"The Kite" Breathing Serious Game: Agile Co-Design for Psoriatic Arthritis

Bárbara Ramalho[‡†], Marta Vicente[‡†], Hugo Escobar[‡†], Sandra Gama[†], Filomena Carnide[‡], Fátima Baptista[‡], José Alvez Diniz[‡], Leontios J. Hadjileontiadis[*§], and Sofia B. Dias[‡]

[‡]*CIPER, Faculdade de Motricidade Humana, Universidade de Lisboa*, Lisbon, Portugal

[†]*Instituto Superior Técnico and HUMAN Lab, INESC-ID, Universidade de Lisboa*, Lisbon, Portugal

[*]*Dept. of Biomedical Engineering & Biotechnology, Khalifa University*, Abu Dhabi, UAE

[§]*Dept. of Electrical & Computer Engineering, Aristotle University of Thessaloniki*, Thessaloniki, Greece

***Abstract*—Serious Games (SGs) have been explored in healthcare for their potential as gamified means for disease assessment and/or intervention. Designing effective SGs requires attention to user requirements and iterative development. We introduce a SG design process for Psoriatic Arthritis (PsA) patients, aiming to enhance their quality of life. The latter is exemplified via "The Kite" Breathing SG, part of the Horizon Europe iPROLEPSIS project, which targets PsA symptoms, promoting relaxation and, potentially, alleviating stress and inflammation. Developed through an agile methodology, it engages patients, researchers, developers, and healthcare professionals in iterative co-design. Incorporating the "Liked, Learned, Lacked, Longed for" (4Ls) technique, feedback is systematically collected, refining designs and prioritizing user-centric features. Insights from 29 experts and patients led to the first working prototype of "The Kite" breathing SG. Ongoing work focuses on refining the game for clinical validation trials in ten months, emphasizing a comprehensive approach to SG design and development.**

***Index Terms*—Serious Games, Psoriatic Arthritis, Game Design, Agile Methodology, Co-Design, Breathing Games**

I. Introduction

SERIOUS games (SGs) have emerged as promising tools in healthcare, leveraging gamification principles to engage users in health-related activities and interventions [1]. Their potential lies in their ability to make healthcare experiences more enjoyable and interactive while addressing specific health concerns. However, designing effective SGs requires a deep understanding of user needs and preferences, as well as a rigorous iterative development process to ensure usability and efficacy [2]. In this line, we introduce a SG design process tailored for individuals with Psoriatic Arthritis (PsA), a chronic autoimmune condition characterized by joint pain, stiffness, and skin inflammation [3]. In addition, the unpredictable nature of flare-ups poses challenges in daily activities, impacting the physical and emotional aspects of individuals with PsA. Stress and anxiety can worsen the physical symptoms of PsA patients, leading to the need for lifestyle adjustments, such as dietary changes and relaxation techniques [4].

The research leading to these results has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement no. 101095697 (iPROLEPSIS: Psoriatic Arthritis Inflammation Explained through Multi-Source Data Analysis guiding a Novel Personalised Digital Care Ecosystem).

The significant impact of PsA has motivated researchers to explore innovative technologies aimed at monitoring and preventing its progression. These technologies include self-monitoring devices and mobile apps that gamify daily routines [5]. Despite extensive research on various types of arthritis and rehabilitation methods, there is a notable gap in the literature regarding the effects of SGs specifically designed for PsA. Given the promising outcomes of SGs in various contexts (e.g., Parkinson's Disease [6], Cardiovascular Disease [7], Mental Disorders [8], Covid-19 [9]), our study aims to investigate the potential of SGs as a means to alleviate PsA symptoms. Taking into account the aforementioned perspectives, this paper aims to contribute to the understanding of using innovative digital solutions, such as breathing SGs, to enhance the well-being of individuals with PsA, and potentially inform the design process of similar interventions in related health contexts. Adopting an agile co-design methodology [10], our approach involves iterative design and development of SGs, incorporating input from both patients and experts. This research methodology allows us to extract essential guidelines for SG design, ensuring that each SG is tailored to meet the unique needs and preferences of PsA patients. The Breathing Games presented here, part of the Horizon Europe iPROLEPSIS project (https://www.iprolepsis.eu), are tailored to target PsA symptoms by promoting relaxation and potentially alleviating stress and inflammation through breathing exercises. Breathing exercises, which have shown promise in reducing stress levels, and games integrating guided meditation or breathing exercise routines, can be beneficial in managing these symptoms [11]. More specifically, "The Kite" Breathing game introduced here incorporates specific breathing patterns, inspired by relevant techniques, such as cardiac coherence breathing training [12] and the Pranayama breathing technique [13].

