

Faculty of Science and Technology

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Can repeated game-play help sufferers of Cognitive Impairment

such as Parkinson's & Dementia

by

James Ford

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Signed: JLFord

Name: James Ford

Date: 17/05/2019

Programme: BSc GP

# Abstract

Motion-Based gameplay (Wii, Kinect, Morpheus) has been shown to help sufferers of Parkinson’s Disease, I would like to explore if reaction-based gameplay could have any similar effects. Alongside this, memory-based gameplay has been shown to have positive effects on Alzheimer’s patients. In this project, I am going to set-up the testing conditions so that in any future testing I can test for any positive results from my application that is planned and designed to be easy to use for those suffering and also hopefully improve their day-to-day life. The application will consist of five memory / reaction-based games that will keep their minds active and hopefully be able to show a gradual increase in performance over the testing time. In the meantime, I have a few testers as a baseline. All of the testing data and the surveys will be documented, and the results will show if this could help sufferers of Parkinson’s Disease in the future.

Contents

[Faculty of Science and Technology 1](#_Toc8986353)

[Can repeated game-play help sufferers of Cognitive Impairment 1](#_Toc8986354)

[such as Parkinson's & Dementia 1](#_Toc8986355)

[Abstract 3](#_Toc8986356)

[Section 1: Introduction & Background Theory 5](#_Toc8986357)

[Introduction 5](#_Toc8986358)

[Aims: 6](#_Toc8986359)

[Primary 6](#_Toc8986360)

[Objectives: 6](#_Toc8986361)

[Section 2: Literature Review 6](#_Toc8986362)

[Literature Review 6](#_Toc8986363)

[Exergaming 6](#_Toc8986364)

[Improving Memory in Parkinson’s Disease 7](#_Toc8986365)

[Summary 7](#_Toc8986366)

[Section 3: Design, Implementation, and Testing process 7](#_Toc8986367)

[Planning Process 7](#_Toc8986368)

[Development 8](#_Toc8986369)

[Testing Strategy 9](#_Toc8986370)

[Section 4: Evaluation and Conclusions 10](#_Toc8986371)

[Results Evaluation 10](#_Toc8986372)

[Results Summary 10](#_Toc8986373)

[Section 5: Critical Evaluation 11](#_Toc8986374)

[Evaluation 11](#_Toc8986375)

[Future Works 11](#_Toc8986376)

[Conclusion 11](#_Toc8986377)

[References 12](#_Toc8986378)

[Appendix 14](#_Toc8986379)

# Section 1: Introduction & Background Theory

## Introduction

Parkinson’s Disease “is a condition in which parts of the brain become progressively damaged over many years”. (NHS Inform, 2018). It has been shown that it has 4 major symptoms; trembling, stiffness of limbs, slowness of movement and general postural instability. Roughly 1 in 500 people are affected by Parkinson’s Disease. “PD [Parkinson’s Disease] can often cause a number of other cognitive disturbances for its suffers, these can include; longer-than-normal-reaction times, language difficulties, short term memory loss and dementia.” (CogniFit, 2019). “Approximately 25%-30% of Parkinson’s patients develop dementia” (WNDU, 2012).

In research that I found it has been shown that regularly playing motion-based games can help manage one of the key symptoms of Parkinson’s, these games include Wii Tennis, Wii-based rowing games (Lancaster University, 2014) and balance board games. Some of the Wii gadgets mentioned “may lead to falls and severe injuries, so that raised platforms such as Wii’s Balance board should be avoided”. (Pachoulakis et al. 2015). However, that doesn’t mean that they didn’t get good results, “After playing the games for 12 weeks, 65 percent of game players demonstrated longer stride length, 55 percent increased gait velocity, and 55 percent reported improved balance confidence.” (UCSF, 2018). "Games for rehabilitation are developing rapidly in recent years. It has been shown that utilization of therapy and gaming technology affects positively on the patients' physical and mental condition. However, to this day there are only few playable games for Parkinson's disease patients." (Assad et al., 2011).

There have been large amounts of research that have shown that video games can help prevent/reduce the risk of Alzheimer’s disease, more specifically it would be the brain stimulation that video games can provide for players. The Daily Express states “Almost any type of mental activity may be beneficial, but they should involve new learning and be reasonably complex, varied and interesting, and engaged in frequently.”

