FREEZING OF GAIT IN PARKINSON'S DISEASE

Research Dissertation

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ABSTRACT

Parkinson's Disease is a neurological disorder that currently affects 1% of people over the age of 60. (Reeve et al., 2014). One of the most distressing symptoms of this disorder is Freezing of Gait. Freezing of Gait is detrimental to a patients' physical and psychological health, yet remains one of the least understood symptoms of PD (Giladi et al., 2001). This study aimed to discover what rehabilitation strategies were currently being used to treat FOG in a clinical setting, and how emerging technologies could be used to positively improve these strategies. Four areas were identified to successfully assist in better understanding the aim. A mixed data approach was taken, with both a semi-structured interview, and quantitative survey being deployed to gather data. Rehabilitation Strategies, Patient Individuality, Implementation of technology, and Gait and Movement, were found to be the most prominent subject areas within the research. Findings suggested that whilst there was merit for the use of emerging technologies to treat FOG, current technologies lack research-based evidence proving their effectiveness. Through the adaptation of existing techniques, there are many areas for further exploration, that will be driven by research. The findings of the research were then synthesised to create a final design justification, and a product was developed to meet the needs of the research. The OneStep system created, assists PwP by providing them with instantaneous cueing when freezing occurs.

Document Outline.

01

INTRODUCTION

Parkinson's Disease (PD) is a chronic neurological disorder that is caused by the death of dopaminergic neurons in the substantia nigra (Dauer & Przedborski, 2003). Scientists have speculated that the cause of PD could be due to a combination of both genetic and environmental factors, however the cause remains unknown (Hardy et al., 2003). The progression of PD differs from person to person due to the diversity of symptoms associated with the disorder. However, even with diversity, there are still cardinal signs of PD that are used to characterise the disease and differentiate it from other parkinsonian disorders. These signs include rest tremor, bradykinesia, rigidity, and gait and balance problems (Jankovic, 2008).

PD is a particularly important topic to research, as statistics suggest that the disease currently affects approximately 1% of all persons over the age of sixty (Reeve et al., 2014). The latest Demographic trends have displayed that the number of elderly people within this bracket will continue to increase significantly. The population aged 60 years or over is predicted to increase by 56% by the year 2030, and this is projected to increase even more drastically by 2050, with the senior citizen population almost doubling in size since 2015. This drastic increase of a singular demographic indicates the need for a shift in global attention, essentially requiring more catering towards the medical needs and healthcare of the soon to be ageing population (Maresova et al., 2019).

Chronic diseases such as Parkinson's have a detrimental influence on both physical and emotional status, due to its ability to affect a persons' mobility, and make them dependent on others (Somrongthong et al., 2016). This can further result in declination of their self-esteem and is destructive to their overall Health-Related Quality of Life (HRQoL).

Although PD involves many unbearable symptoms, Freezing of Gait (FOG) is one of the most debilitating. Around one-third of PD patients experience the phenomenon of FOG, which is loosely defined as the inability to create forward progression whilst walking despite the intention to do so (Nutt et al., 2011). FOG significantly increases a patient's likelihood of experiencing a fall, and the occurrence of FOG is often ensued by nursing home placement (Kerr et al., 2010).

This project aimed to investigate the existing tools and techniques that are being implemented to monitor and assist with freezing of gait in both a clinical and home setting. This in turn helped to discover what techniques are the most effective, so that relevant components of existing techniques could be synthesised. This synthesis went towards the development of the OneStep system, created to help assist PwP with mitigating and measuring their FOG.

PROJECT OUTLINE

Figure [1] Project Outline

02

LITERATURE REVIEW

The ensuing literature review will investigate the effect that Freezing of Gait has on the Health-Related Quality of Life of an ageing population. The review will also compare and analyse existing and emerging tools and techniques used for rehabilitation and monitoring of FOG, in order to synthesise a research direction for further study.

Figure [2] Parkinson's Patient holding cane.

2.1 FREEZING OF GAIT

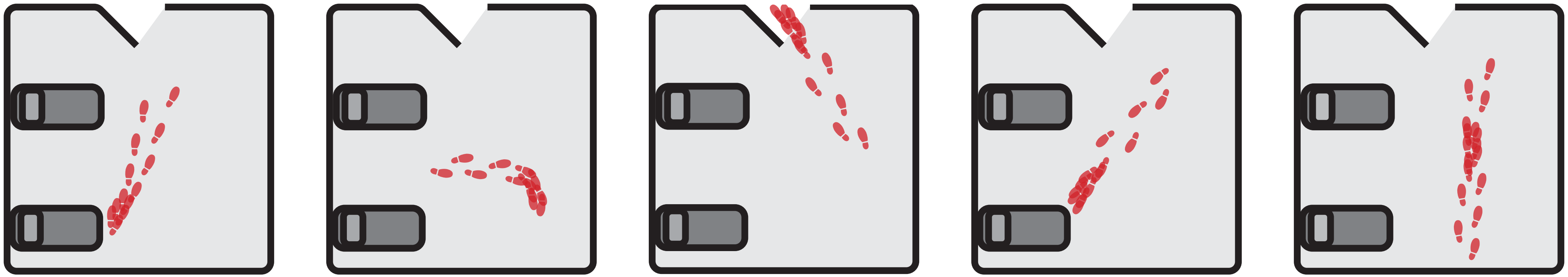
Freezing of Gait is one of the most distressing manifestations to appear with late-stage Parkinson's Disease, yet still remains one of the least understood (Giladi et al., 2001). To define the phenomenon of FOG precisely is challenging, although the clinically sound definition, similar to that explained previously, is "the inability to create forward progression, despite the intention to do so". This inability to produce forward progression can be incapacitating for affected patients and has been found to be generate both physical and psychological impact on the patients HRQoL (Nutt et al., 2011). Although FOG is usually rare in early-stage PD, it is the most commonly reported complaint amongst patients and caregivers as the disease progresses.

Falls experienced during PD are caused primarily due to the underlying balance disorder associated with the condition and are unrelated to external or environmental causes such as loose objects on the floor or collision into static objects (Bloem et al., 2001). A vast number of falls can be attributed to a change in gait posture, particularly the use of trunk movement, or other more complex activities performed simultaneously whilst walking or attempting to balance.

Observations suggested that PD patients struggle to prioritise what the most crucial techniques are when walking (i.e., continuous upright stance), and instead elect towards completing all techniques at an equal level. This poor prioritisation can be a detriment to their gait or balance while walking. It is most common for PD patients to fall forwards when walking (45% of falls), due to their characteristically hunched posture, with laterally directed falls being the second most frequent fall direction (20%) (Bloem et al., 2003).

There are **five types** of clinically recognised FOG, that are illustrated in Figure 3.

Oftentimes, FOG is made worse through overcompensation made by the patient. A study done by Bloem et al. (2004) found that FOG is made worse when patients attempt to overcome the neural block, and that fighting the urge may contribute to more severe FOG.



[1] Start Hesitation
When freezing is detected upon the initiation of walking.

[2] Turn Hesitation
When making a turn, feet become stuck in place.

[3] Hesitation in tight-quarters
When freezing occurs as a patient attempts to pass through a narrow space

[4] Destination Hesitation
When freezing occurs once a patient is less than two meters away from their desired target.

[5] Open Space Hesitation
When freezing occurs in an open space without any provoking factors.

Figure [3] Clinically recognised types of FOG.

“Why focus on FOG? Shouldn’t you be trying to solve all of PD?”

FOG can be even more disabling for HRQoL than sleep, motor severity or mood disturbance due to its inherent unpredictability to occur (Walton et al., 2015). This unpredictability means that FOG could occur in dangerous situations that could provoke stress. The impact this has on a PWP is so disabling, that it can significantly impact how safe a patient feels in public and increases their anxiety around falling or injuring themselves. If they are to experience FOG in a public setting, such an event can feel both frustrating and embarrassing for the PWP, which can further isolate the patient, and make them feel as though they are a burden (Schrag et al., 2006). Falling is an incredibly important component of why FOG was specifically chosen for further research. When a fall occurs to a PWP the outcome is devastating, it restricts the PWP from regular daily living, increases their anxiety around falling, and creates high levels of caregiver stress (Fasano et al., 2017). PD also increases the risk of hip fracture for people over the age of 60, making them four times more likely to experience a hip fracture due to a fall compared to elderly people in a similar age bracket without PD (Walker et al, 2013).

HOW IS PARKINSON’S DIAGNOSED?

To understand what techniques will be deployed to assist with FOG, we must first understand how the disease is diagnosed.

To determine whether a person has PD, the aforementioned cardinal signs are analysed and reviewed against clinical criteria to determine how severe the Parkinson’s is. Correctly diagnosing PD is essential for developing personalised rehabilitation plans and conducting clinical research.

However, due to the personalised disease characteristics, and the lack of cohesive symptoms from person to person, there is no definitive clinical test to diagnose the disorder (DeMaagd & Philip, 2015). Instead, the disease is diagnosed based on clinical scales using a process of elimination.

