

# Using Asynchronous Exergames to Encourage an Active Ageing Lifestyle: Solitaire Fitness Study Protocol

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**Abstract.** A healthy and active lifestyle can significantly improve the well-being and quality of life; however, some elderly people struggle to stay motivated and engaged with any form of exercise. The project Elaine (Elderly, AI and New Experiences) addresses this problem by seeking to improve the quality of life of the elderly through exergames. Currently, the project explores a novel approach in the field of health informatics called asynchronous exergaming. This approach, a new trend in games in the health domain, allows the elderly to workout at their own pace, and in their own time, with their physical activity linked asynchronously to a game. This paper presents the study protocol for Solitaire Fitness, a new asynchronous exergame developed by the team. The game aims at increasing the motivation of the elderly to engage in physical exercise whilst helping to maintain their cognitive abilities. It also describes the protocol for the trial. The result of this research has the potential to benefit elderly that need nudging to be motivated to exercise, health care providers treating people with sedentary lifestyles and researchers investigating ways to encourage the elderly to exercise.

**Keywords.** Serious games, active ageing, games for health, asynchronous exergaming.

## Introduction

Mental and physical health tend to decline significantly as people age. Physical exercise has been shown to be one of the most effective ways to help ageing people to maintain their health as they age [1]. Passive and active exercises are beneficial for the development of muscles, tissues and a strong skeletal structure [2]. Regular physical activities can also reduce the risk of diseases such as diabetes [3], high blood pressure [4], and stroke [5]. A healthy and active lifestyle can significantly improve the well-being and quality of life; however, seniors often struggle to stay motivated and engaged with any form of exercise [6].

The project Elaine has sought to address this problem. One successful Elaine project is a fall prevention system [7-9], mindfully designed for the elderly, that delivers stepping exercises in a playful manner through a video game. Such interactive video games have shown positive results in increasing the levels of motivation and adherence to physical activity amongst the elderly [10, 11]. However, we also learned that the aged cohort has very particular needs and preferences when it comes to exercising. Whilst seniors found the concept of exercising through gameplay very appealing and engaging, the feedback

we received revealed that they are still more inclined to engage in traditional exercise routines and workout at their own time and pace [12, 13]. Also, having to perform full body movements for prolonged periods of time often leads to fatigue, tiredness and in some cases, muscle pain [14]. This is often undesirable to the player, and limits their immersion and flow state.

Based on this user feedback, the team decided to explore the asynchronous exergaming approach [15]. With this approach, the elderly can workout at their own pace, and in their own time, with their workout activity linked asynchronously to the game. The idea is to create compelling game scenarios that can accommodate and adjust to the preferences and motivations of the elderly when exercising. In addition, information is collected on players' feelings and attitudes towards the game and its contents, the selection of exercises that will feed into the game asynchronously; and how the incorporation of such exercises affects the players' progression and gameplay. Such data will inform future research into this field.

To the best of our knowledge, no other project has explored an asynchronous exergaming approach to engage the aged cohort into physical exercise.

The team designed and developed an asynchronous game by linking a well-established card game, Solitaire, and let the elderly chose the form of exercise they are familiar with, allowing them to exercise at their own pace. The game is called Solitaire Fitness. Game mechanics were introduced into the game to try and allow the elderly to more fully immerse in gameplay, and ultimately increase their motivation towards a healthy active lifestyle.

This paper focusses on the protocol for the trial of Solitaire Fitness. Section 1 presents the Solitaire Fitness game. Section 2 defines the protocol for the trial. The objectives of the trial are to:

1. Investigate the effectiveness, usability, and barriers of this new game design concept to increase the motivation of the elderly towards physical activity.
2. Investigate the perceived usability and value from independent living older adults (and other stakeholders) of using this new game design concept to promote physical activity.
3. Investigate the effects this new game design concept could have on the mental and physical health of the elderly.

## **1. Solitaire Fitness**

One first challenge was to select a suitable exercise that can easily be measured and linked to the game. After exploring the relevant literature in this field, Solitaire was selected as the first game to adapt and trial (Fig.1). The game was developed to run on desktop computers, laptops, tablets and mobile phones. The game design and implementation are presented in [16].