This paper is structured as follows: Section II provides relevant background information, while Section III outlines the methodology, including the study context, sample, and data collection. Section IV presents the results and discusses these findings. Finally, Section V concludes the work.

II. Background

The treatment of PsA typically centers on regulating the inflammatory process through a combination of pharmacolog-

ical and non-pharmacological interventions [14]. Traditional methods include using disease-modifying antirheumatic drugs (DMARDs), and synthetic agents targeted PsA [15], [16]. These methods, however, have proven to be ineffective for many patients [16] or effective only for some, and as a result, they have been evolving over the last two decades towards other, more targeted biological interventions complemented by physical, occupational, and massage therapy [17]. Recent research has focused on providing personalized care for PsA patients, aiming to accurately predict and adapt to their individual needs [18]. Personalized medicine studies in the PsA domain have considered various approaches, including investigating immunological responses and addressing factors such as pain management and psychological health monitoring [19]. Recognizing the multisystemic nature of PsA, models have been developed to integrate multidisciplinary teams including experts such as dermatologists, rheumatologists, and psychologists [17]. The legitimacy of SGs as medical interventions is showcased by the approval of the mobile game EndeavorRX for treating attention deficit hyperactivity disorder (ADHD) by the U.S. Food and Drug Administration (FDA) [20]. This precedent supports the exploration of prescription-based SGs for conditions such as PsA, in line with the objectives of iPROLEPSIS project and highlighting the transformative impact of digital health solutions on improving patient outcomes and their quality of life. Furthermore, the study performed by Pallavinci et al. [21] underlines the relationship between media stimuli and emotional arousal, showcasing the effectiveness of games in simulating stress responses. Though their focus was on anxiety disorders, the concept extends to conditions such as PsA where stress and anxiety are known triggers for flare-ups. In a patient-focused study conducted by Wanda *et al.* [22], the demand for technologies covering medication, diet, and pain tracking also echoes our objectives in creating patient-centric tools; however, the frustration expressed by patients regarding existing technologies being labor-intensive and lacking support beyond symptom tracking reinforces the importance of developing solutions that go beyond mere monitoring.

Within this context, incorporating both patients and multidisciplinary experts into the co-design process, "The Kite" Breathing game is introduced here for the first time, aiming to promote relaxation and potentially alleviate stress and inflammation in PsA patients, consequently enhancing their quality of life.

III. Methodology

In the context of emerging health technology solutions, a crucial factor lies in leveraging end-users' experiences and involving them actively throughout the design and development process. This practice, known as co-creation process [23], involves engaging diverse stakeholders such as patients, Healthcare professionals (HCPs), and researchers from the very early stages. This collaborative approach treats end-users as equal partners, engaging them in the ideation, design, and testing phases of new solutions. Adopting a co-creation feedback approach allows artists/designers and developers to tap into the valuable knowledge of end-users, integrating their insights into the agile product development cycle [24], [25].

A. Study context

The current study is a component of the iPROLEPSIS (Psoriatic Arthritis Inflammation Explained through Multi-Source Data Analysis guiding a Novel Personalised Digital Care Ecosystem) Horizon Europe research initiative, aimed at designing, developing, and validating innovative digital biomarkers for PsA assessment and intervention through an Artificial Intelligence-Personalized Game Suite (AI-PGS) collaboratively created with key stakeholders. With a multi-targeting objective and designed to tackle PsA symptoms, the AI-PSG aims to provide intervention activities to improve breathing, mobility, stiffness, balance, coordination, fitness, diet, and mood. This involves employing biofeedback and a holistic approach for managing stress/anxiety, fatigue, and pain, including the creation of various SGs categories, namely: Exercise Games, Dietary Games, Emotional Games, No Pain Games, Sensorimotor Art Games, and Breathing Games. The focus of the present study on Breathing Games emphasizes the importance of mindful breathing techniques to reduce stress and promote relaxation, which can alleviate symptoms of PsA.