The two primary scales that are currently used to diagnose PD is the Unified Parkinson's Disease Rating Scale (UPDRS) and the Hoehn and Yahr scale, with the latter demonstrated in Figure 4. These scales are closely centred on following the progression of the Disease, and allows clinicians to categorise patients effectively.

	Hoehn & Yahr Scale				
stage of PD	1	2	3	4	5
recognised symptoms	Unilateral Involvement only (symptoms only seen on one side of body)	Midline or Bilateral Involvement (symptoms visible on both sides of the body)	Impairment of postural reflexes. Struggle to maintain balance, and difficulty with movement.	Major deterioration of HRQoL, symptoms at this stage are severely disabling	Patient is confined to bed or wheelchair, unable to walk or stand unassisted.

Figure [4] Hoehn & Yahr Parkinson’s Rating Scale

The effectiveness of these tests is not currently suitable, as clinicopathological studies found that clinicians misdiagnose PD in around 25% of patients (Tolosa et al., 2006).

2.2 WHAT ARE THE CURRENT REHABILITATION TECHNIQUES?

Once the severity of the patients symptoms have been verified, the rehabilitation process begins.

The industry standard for clinical rehabilitation of PD and FOG is a combination of medication and therapies. The current strategies have been the standard for over a decade.

LEVADOPA

Levodopa (LD) has been used in the drug treatment of PD for the last 40 years and has remained the benchmark of symptomatic efficacy (Poewe et al., 2010). The use of LD for dopamine replacement has been paired with the largest improvement of motor function in comparison to other existing dopaminergic therapies. LD works by providing an increase in brain dopamine concentrations, that allow for the improvement of nerve conduction, and therefore assist with movement disorder (MedicineNet, 2019).

When dealing with dopaminergic medication, the effectiveness of the treatment is broken into “On” and “Off” stages. The treatment is done this way to ensure that the medication stays effective for as long as possible and does not give the body time to habituate itself with the medication. When you are in an “On” stage your medications are generally working effectively, and your symptoms will be controlled. When in an “Off” stage, LD is no longer functioning correctly, and PD symptoms such as tremor, slow movement and rigidity will re-emerge (DeMaagd & Philip, 2015). However, there is a complex relationship between FOG and dopaminergic medication, that differentiates between PWP. FOG most commonly exists during the “Off” stage of LD, this type of FOG can be relieved by following a rehabilitation plan, and taking regular doses of LD.

However, there are other types of FOG that react differently to LD and are not as easy to control. “Unresponsive FOG,” is a type of FOG that is unaffected by changes in medication and remains even after taking LD. Another more complex type of FOG is “On” FOG, which is used to describe FOG that is induced by medication (Espay et al., 2012).

Levodopa can be an effective way to ameliorate PD complications, but this is not without compromise.

When dopaminergic medications such as LD are at their most effective, there is a high probability in late-stage Parkinson’s that you may experience Dyskinesia. Dyskinesia is a common side-effect of LD, that causes unintended movements, jerking, twitching and restlessness (Calabresi et al., 2010). Severe Dyskinesia induced by LD forces PD patients to choose between “On time” with uncontrolled movements, or “Off time” with more severe PD symptoms. This compromise significantly decreases their HRQoL, and impacts their independent decision making (Poewe et al., 2010).

The primary treatment for “On” FOG is the reduction of medication, however, this reduction is impossible for some PWP as their cardinal PD symptoms get uncontrollably worse when not taking LD (Heremans et al., 2013).

Consequently, this shows that there is a need to assess additional treatment options for FOG. One such treatment option, that has been adopted clinically is cueing techniques.

CUEING

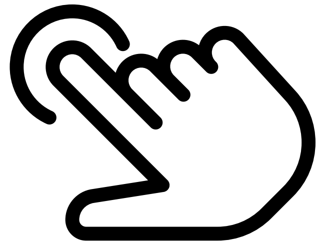
Cueing is a technique that has now become well established clinically, as it has demonstrated its ability to improve gait in PWP. This includes step length, cadence (total number of steps taken per minute), walking speed, and a decrease in the amount of FOG incidents (Rubinstein et al., 2002).

The literature has extensively reported three cueing modalities: visual, auditory, and somatosensory cueing. Each modality reflects a specific stimuli that is utilised by the respective cueing technique (i.e., Somatosensory Cueing will provide Somatosensory Stimuli). Additional modalities may be created when synthesising two types of modalities (i.e., The use of Visual-Auditory cueing to provide both Visual and Audio Stimuli) (Sweeney et al., 2019).

Some examples of these modalities are as follows:

Auditory Cueing adopts the use of a metronome or audible device with the ability to repeat a noise or sound to a set rhythm. This forces patients to consciously focus on timing their steps, and improve their cadence depending on the speed at which the audio rhythm is playing.

Visual Cueing involves visible stimuli, such as parallel lines or footprints marked on the floor. Line marks on the floor provide the patient with better spatial information, which in turn, assists their spatial processing. The regulation of step length forces the patient to think more cautiously about their stride, and the steps they must take for successful gait training.



Somatosensory Cueing implements rhythmic and vibrational feedback to simulate shoulder tapping. This feedback conveys temporal information, that can assist with step timing, simply by tapping on the patient.

Research suggests that Cueing affects the coordination and execution of movement, by compensating for the defective internal rhythm generator of the basal ganglia (Burleigh-Jacobs et al., 1997). In this way, PWP are effectively using visual, auditory, or somatosensory cueing to external rhythms or patterns to the brain, to which movement can be coupled (Janssen et al., 2017).

A study conducted by Bächlin et al. (2010) indicated that rhythmic auditory stimulation is the most effective means of cueing to assist with FOG. This was further confirmed by McCandless et al. (2016) who found that Visual Cueing is beneficial for gait initiation, but not extended periods of walking, making it incomparable to Audible Cueing. The same study conducted by Bächlin et al. (2010) also discovered that metronomes were not entirely effective when it came to audible cueing as they continuously create rhythmic feedback, even when FOG is not present. This in turn, could reduce the cueing effects as the PWP becomes habituated to the stimuli.

To address this limitation, Bächlin et al. (2010) designed an Auditory Cueing system (Seen in Figure 5) that only provided Cueing when a FOG episode was detected.

This rudimentary system integrated both wearable technology, such as wired earphones and sensors, and a minicomputer strapped around the patient's waist. This study involved 10 participants who had experienced FOG as a regular symptom of PD. Of those 10 participants, whilst three expressed no difference in FOG, half of the participants claimed that it improved their FOG and lowered the frequency in which it occurred. One participant expressed concerns that their FOG episodes increased in frequency. In addition, five of the ten participants also claimed to have experienced a shorter FOG duration, with the rest of the participants expressing no change (Sweeney et al., 2019). A trial conducted by Arias & Cudeiro (2010) discovered that FOG episodes decreased in frequency when the Auditory Cueing Devices were given a tempo scaled 10% above the user's regular cadence. The implementation of an adjustable tempo was paramount to the success of the study, as it recognised the disparity of cadence and gait issues between PWP, and the need to adjust for personalisation.