That’s why this project is about seeing if memory / reaction-based games can have a positive effect and possibly make a noticeable improvement to anyone suffering from either of these cognitive impairments. The main premise behind this is to see if cognitive impairment patients can get enough training and warmup from playing these games that it at least eases their troubles a slight, this opens the door for a range of fun repeatable games that will work to a similar effect, as long as it is enjoyable enough for them to want to keep doing it, also as long as it works for them. The two biggest complaints about the motion-based games was that they can injure themselves with the Wii board etc. and that they were boring, “exercises are very repetitive in nature leading to boredom and demotivation and hence lack of adherence.” (Mirror, 2014).

Overall this project should help identify if memory and reaction-based games can be used as a means to help manage / combat Parkinson’s Disease, the test results from this project should give a good indication into whether or not the individual was improving, and the surveys will allow for data to be gathered from the individuals themselves to see if they felt improvements in their reactions and in their ability to play the game.

## Aims:

### Primary

1. To Develop an application that can help improve the lives of those suffering from Alzheimer’s and Parkinson’s.

## Objectives:

1. Fully design 5 different and unique games these will be a mixture of reaction-based games and memory games.
2. Develop these games in unity, trying to keep an ongoing theme throughout & a local aesthetic.
3. Run tests on a small baseline of players, this will help get an understanding of how the general population can handle these games and allow me to address any problems that may arise from this.
4. A full survey would need to be distributed next, this will allow for all of the participants to give their opinions on whether or not they think the practice helped improve their score.
5. Get feedback from professionals who understand exactly how to care for and treat people suffering from cognitive impairment and use this to improve any lacking qualities in the project.

# Section 2: Literature Review

## Literature Review

### Exergaming

Exergaming is quite simply the name given to a video game that is also a form of exercise. Exergaming was pioneered by Autodesk who originally developed two systems HighCycle and Virtual Racquetball, this was in the 1980’s and was quite limited at the time, however they both allowed the user to have a larger than life experience without leaving their homes. (Lu, 2015) states that “it wasn’t until the early 2000s, when “Dance Dance Revolution” (Konami Digital Entertainment, El Segundo, CA) and the Nintendo™ (Kyoto, Japan) Wii™ became internationally popular, that this genre became more recognized within the halls of gaming.”

It wasn’t until later around 2012 and after that Exergaming was being picked up more and more by researchers to try to combat a number of ailments, including Parkinson’s Disease. As you can see from pieces like (Harris et al., 2015), “We have identified that static balance, indicative of PC changes, among older adults can be improved by exergaming,” and “Exergaming was effective in enhancing balance and reducing fatigue in PD patients after 12 weeks of treatment” (Ribas et al., 2017). Most of the research I could find regarding gaming helping Parkinson’s patients, was in some way related to Exergaming, which are games that would be played on a motion-based console, such as the Wii or on specific hardware’s for other devices, such as the Kinect. These games help the sufferers train their stability & muscular strength and has even been shown to make a real difference by the Michael J. Fox Foundation (2012), who claim that over 12 weeks, patients reported gains over several ranges of mobility including, longer strides, increased gait velocity and improved balance. However, this type of treatment would only apply to Stage Three of Parkinson’s and up; I’m hoping that this project can look into designing and developing an app that can help patients combat the cognitive deterioration.

### Improving Memory in Parkinson’s Disease

This study was aimed at improving awareness, improving memory and slowing cognitive decline in people with Parkinson’s disease. The study took a sample size of 50 participants who suffered from Parkinson’s, they then underwent cognitive training for hourly sessions twice a week over seven weeks. “these findings suggest that a healthy brain ageing cognitive training program may be a viable tool to improve memory and/or slow cognitive decline” (Naismith et al., 2013).

As for games that effect sufferers from Alzheimer’s, they are often designed to combat two key issues, the first being “Sundowning” which is the common term used for the confusion and other symptoms that occur in dementia patients as the sun goes down, the second is to help combat depression that can arise in these sufferers. According to Yamagata (2013) “The games that are often used to help combat Alzheimer’s are memory games, audio-based touch game and basic repetitive games.” Robert (2014) commented that there was more positive feedback for games that were vibrant and full of colours when it came to Alzheimer’s patients, this is something that I plan to keep in mind when it comes to finalizing the art for my game. His report also goes into detail about how it is important to have a “Social Bonding”, as social isolation and lack of social interactions are often reported as crucial problems by elderly people and people suffering with dementia-related disorders. If I am allowed to then I would like to be able to stop by semi-regularly to help get some feedback as testing progresses further, but to also help on a social level any way that I can.