B. "The Kite" Agile Design Process

An agile game approach has been utilized for "The Kite" breathing SG. This approach involves gathering feedback from the earliest stages to iteratively refine both the game ideation process and the game prototype. For the abstract ideation process, the Crazy 8s methodology ("sketch 8 ideas within 8 minutes") [26] was initially applied to encourage collaborative innovation in the design of the breathing SG via sketching. A diverse group of stakeholders, including healthcare professionals, patients, researchers, and technical experts, was brought together for this purpose. Overall, a variety of game ideas/sketches were creatively and collaboratively developed during the initial co-creation session (Fig. 1(a)), leading to the creation of preliminary versions of game storyboards. For the initial game prototype, agile sessions actively involved patients and HCPs as co-creators and co-designers to enhance the design of the Breathing Games. Figure 1(b) shows an excerpt from "The Kite" Breathing Game storyboard. In "The Kite" game, the patient controls a kite using their breath, guiding it through specific breathing patterns (e.g., 4 seconds inhale-4 seconds exhale) in the sky. If the patient fails to maintain the specified breathing pattern, the kite deviates from its intended trajectory. The patient must play the breathing game while facing the smartphone, and the breath feedback will be captured through the microphone sensor (Fig. 1(b)). Overall, during each sprint, we held game development meetings to reflect on progress, identify areas for improvement, assess clinical relevance, and plan the next steps. Each session served as an opportunity to review the outcomes of the previous sprint, including the feedback gathered from stakeholders, and to incorporate this feedback into our ongoing development efforts. Finally, employing the "Liked, Learned,

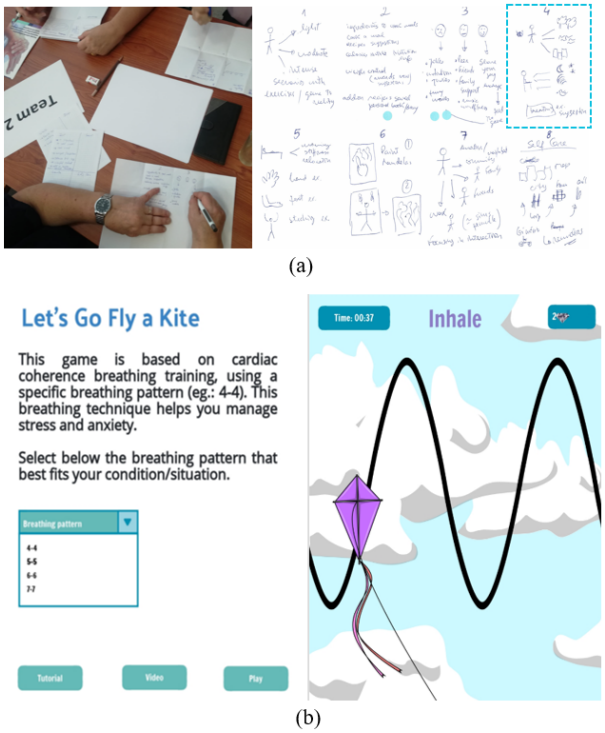

Figure 1. Co-design sessions involving (a) the game ideation process and Crazy-8s sketch (initial sketch of the breathing games category are marked with dashed blue square); and (b) Initial prototype of the breathing game "Let's Go Fly a Kite" storyboard.

Lacked, Longed for" (4Ls) technique [27], more advanced game prototypes and mock-ups were used for the agile sprint retrospective session (Fig. 3), which is central to the present study. All members of the team are required to attend the retrospective and actively participate in the discussion. Overall, the 4Ls retrospective framework is commonly used in game development to gather feedback from stakeholders and guide iterative improvement. It involves categorizing feedback into four areas -Liked, Learned, Lacked, and Longed for-, providing a structured approach to understanding user perspectives. This method enables the reinforcement of liked aspects, learning from experiences to guide future iterations, addressing identified lacks in subsequent phases, and drawing inspiration from longings for future game features or enhancements, streamlining the design process.

C. "The Kite" Architecture

Figure 2 outlines the high-level architecture of "The Kite" breathing game. The patient interacts with "The Kite" SG, which responds to their breathing patterns (e.g., inhale/exhale) captured by the smartphone's microphone, while data collected via the smartwatch (e.g., heart rate variability) is transmitted using Bluetooth. These data are then stored in a cloud-based Data Management System, including user profiles, health data, and game settings, which can then be used for further game personalization. The game was developed in Unity 2022.3 LTS, with the assets designed in Blender.

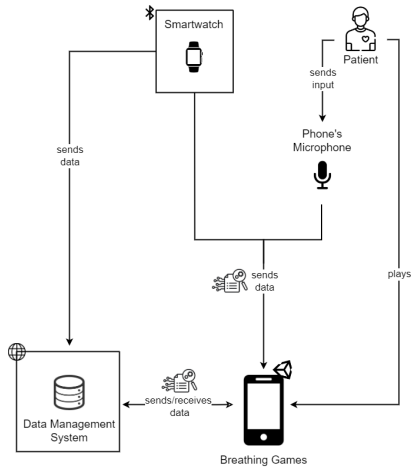

Figure 2. High-level architecture of the Breathing Games, including process and data flow, and interactions with other components.