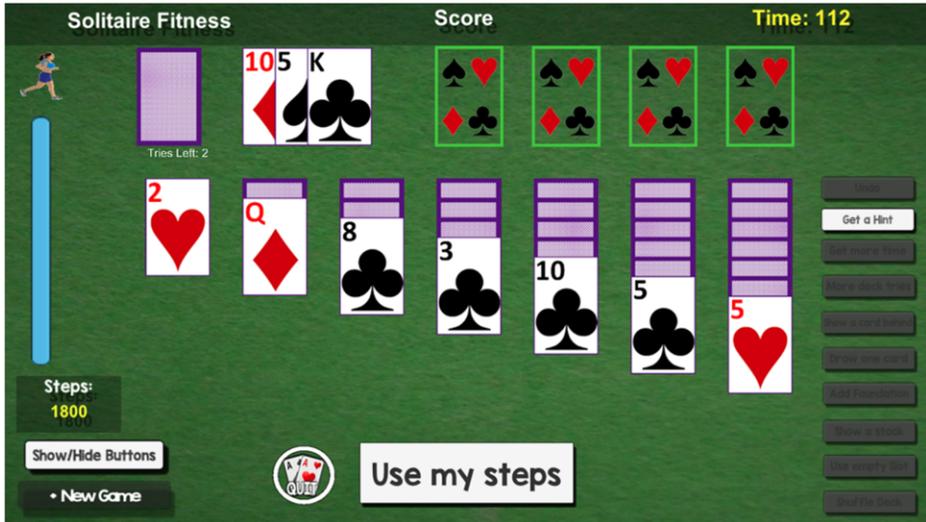


Figure 1. Solitaire Fitness.

With an older target audience, we were cognizant that the user interface design choices needed to meet a number of requirements, namely, the need for greater visibility, e.g., larger texts and visual elements to support understanding. We also wanted to limit the need for additional navigation to reduce the users' cognitive load of remembering interaction steps or certain tools.

The biggest design challenge was finding ways to improve the gameplay experience. Our solution to this challenge was to integrate rewards that the players can access in order to enhance the game. However, we were mindful that the introduction of these new mechanics can still provide the player with an appropriate degree of challenge. In addition to stimulating the player's cognitive abilities, like the original version of the game, Solitaire Fitness is designed to encourage them to exercise. This is achieved by showcasing the result of their exercise and rewarding their exercise efforts by being able to access the unique gameplay mechanics. The game allows players to input the number of steps they have taken from the day before playing. The higher the weekly number of steps an individual the player inputs, the more exclusive advanced additional rewards the game unlocks, which assist the player to progress through the game. Thus, players can utilise their reward from exercising to improve their chances of winning the game. While this suggests that players can cheat; a negative activity that seems to contravene the original intent of the game, some researchers have found that games designs that carefully balance the potential of cheating for more effective physical engagement to the users can be more valuable. In fact, they found that while it is important to limit cheating, being able to cheat can sometimes boost users' enjoyment of using the application [17].

A first framing workshop was run to gather feedback about the game and our idea. We also wanted a clearer view on how to run the trials. This workshop was held at a senior community centre. Six elderly participants, aged 63 to 87, 5 females, 1 male, participated in the workshop. The session revealed that we need to be clearer about the objectives of the game. This is because participants were focusing on fall detection and did not see a direct link with the game we presented. They also highlighted the interest in both the physical and cognitive activities. One participant mentioned "*This is good, I*

walk but I don't exercise my brain". All but one knew how to play solitaire however, not all elderly like card games and we would need to get games or applications that they enjoy instead (e.g. monopoly, dominos). Most reacted positively to the game as reflected in these quotes:

*"I enjoyed playtesting session today (...) Elders like us today need simple stages (...) Using step credits to bump up cognitive performance to facilitate success in finishing the game(...) some may need an assistant for a couple more stages to see if they grasp the concepts of trade off in exercise steps to cognitive agility...anyway I found your cutting edge games design very interesting"* and

*"I see a real motivational advantage for an activity like this in Rehab Hospitals after complex orthopedic surgery in 55-70 yr olds who lack motivation with physiotherapy programme on discharge(...) elders need to make sense of what they're doing & get immediate reward (...)"*

The feedback about the game which we received from this framing workshop including feedback on the game design feedback is presented in [16]. This feedback led to a changed focus when recruiting elderly participants, from 'fall prevention' to 'healthy ageing' which was more appropriate. The feedback also helped us to refine our target audience for Solitaire Fitness: elderly who play games or card games or individuals who want to improve on cognitive activity and are willing to learn a new game.