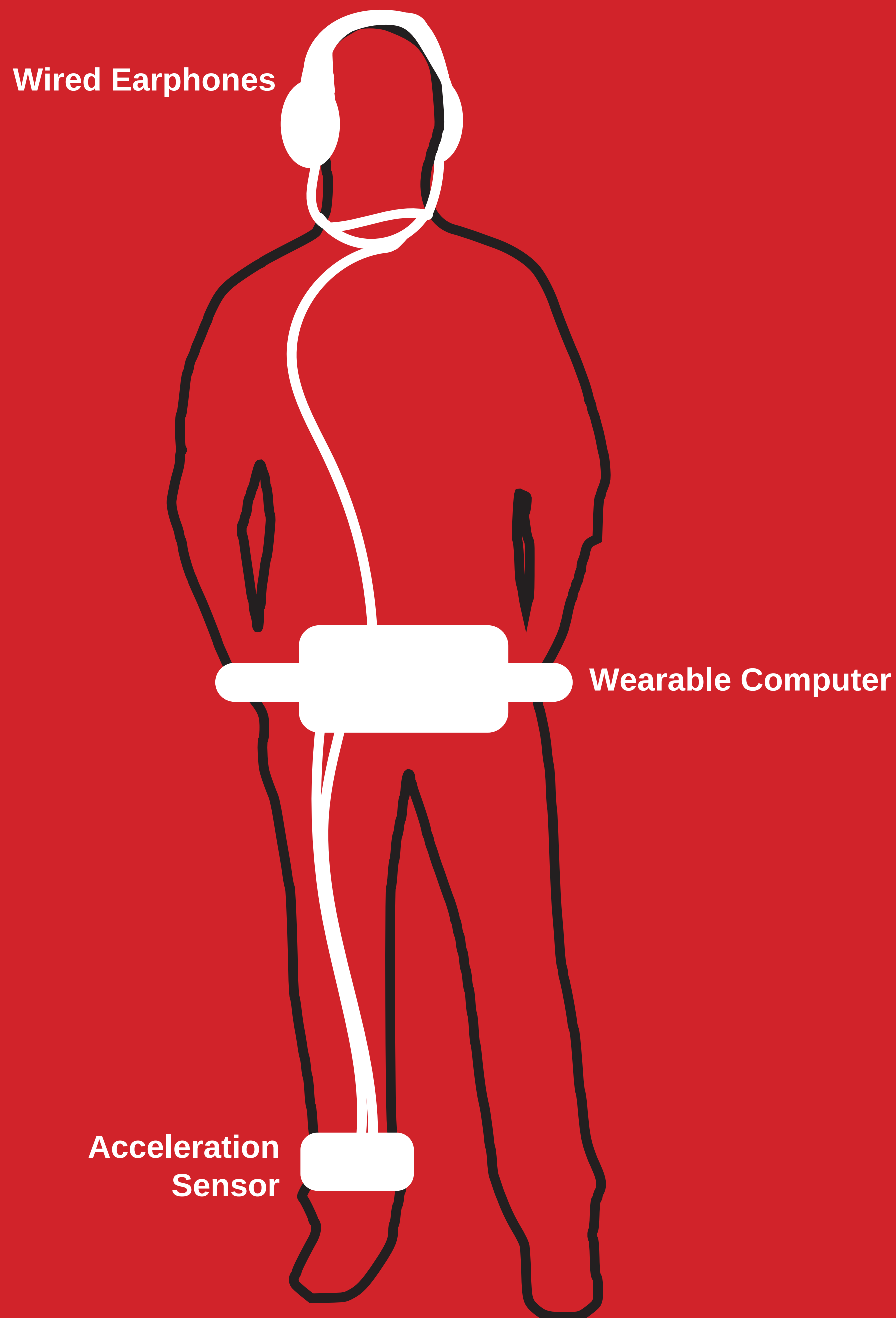


Figure [5] Bächlin et al. (2010) Cueing System

Cueing has been drastically improved in recent years due to emerging technologies.

Although Bächlin et al. (2010) proposed the use of emerging technologies to miniaturise his Auditory Cueing system, Sama et al. (2014) were the first to create such a system. This system, seen in Figure 6 synthesised the work of both Bächlin and Arias. Sama et al. (2014) adopted a smartphone as a feedback device, to increase accessibility, and remove possible stigma around large wearable devices. This led to the refinement of Auditory Cueing systems, and the development of smartphone applications that were tailored specifically for the abilities and needs of PWP (Ahlrichs et al., 2016). Similar results were gathered during a randomised control trial by Ledger et al. (2008), who found that iPod Shuffles were able to be implemented to assist with FOG in a home environment. The modernisation of this system allowed for a completely wireless connection between phone, headset, and sensors, making it easily deployable into everyday life. In addition, the implementation of smartphone technology gave users the opportunity to personalise their cadence speed, or individualised settings, making it more effective for a wider range of user.

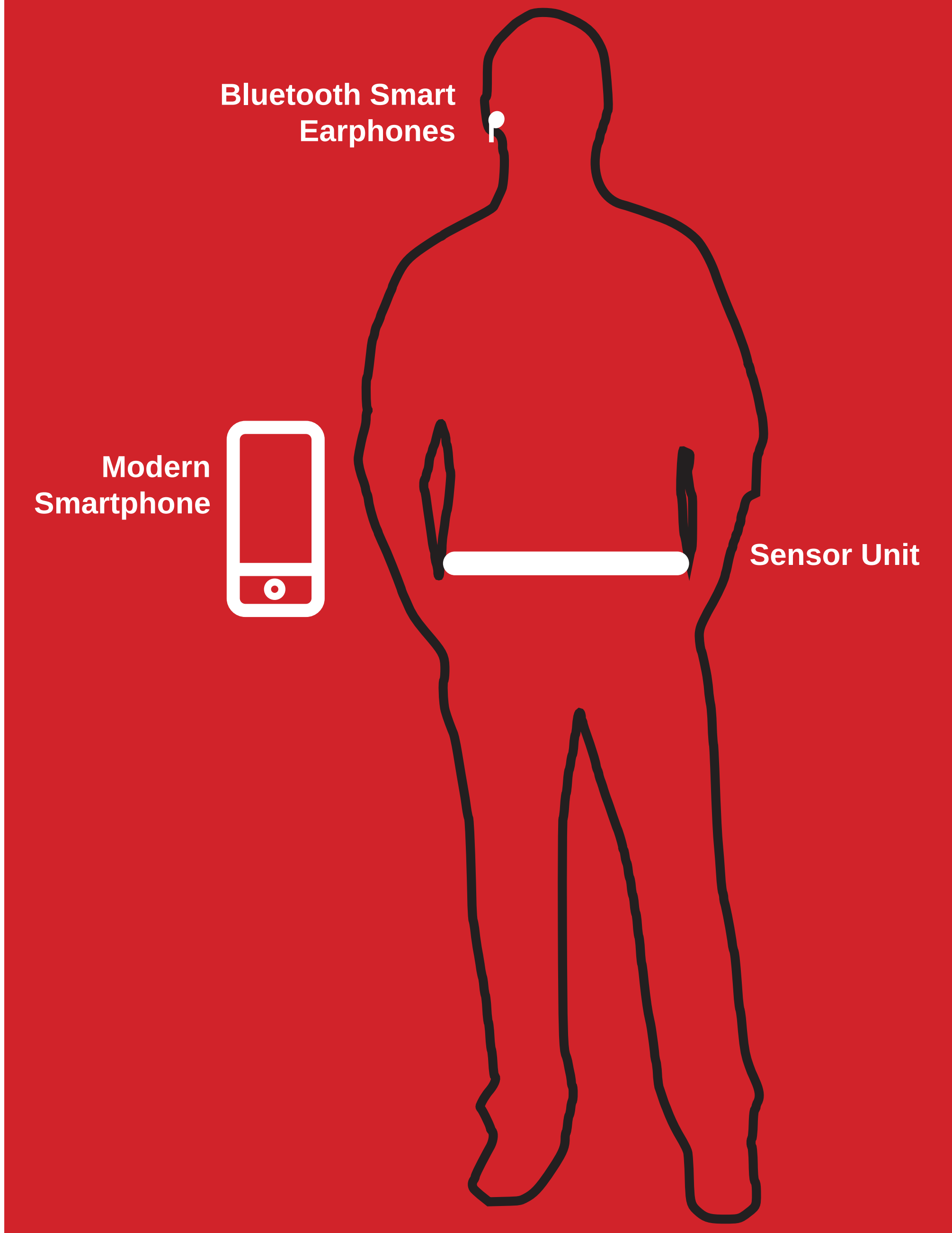


Figure [6] Sama et al. (2014) Upgraded Cueing System

Figure [7] Patient exploring Robot Assisted Gait Training.

2.3 WHAT DEVICES ARE BEING TESTED TO MONITOR & ASSIST?

As technology and design progresses, similarly to the progression of cueing devices, many studies are presenting new ways to prevent and assist with FOG.

WALK-BICYCLE

The Walk-Bicycle (seen in Figure 8) is one product has made interesting progress in the assistance and management of FOG as it is able to reduce the need to create lateral weight shift between a patient's legs during cycling exercises (Snijders et al., 2011). These weight shifts are a necessary part of walking, as they allow for the swing leg to unload prior to step. If the unloading mechanism of a patients walk is impaired, it will likely contribute to FOG (Sweeney et al., 2019).

Figure [8] Strider Adult Walk-Bicycle

A study completed by Stummer et al. (2015) assessed how FOG reacted in PD patients when using a Walk-Bicycle. The Walk-Bicycle was able to significantly decrease the amount of time patients were frozen among PWP who regularly experienced FOG during walking. Interestingly, the Walk-Bicycle did manifest FOG in two patients that did not regularly experience FOG whilst walking. Although, this could be explained by the lack of time given to patients to familiarise themselves with the product. The findings of this study indicate that the underlying mechanisms of FOG vary between patients. Which demonstrates that products such as the Walk-Bicycle may merit some users, but not all, and the effects of such products should be evaluated individually depending on the patient.

Walk-Bicycles are not the only attempt that researchers have made to improve FOG by providing walk assistance.

ROBOT ASSISTED GAIT TRAINING

A 2013 study by Frazzitta et al. (2013) displayed the advantages of combining treadmill training with cueing, and its overall success on FOG rehabilitation. Similarly, Robot Assisted Gait Training (RAGT), a process that adapts these strategies, was found to improve FOG in PD patients. In fact, RAGT has been able to improve several gait restrictions and balance in late-stage PD, suggesting it could be a more valuable rehabilitation method than treadmill training (Capecci et al., 2019).

The potential effect of continuous physical cueing using RAGT was examined by Lo et al. (2010). The study found that the average frequency of freezes experienced when using RAGT decreased by 20.7%, with majority of participants reporting a reduction in FOG episodes throughout the day (Lo et al., 2010).