D. Participants and data collection

The agile retrospective session took place on December 2023, in Rotterdam (Netherlands). This collaborative session brought together a multidisciplinary group of 29 experts (14 females) from nine different countries (i.e., Portugal, Greece, United Kingdom, The Netherlands, Luxembourg, Belgium, Israel, Germany, Latvia), including partners from industry, research, healthcare, and technology sectors within the iPROLEPSIS project. The participants were aged between 22-65 years old and were organized into different teams, namely: Team 1 comprising HCPs (n=6), Team 2 represented Patients (n=4, patient research partners), Team 3 composed of Researchers (n=4), and Team 4 consisting of Technical experts (n=11), in order to ensure a comprehensive exchange of perspectives and expertise. As part of the design team, the session was guided by an expert in the design and development of serious games, accompanied by one facilitator and two observers. The session was designed with a structured flow including four main phases, namely: Introduction and goal setting (phase 1): this phase involved outlining the session's purpose, welcoming patient research partners, introducing facilitators and observers, and presenting an overview of the primary goal of designing the iPROLEPSIS AI-PGS, along with "The Kite" Breathing game prototype (Fig. 3); Explanation of 4Ls method (phase 2): participants received a concise overview of the 4Ls framework - Liked, Learned, Lacked, and Longed for - emphasizing its application to the Breathing game prototype. In addition, instructions were given to clarify that each activity would take approximately 10 minutes, with the necessary materials provided (e.g., paper, pen); 4Ls Activity (phase 3): participants engaged in four activities: Liked, reflecting on positive aspects of the Breathing Game Prototype; Learned, discussing insights gained; Lacked, identifying areas for improvement and deficiencies; and Longed for, expressing desires for future enhancements and participating in brainstorming sessions for potential improvements in user experience and therapeutic/clinical ben-

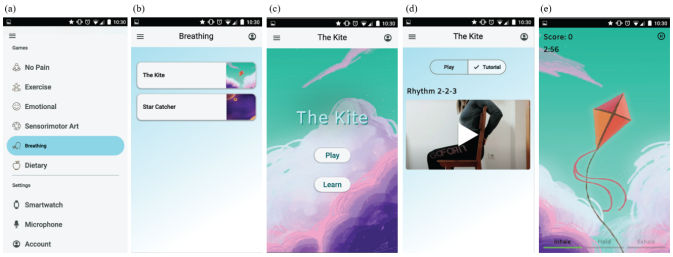

Figure 3. The user interface of the game prototype, including (a) the main menu of the app, (b) the main menu for Breathing Games category, (c) the menu for "The Kite" Breathing Game, (d) the video tutorial demonstrating breathing patterns (e.g., 2-2-3), and (e) the in-Game scene.

efits; and Sharing and discussing (phase 4): representatives from each team, including clinicians, patients, researchers, and developers, presented their perspectives, followed by open discussions and encouraging brainstorming sessions among participants. The entire co-creation session was 90 minutes long. The approach to participant selection for the session was characterized by purposive sampling, a deliberate strategy aimed at carefully selecting individuals with pertinent experiences and viewpoints. It is worth highlighting that session attendance was entirely voluntary, with participants choosing to engage without any form of compensation for their valuable contributions and insights. After the co-creation session, an online questionnaire was shared via Google Forms[1] to evaluate participant satisfaction and gather valuable insights for enhancing future sessions. We received responses from 14 participants who anonymously shared their feedback. The questionnaire comprised five questions, including two closed and three open-ended questions.

IV. Results & Discussion

A. 4Ls Analysis Insights

Overall, the results of the 4Ls analysis provided valuable insights considering the participants' perceptions/preferences regarding "The Kite" breathing game prototype (Fig. 4).

Liked. In terms of positive feedback, some participants (Patients, HCPs) highly appreciated the clarity of game instructions and the simplicity of gameplay. HCPs and Researchers noted that the graphics and feedback mechanisms in the breathing game were engaging and had a positive impact. Moreover, Patients appreciated the visually appealing aspects of the game, highlighting its engaging nature. Additionally, Technical experts recognized the calibration of the game as essential to accurately capture the user's breathing patterns, along with the importance of integrating the smartwatch. The selection of appropriate interaction technology for SGs depends on both the game itself and the target audience, considering users' specific needs and the game's objectives [28]. In the context of Breathing Games, is intended to use continuous real-time heart rate monitoring and stress levels data obtained from the smartwatch to identify Respiratory Sinus Arrhythmia and heart rate variability, synchronizing with respiration patterns during gameplay.

