina Straßburg, Josef Wiemeyer, Regina Bruder, Stefan Göbel, et al. 2020. Quality criteria for serious games: serious part, game part, and balance. *JMIR serious games* 8, 3 (2020), e19037.
- [3] Fabrizia Corona, Rocco M Chiuri, Giovanni Filocamo, Michaela Foà, Pier Luca Lanzi, Amalia Lopopolo, and Antonella Petaccia. 2018. Serious games for wrist rehabilitation in juvenile idiopathic arthritis. In *2018 IEEE Games, Entertainment, Media Conference (GEM)*. IEEE, 35–42.
- [4] Brock Craft and Paul Cairns. 2009. Sketching sketching: outlines of a collaborative design method. *People and Computers XXIII Celebrating People and Technology* (2009), 65–72.
- [5] Kristen Davies, Emma Dures, and Wan-Fai Ng. 2021. Fatigue in inflammatory rheumatic diseases: current knowledge and areas for future research. *Nature Reviews Rheumatology* 17, 11 (2021), 651–664.
- [6] Sofia B Dias, José A Diniz, Dhaval Trivedi, Elias Konstantinidis, Theodore Savvidis, P Bamidis, Sevasti Bostantzopoulou, Hagen Jaeger, Michael Stadtschnitzer, V Charisis, et al. 2018. On exploring design elements in assistive serious games for Parkinson's disease patients: the i-PROGNOSIS exergames paradigm. In *2018 2nd international conference on Technology and Innovation in Sports, Health and Wellbeing (TISHW)*. IEEE, 1–8.
- [7] Sofia B Dias, Herbert F Jelinek, and Leontios J Hadjileontiadis. 2023. Multisensed Emotions as Adaptation Controllers in Human-to-Serious NeuroGames Communication. *IEEE Communications Magazine* (2023).
- [8] Xuejun Du, Pengcheng An, Justin Leung, April Li, Linda E Chapman, and Jian Zhao. 2024. DeepThInk: Designing and probing human-AI co-creation in digital art therapy. *International Journal of Human-Computer Studies* 181 (2024), 103139.
- [9] Christine M Galante. 2020. Supporting young adults with psoriatic arthritis. *Nursing* 2023 50, 11 (2020), 24–31.
- [10] Irina Gessl, Mihaela Popescu, Victoria Schimpl, Gabriela Supp, Thomas Deimel, Martina Durechova, Miriam Hucke, Michaela Loiskandl, Paul Studenic, Michael Zauner, et al. 2021. Role of joint damage, malalignment and inflammation in articular tenderness in rheumatoid arthritis, psoriatic arthritis and osteoarthritis. *Annals of the Rheumatic Diseases* 80, 7 (2021), 884–890.
- [11] Ivan Giovannini, Philipp Bosch, Christian Dejaco, Gabriele De Marco, Dennis McGonagle, Luca Quartuccio, Salvatore De Vita, Enzo Errichetti, and Alen Zabotti. 2021. The digital way to intercept psoriatic arthritis. *Frontiers in medicine* 8 (2021), 792972.
- [12] Tania Gudu and Laure Gossec. 2018. Quality of life in psoriatic arthritis. *Expert review of clinical immunology* 14, 5 (2018), 405–417.
- [13] Simon Hackett, Alexis Ogdie, and Laura Coates. 2022. Psoriatic arthritis: prospects for the future. *Therapeutic Advances in Musculoskeletal Disease* 14 (03 2022), 1759720X2210867. <https://doi.org/10.1177/1759720X221086710>
- [14] Merete Lund Hetland. 2020. Psoriatic arthritis: still room for improvement. *The Lancet* 395, 10235 (2020), 1463–1465.

- [15] M Elaine Husni, Joseph F Merola, and Sara Davin. 2017. The psychosocial burden of psoriatic arthritis. In *Seminars in arthritis and rheumatism*, Vol. 47. Elsevier, 351–360.
- [16] Ming-Yueh Hwang, Jon-Chao Hong, Tsui-Fang Hsu, and Yu-Ju Chen. 2011. The relation between students' anxiety and interest in playing an online game. In *2011 IEEE International Games Innovation Conference (IGIC)*. IEEE, 37–39.
- [17] Ranil Jayawardena, Priyanga Ranasinghe, Himansa Ranawaka, Nishadi Gamage, Dilshani Dissanayake, and Anoop Misra. 2020. Exploring the therapeutic benefits of pranayama (yogic breathing): a systematic review. *International journal of yoga* 13, 2 (2020), 99–110.
- [18] Jake Knapp, John Zeratsky, and Braden Kowitz. 2016. *Sprint: How to solve big problems and test new ideas in just five days*. Simon and Schuster.
- [19] Ratcharin Kongkasuwan, Kotchakorn Voraakhom, Prim Pisolayabutra, Pichai Maneechai, Jiraporn Boonin, and Vilai Kuptniratsaikul. 2016. Creative art therapy to enhance rehabilitation for stroke patients: a randomized controlled trial. *Clinical rehabilitation* 30, 10 (2016), 1016–1023.
- [20] Craig Larman. 2004. *Agile and iterative development: a manager's guide*. Addison-Wesley Professional.
- [21] Ioanna K Lekea, Dimitrios G Stamatelos, and Stefanos Giannopoulos. 2022. Improve Aircraft Pilots' Training Using Structural Failure Incidents: A Serious Game Approach. In *International Symposium on Aviation Technology, MRO, and Operations*. Springer, 75–80.