When comparing with other emerging techniques, RAGT is one of the safest rehabilitation methods to conduct, as the environment (weight support and walking speed) around the user is effectively controlled and monitored by their clinician. Mohammed et al. (2019) conducted a study that discovered an increase in overall compliance in patients when working with RAGT, due to patient enjoyment related to the training.

However, the use of RAGT has been disputed academically. A randomised control trial by Picelli et al. (2013) found no statistically significant differences between the final outcomes of RAGT and Treadmill training. This trial contradicts the need for RAGT, demonstrating its inferiority to existing treadmill training in improving walking ability. RAGT is also limited in its ability to be performed in a home setting due to the size and cost of the device plus has yet to be implemented and tested in an outpatient setting (Pilleri et al., 2015).

PERSONAL KINETIGRAPH

To contrast this, emerging wearable sensors have the capacity to be used both during clinical rehabilitation, and in an outpatient setting. As touched on earlier, wearable sensors are becoming more common to assist with diagnosis and rehabilitation of PD. This is due to their fundamental ability to provide continuous, accurate data measurements, that can be transferred and analysed in real time. While not specifically used to treat FOG, Personal Kinetigraph's (PKG) have become a valuable tool for clinicians to use when diagnosing and assessing a person's PD symptoms. PKG's are a relatively new technology, that are yet to be implemented completed into the diagnosis process. The device must be worn continuously over a six-to-ten-day period in a home environment, and during this time will continuously record motor function, record medication taken, and offer dosage alerts (Jones et al., 2018).

A previously mentioned study by Tolosa et al. (2006) noted that clinicians diagnose PD inaccurately in about 25% of patients. This means that a quarter of PWP are receiving incorrect treatment, or lack of treatment for their proper symptoms altogether.

During early-stage testing of PKG, their ability to assist in the reliable diagnosis of PD was recognised.

A study involving 70 patients was conducted by Jones et al. (2018). In this study it was found that Kinetigraph assessment was consistent with the clinical diagnosis in 76% of patients. The clinical diagnosis of PD was changed in the remaining 34% of patients, as the PKG found that current diagnosis was not sound. The PKG was also able to find previously unidentified symptoms in 25% of patients, such as bradykinesia or dyskinesia. Based on the information provided by the PKG, patient management plans were altered for a substantial number of patients involved in the study.

The use of PKG may enable better identification of more complicated underlying issues that might require a patient to alter current rehabilitation therapies or make medication changes (Jones et al., 2018). The outcomes of PKG may help to improve HRQoL by correctly diagnosing symptoms to create more refined individual rehabilitation plans.

Figure [9] Personal Kinetigraph

VIRTUAL REALITY

Virtual Reality (Schrag et al.) is an emerging technology that has made an increasingly strong pivot towards clinical and medical use. VR could synthesise, and implement components from the previously discussed systems, to facilitate rehabilitation for FOG. It can do this, not only through the use of wearable sensors, to detect and measure FOG episodes, but also the implementation of the above-mentioned cueing techniques.

The application of VR appears promising as a tool for gait and balance rehabilitation in PD. VR allows patients to engage in experiences that are highly individualized, whilst letting them explore enriched and complex digital environments (Canning et al., 2020). These environments can be instantaneously changed or redesigned, allowing users to experience and explore environments that they would otherwise feel unsafe in. The use of VR presents a solution to the issues recognised by Schrag et al. (2006) that were mentioned earlier in this review. The objective of VR in neurorehabilitation is to assess and train behavioural responses in a controlled environment, that are synonymous to those in real life (Bohil et al., 2011).

Limited testing has been done to explore the effects that VR may have on FOG. However, after prior work suggested that FOG and anxiety may be related, a VR based model developed by Canning et al. (2020) was created to investigate this. In this study, PWP were given a head mounted display (HMD) and told to walk along a walkway, presented in the VR environment. The patients were then visually immersed in one of two environments, each with a differing walkway height. The study confirmed that patients experienced more anxiety when using the higher walkway, which increased the duration and frequency of FOG.

VR has proven to be an effective strategy for FOG assessment and monitoring, due to its inherent ability to be individualised depending on the treatment needed.

Figure [10] Patient exploring 3D environment using smartphone

TO SUMMARISE

A thorough analysis of the existing literature revealed the importance of **emerging technologies**, and the roles they play in the monitoring and rehabilitation of FOG. Insufficient literature has been written on the use of **VR to adopt existing rehabilitation techniques**, such as Cueing. This presents a unique overlap between new and existing techniques, that could be synthesised for further exploration. There is also limited information surrounding the effects that **anxiety** has on **FOG**, and more evidence could be discovered to comprehend this phenomena.

Another observation gathered from the analysis of the literature was the lack of individuality that was available in treatment plans for PWP. Which could ultimately be affected by VR as well.

03

RESEARCH METHODOLOGY

This project aims to find the effects that emerging technologies may have on the treatment and rehabilitation of FOG, and how they can be implemented in a clinical setting to improve the overall HRQoL of PWP. Findings in the literature suggested the effectiveness of Virtual Reality as a catalyst for further investigation, as well as the inclusion of wearable sensors, and more individualised treatment plans.

3.1

Considering the rate at which our population is growing, it is important that we begin to facilitate the improvement of life of the ageing population. Neurodegenerative Diseases such as Parkinson's involve incredibly debilitating symptoms that affect such a large portion of the worldwide ageing population. It is paramount that we are continuously attempting to find the most suitable solutions to these symptoms, and the introduction of emerging technologies allows us to explore this further.

The subsequent research will examine what factors decrease HRQoL in a clinical setting, and how emerging technologies could be used to positively affect PWP's and their overall HRQoL.

In an attempt to create a more defined structure that will assist in answering the overall project aim, three sub-questions have been devised:

1. **How comfortable are PWP when it comes to using emerging technologies, what stigmas exist?**

2. **How can Virtual Reality be applied in additional settings to facilitate a decrease in anxiety induced FOG?**

3. **What boundaries exist when implementing such technologies in a clinical setting? Why are they not yet industry standard?**

These research questions will act as a catalyst to drive the primary research forward, to ensure that the indentified gap is solved.

Professionals such as Occupational Therapists (OT) and Physiotherapists will be contacted via email through university connections. PWP and their carers will be contacted through social media such as Facebook groups, or found through contact with OT or Physio.

Page 23 displays the overall structure that will be followed when completing research. This structure demonstrates the methodology that will be used, and the range of participants that will be involved in the study.

This research will comply with and be approved by the Human Research Ethics Committee at Queensland University of Technology. Prior to interviews, subjects will be required to sign consent forms to agree to the recording of data, however any personal attributes will remain anonymous unless specified otherwise. Survey participants will agree to consent by submitting their survey responses.

Figure [11] Research Framework

RESEARCH FRAMEWORK

The Method

3.2

Triangulation will be used as the main method of data collection for this research. Triangulation involves using multiple methods of data collection or sources to build a comprehensive understanding of the research (Carter et al., 2014). Triangulation is most commonly used when working with qualitative data, as it allows us to compare results from differing methods of data collection. The methods of data collection that will be used are both qualitative and quantitative. These methods will be discussed below.

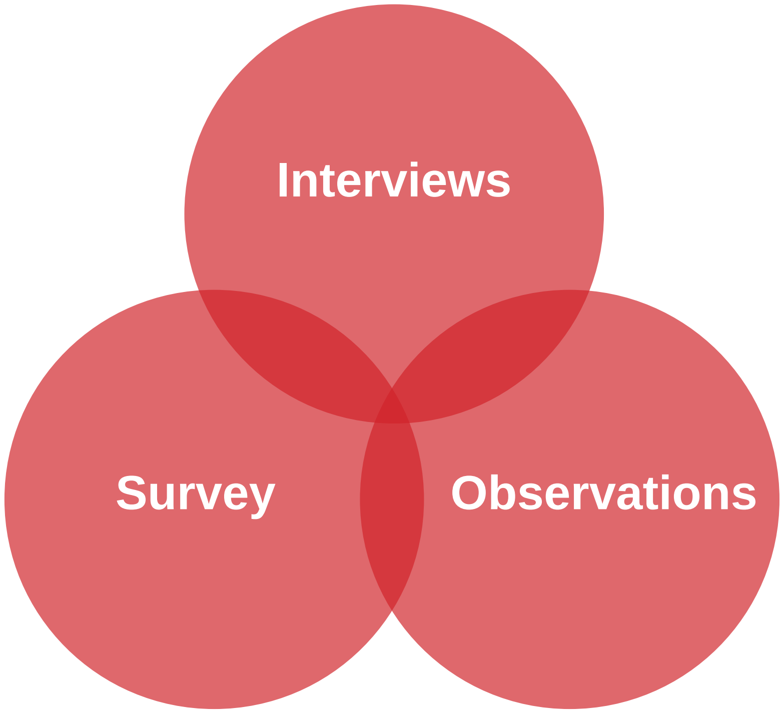


Figure [12] Triangulation of strategies

Interview

Through research, it was found that semi-structured interviews would be the most advantageous in the context of this study. Semi-structured interviews are the most frequent source of data-collection in health-related research. Semi structured interviews are an effective way to explore the emotions, feelings, and thoughts of those being interviewed, and due to the flexibility of the questions, often allow participants to discuss more sensitive or personal information

It is important when conducting semi-structured interviews that a rapport is built with interviewees early on, as this will make participants more comfortable when answering more complex questions. This is especially important when asking questions related to their medical health, or clinical diagnosis.