Lacked. Participants also identified areas needing improvement. Patients suggested enhancing the relaxation mechanism through different kite movements, and Technical experts proposed a more straightforward tutorial and personalized options to improve the overall user experience. Concerns about confusing on-screen elements were also raised, indicating a desire for cleaner backgrounds and clearer indications of game progression (Patients, Technical experts). Continuous feedback on progress is crucial in the SGs as the players work to achieve the characterizing goal [29]. Furthermore, game statistics provide insight into the player's progress post-game, especially in health-oriented games [30]. In this line, we are currently developing feedback bars into the game interface to provide patients with real-time feedback on their current position within the breathing cycle.

Learned. All participants recognized the potential stress-reduction benefits of breathing exercises from the lessons learned. Technical experts underlined the potential impact of breathing exercises on health status and the immune system. Researchers emphasized the insights gained from combining relaxation with enjoyment and the impact of visual and audio stimuli on the effectiveness of the exercise. The effectiveness of a SG relies on providing players with multimodal feedback (e.g., visual, audio, haptic feedback), enabling them to evaluate their advancement and improve performance [31]. Following these perspectives, we are exploring the inclusion of audio cues in the game to complement visual feedback, enhancing immersion and supporting player focus during gameplay.

Longed For. The longed-for aspects highlighted participants' desires for a deeper understanding of the game's scientific basis (HCPs), a hands-free version (Technical experts), motivational features and rewards (Researchers), autonomy in selecting breathing patterns (Patients), and personalized game elements (Patients, Technical experts). High-quality SGs need to achieve an optimal balance between the serious and game elements, ensuring it is entertaining while also fulfilling its characterizing goal [28]. In this line, a breathing-based Serious NeuroGame has been proposed targeting entertainment and breathing control to achieve the characterizing goal of reduced anxiety [32]. In this way, we are also exploring opportunities to incorporate scientific information into the breathing game. This will offer patients insights into the therapeutic benefits of breathing exercises, including their effects on inflammation and overall well-being (serious aspect). Simultaneously, we aim to improve graphics, refine concept art, and enhance aesthetics to enrich the gaming experience (game aspect). Improvements in both components, serious and game-related, will thus contribute to ensure an appropriate balance.

B. Co-creation evaluation

The responses collected from the online questionnaire, intended to evaluate participants' overall satisfaction and gather valuable insights for improving future agile co-creation design processes, are briefly summarized.