## Summary

From my research, I’ve seen that many games in the past have focused on creating games that help the awareness and reflexes of people with Parkinson’s Disease, Alzheimer’s, and Dementia. I would like to create games that do the same thing; however, my focus would be helping them improve their attention span and help them gain faster reflexes. I feel this is important for them as even though they might be deteriorating, practicing and enhancing their reflex and attention skills could help them improve these skills to the point that they’re able to react faster and keep focus in games and their everyday lives. Also, previous researchers have created games where patients haven’t had the chance to interact with other people, which isn’t improving the depression they develop with these conditions. I would like to possibly create games where they can play with other people or even against an AI in the future, this is an important part of their game play as they need something to grab their interest and playing with another player not only adds more interest to the game but may even improve the loneliness of the patient playing.

# Section 3: Design, Implementation, and Testing process

## Planning Process

The planning process consisted of a large amount of research into what apps are currently on the market that sell themselves as cognitive training/brain training games. These include Mind Games (2018), Elevate (2019), Memorado (2019) and Skillz (2019). I knew that I wanted to make something along the lines of these games.

I first thought that I should have 5 different fairly stand-out levels with calming backgrounds, bold colours, a lot going on, on the screen to improve their focus and clarity. I later had some feedback from an expert with more than 25 years of experience working with and caring for the cognitive impaired, she informed me of some of the problems that my app was currently facing and gave me some ideas and examples of how to fix them.

The first was that my backgrounds were too over-the-top and confusing. Some of the patterns I had for certain levels had too many patterns in them and she stated that this could confuse or upset some patients suffering with dementia. She also stated it can also make some of these sufferers hallucinate and overall, I should try to stick to a more simplistic background and pattern design. With this feedback I changed the colour scheme of the application and made the background the same for each of the levels.

The next big issue I had was that my colours didn’t stand out enough in some cases, I was told that “the gold butterflies should probably be made brighter so that it doesn’t blend into the background and so that it is more easily seen”, I was also informed that bright reds and bright blues can have calming effects, bright green and bright oranges stand out as well, and that “the bolder the colour, the better”. I used this information to completely change all of the button colours, score colours and object colours in the game to make the more important items stand out the most.

The last bit of feedback I got regarding the design was with the card patterns and objects used in minigames 2 and 5, it can be difficult knowing what kinds of objects and everyday items a dementia patient would remember or acknowledge. This is why I was recommended to make all of the objects and symbols in the game very recognizable and was encouraged to use basic and simple shapes as much as possible.

## Development

This application was made in unity, I chose this to make porting to android devices easier. I did use TextMesh Pro which is a powerful asset for replacing unity’s UI Text & Text Mesh, this allowed me to use a number of advanced text rendering techniques and make use of some custom shaders. For the games I decided that I wanted a mixture of reaction-based games and memory games. The first game is a reaction based game where the player needs to click the butterflies as they fall, each of the colours represent a different score, this hopefully keeps players attention so that they don’t just hit all of the butterflies, they instead choose the ones worth the most (gold) and try to avoid the minus points (red). Going forward I was informed that I should remove one of the butterflies as there may be too much going on, on the screen so I should “try to keep the choice to just one rather than two plus points”.

The next game is a card matching game where the player needs to flip 2 cards and check if they match, if they do then they disappear, if they don’t then the cards flip back, and the player needs to select 2 more. This game is about remembering where the cards are and keeping track of which are which. When I first showed this to the expert, I explained that I planned to have three stages of varying difficulty, the first had 8 cards (4 pairs), the second had 14 cards (7 pairs) and the last had 20 cards (10 pairs). However, she explained that anything more than 10 cards could fluster or confuse dementia patients, she said that the idle range would be around 4-10 cards. With this in mind I choose to just have the first stage active and see where it goes from there.

Game three is probably the least polished, in this game you need to hit the bullseye before they disappear, they pop up randomly and vanish quickly. The core idea of this game was Whack-A-Mole. This game was different originally, the player would have to select the cardinal direction that the middle most arrow as pointing, then the screen would fill with small group of arrows all pointing different directions. However, this would have confused anyone with middle stage dementia and potential early stages as well, this was due to so much going on, on the screen, with this in mind I couldn’t really think of a way to dial the game back a small amount. I instead opted for changing it entirely, however, now I’m told that the bullseyes may be going too fast and this may still confuse sufferers of the middle stages of dementia, however, the early stages should be able to play this game now. Making the changes in this game to get it to a stage that sufferers from the middle stages of dementia can play won’t be difficult, the next version of the project would have the patch to slow all the bullseyes.