- [22] Ennio Lubrano, Silvia Scriffignano, Kurt De Vlam, Mario Ronga, Fabio Massimo Perrotta, and Rik Lories. 2023. Triple jump for the optimal management of psoriatic arthritis: diet, sleep and exercise—a review. *RMD open* 9, 3 (2023), e003339.
- [23] Vija B Lusebrink. 2004. Art therapy and the brain: An attempt to understand the underlying processes of art expression in therapy. *Art Therapy* 21, 3 (2004), 125–135.
- [24] Dunia J Mahboobeh, Sofia B Dias, Ahsan H Khandoker, and Leontios J Hadjileontiadis. 2022. Machine learning-based analysis of digital movement assessment and ExerGame scores for Parkinson's disease severity estimation. *Frontiers in Psychology* 13 (2022), 857249.
- [25] Aaron S Miller, Joseph A Cafazzo, and Emily Seto. 2016. A game plan: Gamification design principles in mHealth applications for chronic disease management. *Health informatics journal* 22, 2 (2016), 184–193.
- [26] Thao Thi Nguyen, Christian G Jensen, Lina Khoury, Bent Deleuran, Esther S Blom, Thomas Breinholt, Robin Christensen, and Lone Skov. 2021. Effectiveness of mind–body intervention for inflammatory conditions: results from a 26-week randomized, non-blinded, parallel-group trial. *Journal of Clinical Medicine* 10, 14 (2021), 3107.
- [27] Federica Pallavicini, Alessandro Pepe, and Fabrizia Mantovani. 2021. Commercial off-the-shelf video games for reducing stress and anxiety: systematic review. *JMIR mental health* 8, 8 (2021), e28150.
- [28] Panagiotis D Paraschos and Dimitrios E Koulouriotis. 2023. Game difficulty adaptation and experience personalization: A literature review. *International Journal of Human–Computer Interaction* 39, 1 (2023), 1–22.
- [29] Despoina Petsani, Evdokimos Konstantinidis, Aikaterini-Marina Katsouli, Vasiliki Zilidou, Sofia B Dias, Leontios Hadjileontiadis, and Panagiotis Bamidis. 2022. Digital biomarkers for well-being through exergame interactions: exploratory study. *JMIR Serious Games* 10, 3 (2022), e34768.
- [30] Hamidreza Sadeqi, Kobra Rahzani, Davood Hekmatpou, and Siamak Rakei Isfahani. 2024. The effect of adult coloring (mandala pattern) on pain and anxiety associated with dressing changes in burn patients: A randomized controlled trial. *Scars, Burns & Healing* 10 (2024), 20595131231218062.
- [31] Theodore P Savvidis, Evdokimos I Konstantinidis, Sofia B Dias, José A Diniz, Leontios J Hadjileontiadis, and Panagiotis D Bamidis. 2018. Exergames for Parkinson's disease patients: how participatory design led to technology adaptation. In *Data, Informatics and Technology: An Inspiration for Improved Healthcare*. IOS Press, 78–81.
- [32] Apoorva Shukla, Sonali G Choudhari, Abhay M Gaidhane, and Zahiruddin Quazi Syed. 2022. Role of art therapy in the promotion of mental health: a critical review. *Cureus* 14, 8 (2022).
- [33] Patricia Siegel, Melissa Tencza, Beverly Apodaca, and Janet L Poole. 2017. Effectiveness of occupational therapy interventions for adults with rheumatoid arthritis: a systematic review. *The American journal of occupational therapy* 71, 1 (2017), 7101180050p1–7101180050p11.
- [34] Ho So and Lai-Shan Tam. 2021. Cardiovascular disease and depression in psoriatic arthritis: multidimensional comorbidities requiring multidisciplinary management. *Best Practice & Research Clinical Rheumatology* 35, 2 (2021), 101689.
- [35] Ali Soyoof, Barry Lee Reynolds, Rustam Shadiev, and Boris Vazquez-Calvo. 2024. A mixed-methods study of the incidental acquisition of foreign language vocabulary and healthcare knowledge through serious game play. *Computer Assisted Language Learning* 37, 1-2 (2024), 27–60.
- [36] Nora Suleiman-Martos, Rubén A García-Lara, María J Membrive-Jiménez, Laura Pradas-Hernández, José L Romero-Béjar, Germán Domínguez-Vías, and José L Gómez-Urquiza. 2022. Effect of a game-based intervention on preoperative pain and anxiety in children: A systematic review and meta-analysis. *Journal of Clinical Nursing* 31, 23-24 (2022), 3350–3367.
- [37] Francesco Tassarolo, Despoina Petsani, Valentina Conotter, Giandomenico Nollo, Giuseppe Conti, Maria Nikolaidou, Giulia Onorati, Panagiotis D Bamidis, and Evdokimos I Konstantinidis. 2022. Developing ambient assisted living technologies exploiting potential of user-centred co-creation and agile methodology: The CAPTAIN project experience. *Journal of Ambient Intelligence and Humanized Computing* (2022), 1–16.
- [38] Simon E Thurnheer, Isaac Gravestock, Giuseppe Pichierri, Johann Steurer, and Jakob M Burgstaller. 2018. Benefits of mobile apps in pain management: systematic review. *JMIR mHealth and uHealth* 6, 10 (2018), e11231.
- [39] Filip Van den Bosch and Laura Coates. 2018. Clinical management of psoriatic arthritis. *The Lancet* 391, 10136 (2018), 2285–2294.
- [40] Sergio J Viudes-Carbonell, Francisco J Gallego-Durán, Faraón Llorens-Largo, and Rafael Molina-Carmona. 2021. Towards an iterative design for serious games. *Sustainability* 13, 6 (2021), 3290.

Received June 20, 2024; revised XX XXXX 2024; accepted XX XXXX 2024