[1]https://forms.gle/H4mTzgSDaBXMxFwz5

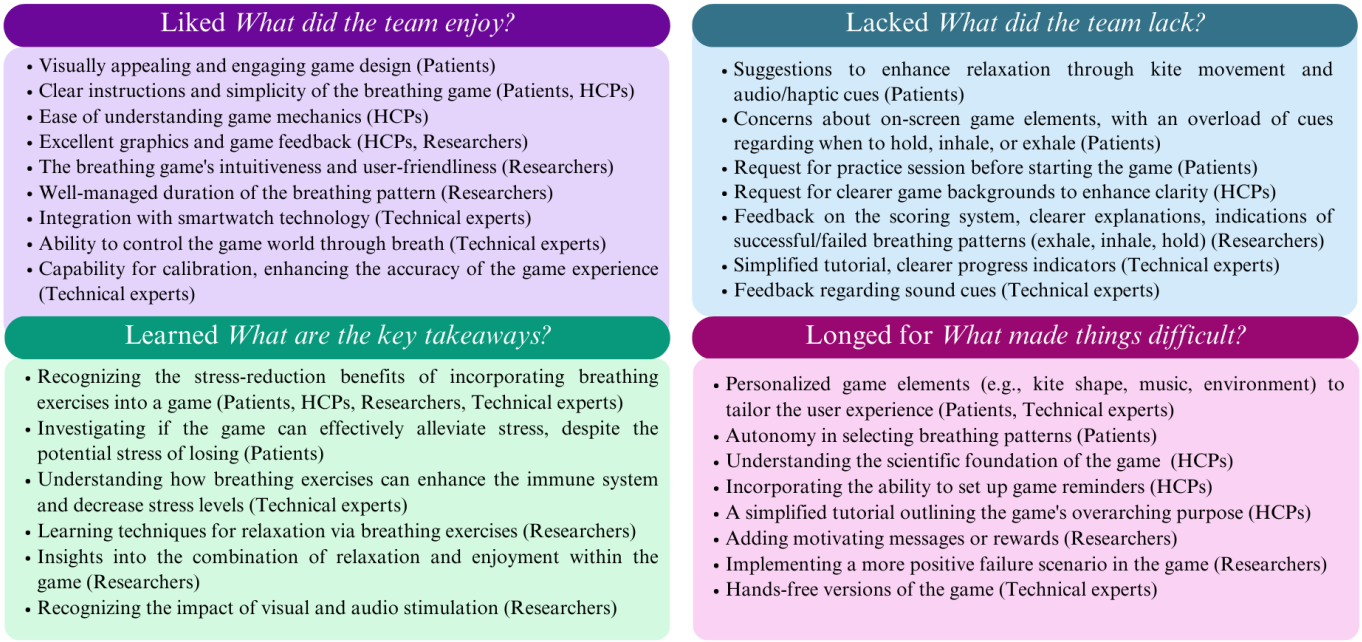

Figure 4. The outcomes of the 4Ls framework - Liked, Learned, Lacked, and Longed for - highlighting its application to "The Kite" Breathing game prototype.

Overall satisfaction. Regarding the closed-ended question "How do you feel about this co-creation session?" the majority of participants had a positive experience; 71 % of them reported a high level of satisfaction and an additional 21 % expressed satisfaction. It is worth noting that only one participant had a neutral level of satisfaction with the session, underscoring the overall positive sentiment among the participants. Concerning the question "Would you like to attend possible future sessions?" the majority of participants (86 %) expressed their desire to participate in future sessions. This enthusiastic response underlines the willingness of participants to continue engaging in co-creation activities.

Things to keep. Concerning the open-ended question "What did you like most about this co-creation session?", participants highlighted various factors to be considered for future co-creation sessions. These include a focused approach to a singular game, the effective use of the 4Ls methodology, emphasis on interactivity, practicality, and engagement for productive feedback and improvement opportunities. They valued the quality of game design, especially the concept art, mock ups, and prototype, along with the session's educational value and its ability to improve team spirit, as follows: *"I liked the Concept Art of the Games, the mockups and the prototype of the breathing games (UI, feedback), great work!"* (participant6); *"This session was engaging, educating, and increased team spirit among partners."* (participant9). Constructive feedback was also appreciated for enabling game progress, and the involvement of diverse groups. Finally, collaborative team brainstorming sessions emerged as a beneficial element to maintain for future sessions, contributing to their success and participant satisfaction.

Changes to be made. The participants highlighted some fundamental changes and improvements for future co-creation sessions ("What you did not like on this co-creation session?"). These include reconsidering the organization of teams based on areas of expertise (e.g., technical versus clinicians). Participants noted that time constraints were a challenge, with some feeling that there were too many groups given the allocated time, as expressed by one of the respondents: *"This session involved too many groups and was too short in duration."* (participant4). Addressing this issue by optimizing group sizes or extending the duration could enhance future sessions.

Recommendations and possible improvements. Regarding the open question "Is there anything you want to propose as a possible improvement?" some recommendations provided by participants offer valuable insights for improving future co-creation sessions. The most notable suggestions are based on time allocation, emphasizing the need for more time to facilitate in-depth discussions, allowing for better understanding and testing the breathing game. Some participants proposed forming more heterogeneous teams to encourage diverse perspectives and richer collaboration. Others recommended showcasing the entire app flow instead of solely focusing on the game design, despite potential time constraints, as follows: *"Perhaps displaying the entire app flow to participants, not just the breathing game itself, would help to understand the entire game environment; however, this is constrained by the time allocated for the task."* (participant11); *"The session could have more time for discussion."* (participant2). Overall, the key strategies to enhance future co-creation sessions involve extending session duration, promoting heterogeneous groups, and providing more comprehensive app demos. Identified

weaknesses and areas for improvement include challenges in team organization, time constraints on discussions, and the need for clearer demonstrations of the app's full functionality to ensure better understanding among participants. Future work involves transitioning "The Kite" Breathing SG to full-scale development using the Unity engine, including the creation of 3D models for the game scene. We will continuously integrate stakeholder feedback and refine algorithms for data collection, and preparing for clinical validation trials within the next ten months. Comprehensive user testing is also intending to be conducted to assess usability and effectiveness in real-world settings. Furthermore, we are exploring opportunities to integrate advanced technologies, such as artificial intelligence, to enhance engagement and personalization, thereby improving the efficacy of the SG in addressing PsA symptoms and enhancing patients' overall quality of life.

V. Conclusion

Breathing games tailored for PsA patients offer significant potential to alleviate stress, inflammation, and associated symptoms, complementing conventional care methods. This work presents the agile design process for a personalized breathing game within the iPROLEPSIS framework. Through iterative co-design involving stakeholders, the game prototype was refined to meet the specific needs and preferences of PsA patients. The agile retrospective, employing the 4Ls technique, gathered valuable multidisciplinary insights crucial for shaping subsequent iterations. This approach ensures the game effectively addresses targeted symptoms, maintains clinical relevance, and enhances the well-being of PsA patients.