The semi-structured interviews that will be used can be seen in Appendix A2. These interviews are structured to ensure that the questions grow in complexity as time progresses, to build a strong rapport with the interviewee during the initial few prompts.

The interviews aim to collect data on the processes, and existing technology used when treating FOG in PD, and how these processes effect PWP. Both Clinicians and PWP must be interviewed to understand the current barriers in treatment, and the pain points faced by both the patient and clinician.

Interviews will be conducted both online and in-person, in an informal style. Any interviews conducted will follow government regulations in regard to COVID-19, and this will be considered when organising interview meetings. Interviews will last approximately 30 minutes and involve 10-12 open-ended questions.

Survey

Surveys will also be used as a primary source of data collection due to their ease of distribution, especially online. Both a multiple-choice and short answer survey will be produced for the collection of data.

Multiple choice surveys are an effective way to gather large amounts of quantitative data relating to a specific user group. The answers given in multiple-choice surveys often lack depth, as you are limited to a predetermined list of responses. However, they are effective at gaining insight into trends experienced by the user group and are often more likely to be completed due to the simplicity of questions asked. The multiple-choice survey will be distributed to Social Media groups, and Parkinson's Queensland, to ensure a large participation in the study. The multiple-choice survey will involve 15 simple questions and take approximately 10 minutes to complete.

A Short Response survey will also be used to gain insight into PWP specifically, to assist in understanding the emotional and personal response to FOG, and the treatments they are currently experiencing. This survey will also discuss what strategies individuals find most effective, and how clinical rehabilitation effects their overall quality of life. Due to the on-going risks of COVID-19, it will be more effective to reach the user group through online forums. Online data collection and interviews will be prioritised. The short response survey will involve 8 questions and take approximately 25 minutes to complete, due to the complexity of the questions.

Both Surveys will be created on and released using SurveyMonkey or other similar software.

Observation

Unobtrusive observation will be used to monitor PD patients throughout a regular rehabilitation session, to assess their pain points and emotions throughout the journey. These observations will also monitor how differing rehabilitation methods affect FOG. Through observation it will then be easier to assess similarities between patient journeys, which will ultimately assist in determining what trends exist. Unobtrusive observation is an effective strategy to implement due to the lack of interactivity with the participant. This allows for fluid and uninterrupted observation, that is unchanged due to the presence of a researcher.

Limitations

When dealing with PD, there are many limitations that should be considered when trying to gather data from such a diverse user group. PD is a sensitive disease and symptoms can become debilitating increasingly quick. It is important to note that in some late-stage Parkinsonism, PD patients are unable to consent, and in this case, data may need to be destroyed, or may need to be filled out on their behalf. In previous studies, it has been common for family members or carers to fill out surveys on behalf of the PWP. This means that any answers completed by a carer or family regarding personal feelings may be biased, or only based on face-level conditions, and are not an accurate representation of what the PWP may be feeling.

Clinical related study may also be made difficult due to the current entry protocols being implemented at hospitals due to the risks of COVID-19. Observations may be limited in a clinical setting or may need to be completed primarily online.

04

THE RESEARCH

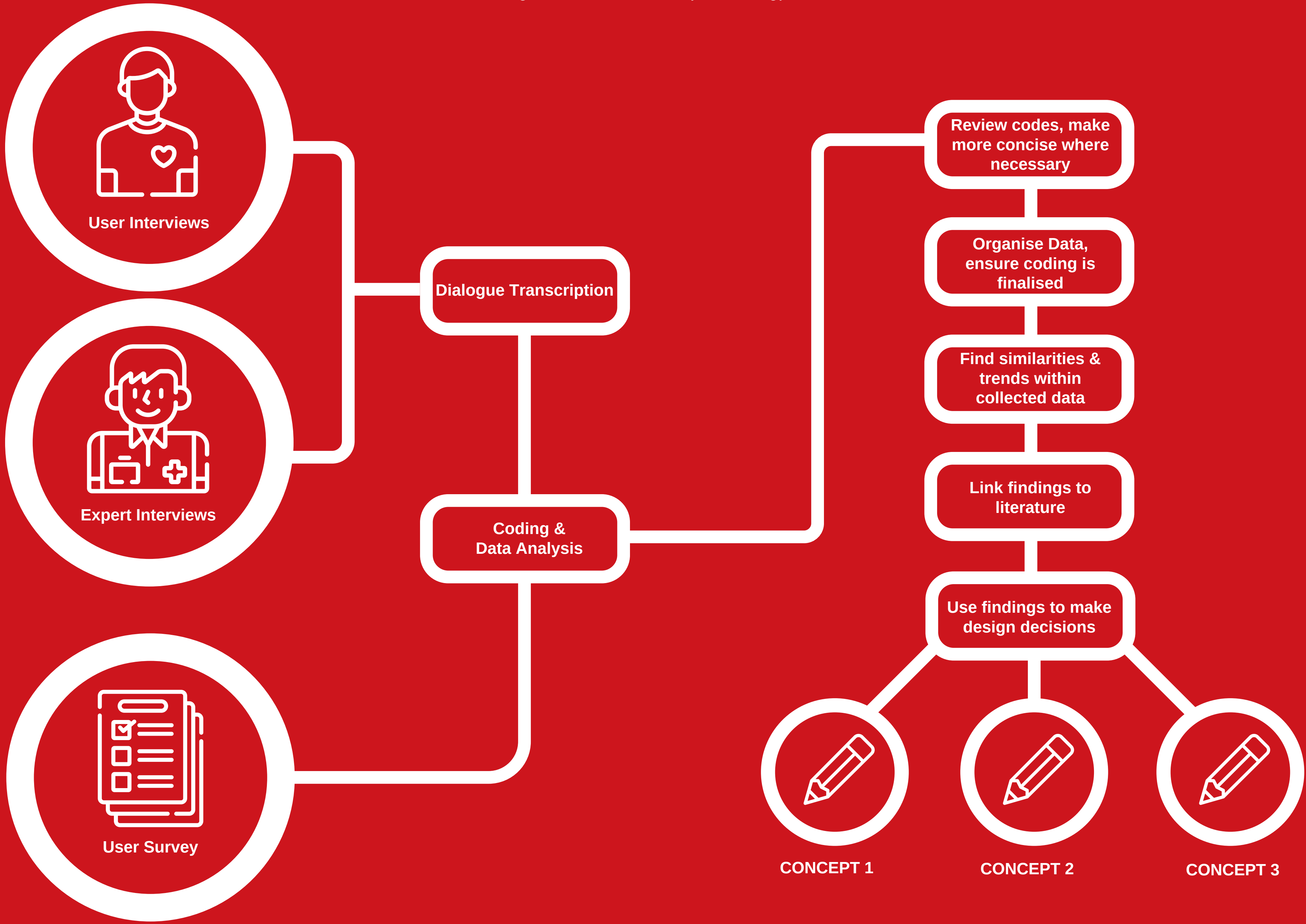
RESEARCH IMPLEMENTATION

The ensuing research aimed to explore what factors decrease HRQoL for PWP in a clinical setting, and how emerging technologies could be used to positively affect the treatment of FOG in Parkinson's Disease. This includes the effect of emerging technologies, what successful strategies are currently being implemented to treat this, and how PWP feel about the use of emerging technologies for the treatment of FOG.

Figure 1 displays the updated research structure that was deployed during the research phase of the project

ANALYSIS STRATEGY

Figure 1: Research Analysis Strategy



CONDUCTING RESEARCH

Semi-Structured interviews were conducted with three physiotherapists, and one person with Parkinson's. By interviewing both Physiotherapists and PWP, it gives more insight into the difference in experience of both parties during treatment and provides insight into the patient/professional relationship. This participant group was chosen due to their unique and diverse experiences, which provides more information into what rehabilitation strategies have been successful, and how patients react to these strategies. The patient interview was beneficial as it provided emotional insight into the patient experience during rehabilitation.
All interviews except one were organised over social media through community groups and forums, with one interview being organised through a QUT network.

The interviews all took place online in either Zoom or Google Hangouts, due to either participant preference/ schedule, or location. Following the Semi-structured interview format, all questions were open-ended, allowing participants to provide more in-depth responses. The interviews all begun by building rapport, which allowed them to be more comfortable sharing information regarding their emotions or feelings during experiences discussed (Dejonckheere & Vaughn, 2019).