The fourth game is Simon Says, the player needs to watch the pattern on the screen, then they need to key the same pattern back into the app, there are 3 stages to this game, I did originally plan to have larger patterns warned that the pattern should only really have 3-4 lights in a sequence, however I was told that the “The pattern game is perfect. Not too hard and easy to follow”.

The final game is sequence memory / reaction game where the player needs to decide if the two left most objects are the same object or not, once they pick yes or no, the leftmost one is removed, and they need to decide again, this goes until the time runs out. This game was originally a game where the player would get two key works appear at the top of the screen, then around 20 images would appear on the screen and they would have to click on all of the images that the words applied to, for example if car came up you could select the Ford, BMW & Range Rover, whilst leaving the butterfly, horse & cat. However, I was again told that I should dial the game back a bit if I wanted dementia patients to be able to play this, so I chose to again change the game entirely and went with this. I was told that the design of this one is good and the colours stick out nicely, however I should only have about 4 shapes or so in a line and not 6-7 but this is something I can easily change for future versions. The development went similarly to the design phase, However, didn’t get any feedback until quite late and the changes may have suffered from this.

## Testing Strategy

In the future when it comes time to test Parkinson’s and Alzheimer’s patients with my games I originally wanted to have one group of testers play all of the games one after another and collect results and have another group of testers just play the fifth game with no warm-up of the other four. This would have allowed me to see if the repetitive gameplay would help patients improve at a faster rate. However, having spent more time going through other research and seeing how my baseline have played my app, I think it would be better if all of the patients play all of the games for an extended period of time and look for more improvements that way. This is because my baseline have said that they enjoy different games and they feel that they have improve on different games as well, so I think it would be more beneficial if the cognitive impaired patients played all of the games as well so they can improve on what they struggle with and enjoy what they find fun.

# Section 4: Evaluation and Conclusions

## Results Evaluation

Through these results I have learnt that the baseline is high some people getting consisting perfect scores, this lets me know that these games are easy to an extent, however I do feel that when to comes to testing these games on someone slightly less capable then the baseline that they will struggle more and have harder time getting scores even close to the average. As you can see in the graph, the baseline of testers was able to keep the average consistently high with it peeking as they went further through. As you can see in the appendix, survey question 3, the baseline seemed to enjoy playing Mini-Game 1 the most. I did notice that the average score for mini-game 5 dip at one point, I went back and looked through the files and saw that one of the participants only made one pick then let time run out to get 100% accuracy, this could be something that I look at tweaking in the next version, give more incentive to get higher score rather than better accuracy.

## Results Summary

Most of the baseline improved on game one the most as you can see, however the best overall averages belong to game four, I think this means that I should try to implement a small hurdle to the mini-game in question, try to make it a tad more difficult. It seemed that people had the hardest time with game 3, this is something I am going to have to address in the next version. I need to either slow the bullseyes down or make them larger on the screen.

# Section 5: Critical Evaluation

## Evaluation

Overall in project I think that the games came out at a good standard for Dementia and Parkinson’s players, this is based on the feedback I’ve gotten from an expert who has more than 25 years working with and caring for these patients. I think that my biggest mistake was the underestimated this dissertation, I am thoroughly disappointed with this document. In future I need to understand the scope of a document like this, I knew it would difficult to write and analytical describe my process, however I thought I would have a better grip on the whole thing. I’ve also found that making a game for a mobile device like android is fine, but It would probably serve me better to make the product available on all mobile devices, such as apple. This would allow me to increase the amount of people who would baseline this game, it would also make the application more available to any patients with a mobile not just the once with android. In the next version ill also make sure to make all of the game object scale correctly to tablet devices, this will again increase availability.

## Future Works

There are a large amount of things I would change with this project if I could go back and do it again, the main one would be to be more specific when it comes to my proposal, I think that my project got a little skewed when I decided to evaluate Parkinson’s & Alzheimer’s patients. This has changed the way I look at creating games however, I usually prefer to make more complex and challenging games, so have to dial it back for this project which was more difficult then I imagined, however I understand the need now and I think I will be able to dial games back more easily in the future.

## Conclusion

In conclusion this project helped me understand cognitive impairment in a way that I couldn’t have before, I personally never realized how dialed back games like these need to be for people with cognitive impairment, it has given me a new view on the way these types of games are made and it allows me to appreciate the balancing act that is needed for the creation of these games, as you need to make them difficult enough to keep someone’s attention but still not too difficult or overwhelming that someone with dementia or Alzheimer’s gets confused.

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# Appendix

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