Acknowledgments

The authors express their gratitude to all Patient Research Partners for their voluntary participation in the study. In addition, they extend their gratitude to all members of the iPROLEPSIS consortium for their valuable contributions.

References

[1] N. Sharifzadeh, H. Kharrazi, E. Nazari, H. Tabesh, M. Edalati Khodabandeh, S. Heidari, and M. Tara, "Health education serious games targeting health care providers, patients, and public health users: scoping review," *JMIR serious games*, vol. 8, no. 1, p. e13459, 2020.

[2] M.-A. Maheu-Cadotte, V. Dubé, S. Cossette, A. Lapierre, G. Fontaine, M.-F. Deschênes, and P. Lavoie, "Involvement of end users in the development of serious games for health care professions education: systematic descriptive review," *JMIR serious games*, vol. 9, no. 3, p. e28650, 2021.

[3] V. Ocampo and D. Gladman, "Psoriatic arthritis," *F1000Research*, vol. 8, 2019.

[4] E. Lubrano, S. Scriffignano, K. De Vlam, M. Ronga, F. M. Perrotta, and R. Lories, "Triple jump for the optimal management of psoriatic arthritis: diet, sleep and exercise–a review," *RMD open*, vol. 9, no. 3, p. e003339, 2023.

[5] S. Bell, J. F. Merola, D. E. Webster, S. R. Pennington, W. Liao, A. Ogdie, O. FitzGerald, C. Ritchlin, and J. U. Scher, "Aiming for cure and preventive initiatives in psoriatic disease: building synergy at npf, grappa, and ppacman," *Current Rheumatology Reports*, vol. 22, pp. 1–7, 2020.

[6] D. J. Mahboobeh, S. B. Dias, A. H. Khandoker, and L. J. Hadjileontiadis, "Machine learning-based analysis of digital movement assessment and exergame scores for parkinson's disease severity estimation," *Frontiers in Psychology*, vol. 13, p. 857249, 2022.

[7] S. Dias, L. J. Hadjileontiadis, and H. F. Jelinek, "Multigrehab: Developing a multimodal biosignals acquisition and analysis framework for personalizing stroke and cardiac rehabilitation based on adaptive serious games," in *2022 IEEE International Conference on Digital Health (ICDH)*. IEEE, 2022, pp. 175–177.

[8] E. Ganiti-Roumeliotou, N. Pandria, V. Petronikolou, M. Karagianni, S. B. Dias, L. J. Hadjileontiadis, and P. D. Bamidis, "Mindofmine: A brain-based serious game approach for supporting cognitive deficits in mental disorders," in *2023 IEEE 11th International Conference on Serious Games and Applications for Health (SeGAH)*. IEEE, 2023, pp. 1–4.

[9] S. Dias, P. Silva, I. Chrysovergis, V. Charisis, G. Tsoumalis, Z. Bampos, A. Papazoglou, D. Iakovakis, S. Hadjidimitriou, L. Hadjileontiadis *et al.*, "Smartphone-based biofeedback games for shielding of immune system against covid-19: the covidshield game suite design approach," in *Proceedings of the 9th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-exclusion*, 2020, pp. 93–97.

[10] A. Przybyłek, M. Albecka, O. Springer, and W. Kowalski, "Game-based sprint retrospectives: multiple action research," *Empirical Software Engineering*, vol. 27, pp. 1–56, 2022.

[11] S. Ganesan, G. S. Gaur, V. S. Negi, V. K. Sharma, and G. K. Pal, "Effect of yoga therapy on disease activity, inflammatory markers, and heart rate variability in patients with rheumatoid arthritis," *The Journal of Alternative and Complementary Medicine*, vol. 26, no. 6, pp. 501–507, 2020.

[12] R. McCraty and M. A. Zayas, "Cardiac coherence, self-regulation, autonomic stability, and psychosocial well-being," *Frontiers in psychology*, p. 1090, 2014.

[13] R. Jerath, J. W. Edry, V. A. Barnes, and V. Jerath, "Physiology of long pranayamic breathing: neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system," *Medical hypotheses*, vol. 67, no. 3, pp. 566–571, 2006.

[14] A. Vivekanantham, D. McGagh, and L. C. Coates, "Current treatments and recommendations for psoriatic arthritis," *Best Practice & Research Clinical Rheumatology*, vol. 35, no. 2, p. 101680, 2021.