A user survey, visible in appendix A1 was created using Google Forms, and involved twelve Likert scale questions, and one short response question. This survey was deployed in 20+ Facebook Community groups with upwards of 2000 members in each and received 41 responses. The responses gathered were filled out only by PWP who had experienced FOG. This survey was deployed to gather more quantitative data on the user group. This type of survey was an efficient choice for identifying trends experienced by a large majority of PWP. Likert scale surveys are advantageous, as the results are easy to understand, and draw conclusions from. This type of quantitative data collection is also easy for the participant to understand (McLeod, 2019). This makes the survey more likely to be completed. Due to accessibility issues of the proposed users, it was more efficient to gather data using a survey. The 41-response survey gathered user data on experiences with previous treatments, how FOG affects quality of life, and opinions on emerging technologies such as VR.

The survey also involved one short response question which aimed to gather preference on existing wearable products, and better understand what participants believed was the most appealing aspects. The short response question included asked participants to select one of four pictured technologies and describe what characteristics they found most appealing within their chosen technology.

Observation, was not able to be completed, as with the ongoing pandemic of COVID-19, it was incredibly difficult to gain access into hospitals and treatment facilities without the proper credentials. Due to this, it was difficult to fully grasp user emotion and experience throughout a clinical treatment session.

MEANS OF ANALYSIS

Once the data was collected, a thematic analysis was conducted to better understand the themes present within the interview transcripts. Thematic analysis enables new insights and concepts to be generated that are entirely derived from the data collected (Braun, 2006). After the finalisation of interviews, the qualitative data gathered was transcribed by uploading audio recordings to Otter.ai, a free online transcription tool. The benefit to online interviews was that the transcription of audio for the most part was clear, coherent, and understandable, making the transcription process relatively easy.

An initial self-familiarisation of the data was completed to make important comments, and ensure the audio was transcribed effectively.

Once transcription was complete, a deductive coding matrix was created to code the data. The deductive codes were driven by information found in the literature, and these codes aimed to comprehend the underlying themes, challenges, and strategies discussed within the interviews. These codes were effective at exploring what portions of the literature were relevant to the interviews.

Once an initial round of deductive coding was complete, an inductive approach was taken to find themes and patterns within the transcriptions that were not necessarily apparent during the literature review. Codes were created when specific portions of text involved any interesting or relevant information. This information was then categorised within a code and given a colour and abbreviation to properly organise it. All transcriptions were coded in an inductive manner, adding more codes as they became apparent throughout the transcription. After the first pass of inductive coding was completed, a second pass was required to define whether any codes created for later coded transcriptions were applicable to already coded documents.

Once all codes were developed and the transcriptions were completed, the existing codes were categorised into themes as seen in appendix 7. Categorising the codes assisted in determining the overarching themes within the research, and whether these themes are positive or negative.

A frequency table, seen in appendix 8 was also used to determine what codes were more apparent within the transcriptions, and how they impacted the participant. The more important codes were broken up into three categories:

- Mentioned more than 10 times throughout the interviews.
- Mentioned by all interview participants.
- Mentioned by 3 out of 4 interview participants.

The frequency table also uncovered which codes were rarely used, and these codes were either combined with a related code or discarded completely. Once the codes were synthesised and finalised, the remaining codes were able to be categorised into four themes that will assist in driving the product development.

The survey responses were downloaded, and the quantitative data was transformed into bar graphs to better understand and analyse the trends and patterns between participant answers. Alluvial charts were used in situations where data needed to be compared, to better understand how patient individuality may affect their preferred treatment method.

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ANALYSIS & FINDINGS

CURRENT REHABILITATION TECHNIQUES

The first prominent theme identified in the literature was the currently used rehabilitation techniques, and how they are being used to successfully assist in the rehabilitation of FOG. A finding that was apparent immediately when conducting interviews was that Audible Cueing, was the most used, and most preferred treatment method for FOG, due to its ability to adapt for use in a range of contexts and treatments. This notion was supported by all three of the interviewed physiotherapists (PHT), who each deploy their own cueing techniques depending on the patient. All PHT shared similar thoughts regarding the use of Audible Cueing, and how it could be memorised and adapted for use in home, and in public.

The use of audible cueing was the most prominent code, appearing 25 times throughout the 4 transcribed interviews. Visual Cueing was another important code, appearing 11 times throughout the interviews. Visual Cueing can also be an effective treatment if the patients' symptoms require it, however Visual Cueing, along with Somatosensory Cueing are more difficult to replicate in a home or public setting, making them less preferential for treatment. One interviewed PHT stated that the use of curated music playlists playing at tempo-to-cadence was able to improve FOG in their patients by allowing them to walk comfortably at the pace of the music. Audible Cueing was also the preference of the one PD patient interviewed.

"I used to have my grandfather clock and carry it around". - Interviewee A

As seen in figure 2, the survey results regarding rehabilitation techniques indicated a need for newer rehabilitation techniques, with 83% of participants believing that there is a need for newer techniques to be implemented in a clinical setting with 17% remaining neutral. This is furthered by the discovery that 50% of participants believed that current techniques were difficult to perform at home, or in any outpatient setting.

Figure 2: Infographic adapted from survey findings

PATIENT INDIVIDUALITY

Another prominent theme that was obvious during both the interviews and surveys was the extent of patient individuality in terms of symptoms, and the devastating effect this has on ensuring personalised and thought-out rehabilitation. As previously mentioned, there are a range of successful rehabilitation strategies that can be used; however, due to the individuality of the disease, the effectiveness of any given strategy will vary from person to person. Interviewee B indicated that whilst they had run and organised a group treatment session, all participants had individualised symptoms, meaning there was no way to guarantee group success until each patient had been given an individualised treatment method and plan.

“I occasionally use music or metronomes. But if I have a group of people, the rhythm tends to be different from one person to the next. So when I’m one to one with people, I can find rhythm that works.” - Interviewee B

The extent of this individually was that whilst a group of patients may all require audible cueing, the audible cue must be carefully curated to match the patient to be successful, whether that is done through the implementation of more than one cueing strategy or tempo-to-cadence.

Another specific patient challenge that was mentioned in almost all interviews was the effect that Levodopa has on the effective treatment of FOG. Interviewee A, a PWP, stated that due to the progression of their disease, if their LD medication wears off, they are essentially stuck in place unless they hear an audible cue.

“Two and a half hours they wear off and then youre absolutely stuck!” - Interviewee A

This scenario is not uncommon, however the treatment of such an event is completely different depending on the person, making it difficult for clinicians to provide proper personalised care.

FOG also impacts patients’ emotions differently, with survey results seen in figure 3 displaying that only 68% of participants believe that FOG negatively impacts their confidence and self-esteem. With 24% remaining neutral, and 7% disagreeing.

FOG impacts my confidence and self-esteem

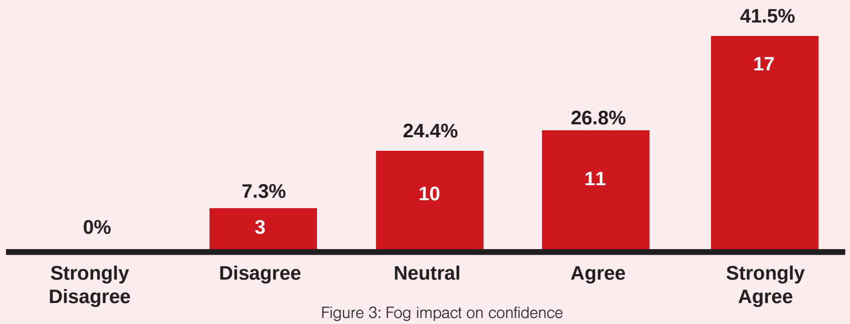


Figure 3: Fog impact on confidence

My FOG gets worse in social or anxiety inducing situations

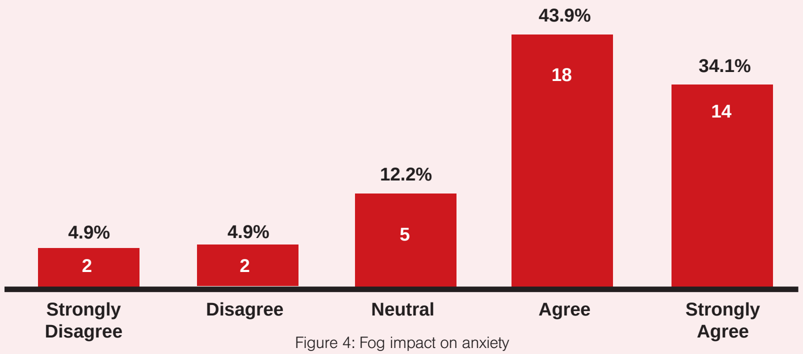


Figure 4: Fog impact on anxiety

However as seen in figure 4, 77% of participants agreed that their FOG got worse in anxiety inducing or social situations. Interviewee B indicated that whilst anxiety can cause freezing, freezing can also cause anxiety, leaving patients in a vicious cycle. This was followed up by the statement that PD symptoms manifest worse for various reasons, and that although anxiety may be a cause, it is not a primary cause for concern. Of the 41 participants in the survey 21 of the participants believed that FOG was the greatest impact on their overall quality of life.