## **2. Trial methods and Protocol**

### *2.1. Participants*

Trials of the improved game are being conducted with 20 independent-living older people that are computer literate. The team is currently recruiting participants who are older than 65 years of age, live independently, can walk without any assistance, do not have any mild cognitive or physical impairment, are familiar with the Solitaire game, have sufficient proficiency in English to understand instructions for using an android tablet and willingness to wear a fitness activity tracker. Our broad recruitment strategy includes the use of us advertisement and flyers, social media, email newsletters. Advertisements and flyers are placed in senior community centers, retirement villages and other community meeting places where flyers are allowed to be displayed.

### *2.2. Study procedures*

We plan to use an observational approach with mixed methods analysis to address the research objectives. We will collect prospective longitudinal data (quantitative) from a Solitaire Fitness and an activity tracker to be able to assess whether the asynchronous exergame has an effect in motivating older people to exercise. Selected participants will be given a mobile device with Solitaire Fitness and a fitness activity tracker to use for 6 weeks. Participants will initially be required for a one-hour introductory session, where they will be provided and set up with the android tablet set to run Solitaire Fitness as well as a Fitbit activity tracker. Participants will be interviewed, asked to complete baseline questionnaires and a first set of computer-based motor and cognitive tests during this introductory session. The tests used are Gait Speed, Choice Step Reaction Time Test, 5 Seat to Stand, Letter-Digit substitution and Stroop.

During the first 3 weeks, participants' physical activity from their wearing of the Fitbit will not have any effect on gameplay. This is to be able to distinguish between the motivation to exercise that may come from wearing the Fitbit, from the motivation that come from the Solitaire Fitness game. By the end of week 3, participants will be required to complete the computer based motor and cognitive tests for the second time.

From week 4 to week 6, participants' physical activity will have a direct effect on gameplay. The participants will be presented with new game mechanics and rewards. The number of rewards will be proportional to the individual's tracked physical activity. Cognitive and motor tests will be conducted at baseline, end of week 3 and at the completion of the trial. Participants will then be asked to complete a semi structured interview at the completion, in week 6. Computer- based motor and cognitive tests will be administered for the last time.

### *2.3. Data Collection and Data Analysis*

Simple computer-based tests will be used to assess basic cognitive and motor functions to evaluate changes in mental and physical health. Semi-structured interviews (qualitative analysis) will be used to determine issues of usability and barriers towards this new game concept designed to encourage the elderly to exercise. Data from the game (games played, collective sessions including multiple games in a single sitting, rewards used within each game, frequency of rewards used within each game and steps entered) will be collected to assess adherence. Data from the activity trackers will be collected and used to quantify physical activity and exercise. Cognitive and motor tests will determine whether the game had improvements in participants' physical and mental health.

## **3. Conclusion**

The aim of the trials is to validate an approach on how to integrate enjoyment and highly interactive elements from games to strengthen cognitive learning, whilst motivating players to exercise. The new exergame, Solitaire Fitness focuses on providing players with rewards that they can unlock depending on their level of activity during the week. The inclusion of this reward element allows a unique gameplay to unfold, allowing for players with different rewards to change the flow of gameplay and methods to win the game. Equally important, the game is designed to collect a measurable set of data monitored by the user online from the gameplay. This enables the researchers, and potentially, health professionals to measure the success of the project through the amount of exercise taken by the user and frequency of rewards implemented within the game.

The trials' hypothesis is that the link between physical activity and rewarding game mechanics can increase adherence to the game and to physical activity. Unlike traditional exergames, our approach gives participants the freedom and flexibility they need while keeping a connection between gameplay and exercise. The result of this research has the potential to benefit the elderly, health care providers treating people with sedentary lifestyles and researchers investigating ways to encourage the elderly to exercise.

Games such as Solitaire Fitness have the potential to motivate elderly to be more active, which is the key to a better mental and physical health. More importantly, the concept of asynchronous exergaming also gives them the opportunity to socialize while working out, which was one of the main limitations of the traditional exergaming

approach. This can potentially boost their social lives and have a positive impact on the quality of life of the senior community.

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