[15] A. Ogdie, L. C. Coates, and D. D. Gladman, "Treatment guidelines in psoriatic arthritis," *Rheumatology*, vol. 59, no. Supplement_1, pp. i37–i46, 2020.

[16] C. Magee, H. Jethwa, O. M. FitzGerald, and D. R. Jadon, "Biomarkers predictive of treatment response in psoriasis and psoriatic arthritis: a systematic review," *Therapeutic Advances in Musculoskeletal Disease*, vol. 13, p. 1759720X211014010, 2021.

[17] S. Hackett, A. Ogdie, and L. C. Coates, "Psoriatic arthritis: prospects for the future," *Therapeutic Advances in Musculoskeletal Disease*, vol. 14, p. 1759720X221086710, 2022.

[18] A. B. Gottlieb, A. F. Wells, and J. F. Merola, "Telemedicine and psoriatic arthritis: best practices and considerations for dermatologists and rheumatologists," *Clinical rheumatology*, vol. 41, no. 5, pp. 1271–1283, 2022.

[19] B. Batko, "Patient-centered care in psoriatic arthritis—a perspective on inflammation, disease activity, and psychosocial factors," *Journal of Clinical Medicine*, vol. 9, no. 10, p. 3103, 2020.

[20] S. W. Evans, T. P. Beauchaine, A. Chronis-Tuscano, S. P. Becker, A. Chacko, R. Gallagher, C. M. Hartung, M. J. Kofler, B. K. Schultz, L. Tamm *et al.*, "The efficacy of cognitive videogame training for adhd and what fda clearance means for clinicians," *Evidence-Based Practice in Child and Adolescent Mental Health*, vol. 6, no. 1, pp. 116–130, 2021.

[21] F. Pallavicini, P. Cipresso, S. Raspelli, A. Grassi, S. Serino, C. Vigna, S. Triberti, M. Villamira, A. Gaggioli, and G. Riva, "Is virtual reality always an effective stressors for exposure treatments? some insights from a controlled trial," *BMC psychiatry*, vol. 13, pp. 1–10, 2013.

[22] M. Wada and J. R. Wallace, "Designing technologies for self-care: Describing the lived experiences of individuals with rheumatoid arthritis," *Human Factors in Healthcare*, vol. 2, p. 100025, 2022.

[23] R. Palumbo, *The bright side and the dark side of patient empowerment: Co-creation and co-destruction of value in the healthcare environment*. Springer, 2017.

[24] F. Tessarolo, D. Petsani, V. Conotter, G. Nollo, G. Conti, M. Nikolaidou, G. Onorati, P. D. Bamidis, and E. I. Konstantinidis, "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*, pp. 1–16, 2022.

[25] S. B. Dias, J. A. Diniz, E. Konstantinidis, T. Savvidis, V. Zilidou, P. D. Bamidis, A. Grammatikopoulou, K. Dimitropoulos, N. Grammalidis, H. Jaeger *et al.*, "Assistive hci-serious games co-design insights: the case study of i-prognosis personalized game suite for parkinson's disease," *Frontiers in Psychology*, vol. 11, p. 612835, 2021.

[26] J. Knapp, J. Zeratsky, and B. Kowitz, *Sprint: How to solve big problems and test new ideas in just five days*. Simon and Schuster, 2016.

[27] E. G. Gorman, Mary, "The 4ls: A retrospective technique," 2010.

[28] P. Caserman, K. Hoffmann, P. Müller, M. Schaub, K. Straßburg, J. Wiemeyer, R. Bruder, S. Göbel *et al.*, "Quality criteria for serious games: serious part, game part, and balance," *JMIR serious games*, vol. 8, no. 3, p. e19037, 2020.

[29] E. M. Whyte, J. M. Smyth, and K. S. Scherf, "Designing serious game interventions for individuals with autism," *Journal of autism and developmental disorders*, vol. 45, pp. 3820–3831, 2015.

[30] P. Rego, P. M. Moreira, and L. P. Reis, "Serious games for rehabilitation: A survey and a classification towards a taxonomy," in *5th Iberian conference on information systems and technologies*. IEEE, 2010, pp. 1–6.

[31] H. Desurvire and C. Wiberg, "Game usability heuristics (play) for evaluating and designing better games: The next iteration," in *Online Communities and Social Computing: Third International Conference, OCSC 2009, Held as Part of HCI International 2009, San Diego, CA, USA, July 19-24, 2009. Proceedings 3*. Springer, 2009, pp. 557–566.

[32] S. B. Dias, H. F. Jelinek, and L. J. Hadjileontiadis, "Multisensed emotions as adaptation controllers in human-to-serious neurogames communication," *IEEE Communications Magazine*, 2023.