IMPLEMENTATION OF TECHNOLOGY

A third prominent theme was the discussion of emerging technology implementation into clinical rehabilitation for FOG. This theme was frequent throughout all interviews, with discussions of wearable technology, what technologies have been implemented and what has been successful, and the limitations of emerging technology for both the patient and clinician.

An evident limitation of emerging technology implementation in FOG rehabilitation was the struggle experienced by patients when learning new technologies, this struggle was described by clinicians in two of the interviews, and was further confirmed by the survey, which found that over half of the PWP who participated in the survey felt that it was difficult to understand new and emerging technology.

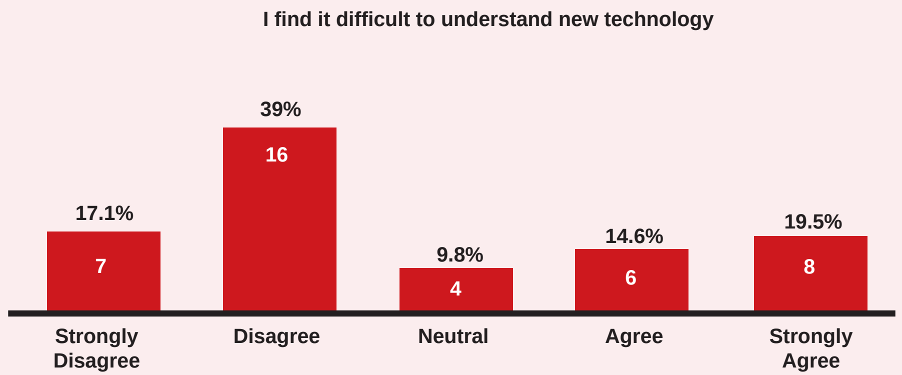


Figure 5: Participant level of technological understanding

Interviewee C stated that although technology based treatment methods may be difficult for patients to understand now, due to our increasing understanding of technology, as current adults become a part of the aging population, the strategies may become more efficacious.

Another code that was frequent throughout the interviews was the use of Virtual or Augmented Reality. All physiotherapists interviewed expressed interest into the use of VR as a treatment method for FOG, however both Interviewee C and S explained that they lack the technological understanding to implement it themselves. A limitation of this technology identified during the interviews was that due to the lack of evidence based research on VR rehabilitation for FOG, clinicians working within the public health sector are unable to obtain the appropriate funding to acquire VR systems for testing.

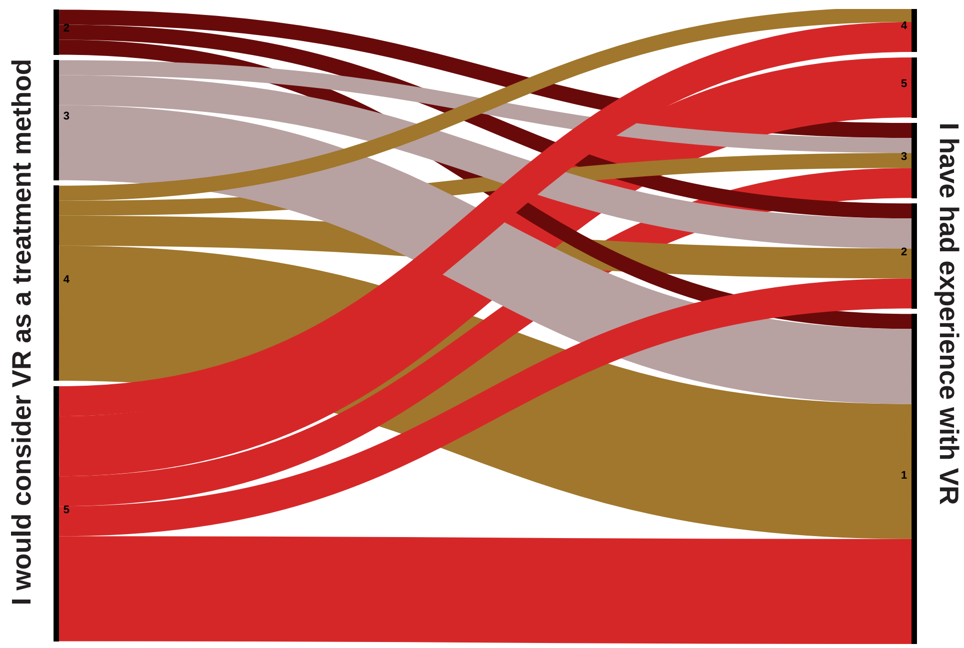


Figure 6: Understanding whether experience influences the use of VR as a rehabilitation method.

Participant response in the survey heavily indicated towards patient interest in the use of VR. 70% of participants agreed to the use of VR as a treatment method with 60% of the participants having little to no VR experience, as seen in figure 6.

Participants were also given the opportunity during the survey to analyse four existing wearable technologies and select which they found most appealing, and then provide a short response as to their reasoning. The results overwhelmingly showed that the PKG was the most appealing technology. The short response results shown in figure 8, displayed that ease of use, and lack of intrusiveness were the reason behind the PKG's overwhelming success visible in figure 7. However, looking discreet and less conspicuous were also key in the appeal of the product.

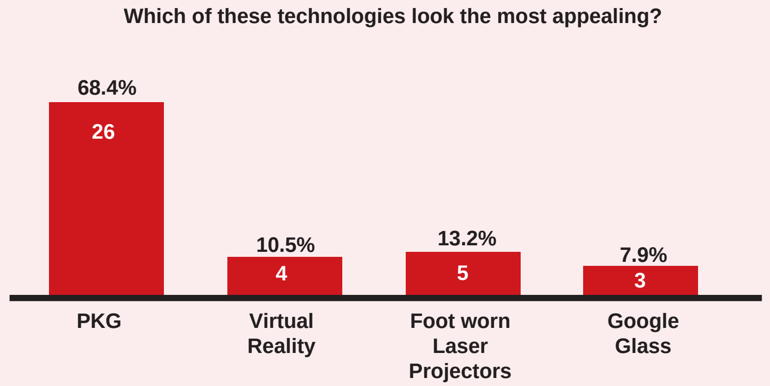


Figure 7: Wearable Technology Preference

Design Characteristics	Frequency Used
Looks Normal	3
Easy to Wear/Use	5
More Comfortable	1
Looks Discreet	4
Less Conspicuous	4
Less Intrusive	5
Subtle	2
Not Bulky	1
Portable	1

Figure 8: Understanding what characteristics make a successful product.

GAIT AND MOVEMENT

The final theme that was recognised was not brought up frequently throughout interviews, however, was discussed briefly in all four. Although all physiotherapists interviewed had different interventions to achieve the re-initiation of gait, it was obvious that the best way to minimise FOG during treatment was to implement strategies of gait re-initiation. As common with the rest of PD symptoms, how gait is re-initiated differs from person to person. Interviewee D described ways of re-initiating gait such as "kicking a ball" or "swaying from side to side." Interviewee A described multiple strategies they used to re-initiate their own gait, an example of this was to re-initiate gait by simplifying your situation.

"If walking to another room carrying books is difficult then put down the books and then it can be easier. When the going gets difficult, purposely pick up lots of books. Now it is quite impossible. Now put them down and find the going is easier." – Interviewee A

Gait re-initiation effectively allows the patient to restart their walk, whether it is assisted by cueing or unassisted, by implementing gait re-initiation strategies clinicians can limit the risk of fall, further improving the patients immediate HRQoL.

LIMITATIONS

The small sample size used in the survey means that a larger standard deviation in the data, and the results gathered may not accurately represent the entire population. Another limitation that accompanies a small sample size is uncoverage bias. As this survey was posted in Parkinson's Disease support groups, only people who are in the selected group can participate (unless shared further). This means that other potential participants who are not a part of the specific groups selected do not get the opportunity to fill out the survey. Another limitation to this survey was the online aspect, as this survey was developed to be filled out digitally, the participants are limited to those that understand how to use Facebook, and how to use a computer. As PD generally effects people 60 years and over, it is obvious that this sample group may not be as technologically versed as other age groups, thus limiting participants. Despite limitations, the sample size was effective in gathering the data required to provide insight into the proposed research question.

SUMMARY

The research aimed to explore what factors decrease HRQoL for PWP in a clinical setting, and how emerging technologies could be used to positively affect the treatment of FOG in Parkinson's Disease. Four areas were identified to successfully assist in better understanding the aim. Rehabilitation Strategies, Patient Individuality, Implementation of technology, and Gait and Movement. Each of these areas explores an important theme within the successful rehabilitation of FOG in PD.

06

DISCUSSION

INTRODUCTION

The research aimed to explore what factors decrease HRQoL for PWP in a clinical setting, and how emerging technologies could be used to positively affect the treatment of FOG in Parkinson's Disease. The intent of the data was to gain a deeper understanding of the aim, and related sub-questions:

- How comfortable are PWP when it comes to using emerging technologies, what stigmas exist?
- How can Emerging Technologies be applied in additional settings to facilitate a decrease in FOG?
- What rehabilitation methods are currently successful in the treatment of FOG?

By answering these questions, a better understanding of the current strategies implemented, and the limitations surrounding the implementation of wearable or emerging technology will be acquired.

Through in-depth analysis of the qualitative data, four overarching themes were discovered to help drive the product development, and better understand what factors currently effect rehabilitation success. The analysis of the findings will be used to drive the design of a product/system that will aim to improve upon the current rehabilitation techniques used when dealing with FOG in PD. Any solution created based on the findings will involve the use of wearable, or emerging technologies to alleviate the symptoms of FOG.

The literature analysed before the research was undertaken, showed that there were many effective techniques that had been trialled to assist with the rehabilitation of FOG in PD, however due to the complexity of the disease, and the individual symptoms of each patient, no core strategies have been finalised to efficaciously treat a majority.

The literature also showed promise in the implementation of VR for the treatment of FOG, however, insufficient literature was discovered to support the hypothesis that VR could adopt existing rehabilitation techniques such as cueing to effectively alleviate FOG symptoms during treatment.

CURRENT REHABILITATION TECHNIQUES

In the participant survey, it was made apparent that 50% of participants believed that current rehabilitation techniques were difficult to perform at home. Depending on their specific diagnosis, this could be due to the type of technique they were given. For example, as audible cueing was the most popular between interviewee's due to its ability to be used in a range of contexts, including at home, it could be considered that the remaining 50% of participants who do not believe that current techniques are difficult to perform have symptomatic efficacy when using audible cueing. Those that achieve success through Visual or Somatosensory Cueing will struggle adopting these techniques in an outpatient setting. This is because it is much easier for a patient to memorise a song/beat, than visualise lines on the ground (visual cueing) or feel an external beat (somatosensory cueing). This is a significant finding as it displays the lack of home-based therapy options available for those who require alternative cueing methods.

This finding contradicts the previous literature, which found that there was still further evidence needed to understand which cueing method was the most beneficial. (Sweeney, 2019)

The development of auditory cueing systems continues to improve, with the literature indicating that rhythmic auditory stimulation is the most effective means of cueing to assist with FOG (Bächlin et al., 2010). This supports claims given by interviewee B, C and D, who all claimed to have symptomatic efficacy when using Audible Cueing on patients.

The interviewees also suggested that although not as widely effective and Audible Cueing, Visual Cueing was an effective strategy when implemented at the correct moment, specifically, in scenarios where patients must think critically about their stride, and cadence. The literature suggested that both Visual and Audible cueing are used more often as they have evolved more technologically than somatosensory cueing (Sweeney, 2019). This could be a potential reason for the lack of implementation of somatosensory cueing devices in current rehabilitation strategies.

PATIENT INDIVIDUALITY

Patient Individuality has been a strong theme throughout the project and is a key driver in relation to the development of a product or service, as is the diversity of symptoms and patient challenges. Whilst successful rehabilitation methods have been discovered, it is difficult to ensure that PD patients are receiving fully personalised treatment plans, especially when in an outpatient setting. The research concurred that due to the diversity in symptoms and treatment methods, patient individuality is a large concern in the treatment of FOG and other parkinsonian disorders, as it removes the ability to create set rehabilitation plans or strategies to solve the issue. When properly treating FOG, clinicians must first understand what rehabilitation method works best for that particular patient, and in what way the particular method chosen should be implemented for maximum treatment efficiency (Ginis, 2018). As there is no way to tell prior to the consultation which method will work best, Interviewee D and C stated that clinicians are often left to undertake trial and error to best understand the patient they are treating. Currently, there is a lack of products that can individually target symptoms of FOG. This leaves room for intervention to develop a product that can essentially be used in the individualised treatment of FOG, that can be adapted for a variety of contexts.

The research revealed that although anxiety can induce FOG, it is not often the primary cause, and can be due to a range of other health related issues, such as lack of sleep, or other external stresses that may make their freezing act up. Interviewee B discussed how FOG can also induce anxiety, making the patient anxious about initiating their gait, which can sometimes lead to a vicious cycle of being too anxious to begin forward progression. As was discussed in the findings, initiation of gait is paramount to the immediate alleviation of FOG, and this is significant as it identifies a user pain point that could be targeted for product implementation.

The use of Levodopa as mentioned in the literature, is the benchmark of symptomatic efficacy for the treatment of PD (Poewe et al., 2010). When taking LD, the brain increases its dopamine concentrations, allowing for improved nerve conduction, and more advanced movement (MedicineNet, 2019). However, as this medication wears off every 3-4 hours, patients can be left stranded if they are unable to obtain their next recommended dosage (Rascol et al., 2020). This is a constraint, as it means that patients without their medication could essentially become stranded as their medications wear off – which could be dangerous or life threatening in a public place. The fear of medication wear off could leave PWP in a constant state of anxiety in public, as they anticipate their symptoms returning.

IMPLEMENTATION OF TECHNOLOGY

The literature suggested that although VR paradigms had been efficacious in the treatment of other neurological disorders, VR lacked the proper research-based evidence in its ability to treat FOG (Canning et al., 2020). However, due to this lack of evidence, a gap was evident to better understand how VR could be used to adopt existing rehabilitation techniques, to provide a more individualised and modern treatment method that adapted the successful techniques currently used. All Interviewees expressed interest in the use of VR to assist with FOG, however it was noted that unless research-based evidence could be provided, public health entities would not invest in a product or service.

Most study participants agreed that VR would be an interesting treatment method to attempt, however, there was a distinct correlation between those that had no experience with VR, and those that would not consider VR as a treatment method for FOG. This may be because of a predetermined bias or fear of having to adopt a new process that may seem overwhelming or difficult.

IMPLEMENTATION OF TECHNOLOGY CONT.

Majority of survey participants with no VR experience either agreed or strongly agreed to using VR as a treatment method. While all the participants that would not consider VR had little to no experience with it, every person that had VR experience strongly agreed to using it as a treatment method.

Of those that had experience in VR, all strongly agreed to using it as a rehabilitation method. This may be due to personal success or improvement they have previously experienced, or just for pure enjoyment. This was an interested finding as it provided merit in the treatment of FOG using VR.

The analysis of existing wearable technologies provided insight into what the most successful aspects were in relation to a successful product. The table highlighted above showed the most important aspects of the highest rated product. This finding was noteworthy as it provided insight into what design criteria may be important when designing a wearable for PWP.

GAIT AND MOVEMENT

The use of reinitiating gait as a rehabilitation technique has proven efficacious in the treatment of FOG, and this has been confirmed during all interviews. Although different interventions are implemented, the general theme followed is that the clinician will instruct the patient to pause their gait, and attempt to re-initiate, rather than fight the freezing episode. This technique is proven by the literature, as (Bloem et al., 2003) stated that PD patients struggle to prioritise what is most crucial when freezing, which can come as a detriment to their gait or balance. A study done by Bloem et al. (2004) discovered that overcompensation when a patient attempts to overcome a neural block can often lead to more severe FOG. By adapting the gait re-initiation strategy, the PWP can effectively prioritise their gait, and avoid potential falls when walking. This technique is beneficial as it ensures patient safety should freezing occur and allows the patient to take personalised steps towards improving gait, such as deploying specific cueing techniques.

Most findings were consistent with the previous literature, however the discussion of anxiety induced FOG was not as significant in the research, with interviewees believing that the treatment of anxiety induced FOG is secondary to regular FOG treatment.

07

DESIGN PROPOSAL

INTRODUCTION

Virtual Reality, and other emerging technologies have the ability to provide more thought-out and successful individualised rehabilitation strategies for FOG. The discussion explored the use of existing rehabilitation methods and patient challenges to determine whether the current treatment options were efficacious in improving the HRQoL for PWP who experience FOG, and how these methods could be adapted to provide more individualised care through the use of emerging technologies. The recent emergence of technological based rehabilitation strategies has created a unique opportunity for product development in a sector that currently lacks the use of such technologies to provide individualised and efficacious rehabilitation.

To ensure that the final product, service, or system fits within this sector, the four key themes of the research should be considered throughout product development. These themes revolve around the core challenges, recommendations and limitations of existing technologies and rehabilitation strategies.

The ensuing proposal explores how these key themes may be adapted to fit within a solution that will assist will improve the HRQoL of PWP who experience FOG.

DESIGN INTENT

The intent of the design is to develop a product or service that effectively adapts the successful aspects of existing rehabilitation strategies to assist in the clinical rehabilitation of FOG in both an in-patient and out-patient setting, through the use of emerging technologies.

OBJECTIVES

To further drive the design direction of the project, three objectives were derived using the findings and core themes identified during the research analysis.

- The design should be able to provide individualised care to a symptomatically diverse user group.
- Cueing techniques must be adopted to ensure symptomatic efficacy.
- The solution must promote or involve gait initiation.

JUSTIFICATION

Freezing of gait remains one of the least understood manifestations of late state Parkinson's disease, and can be incredibly distressing for those who experience it. (Giladi et al., 2001) Patients who are affected by FOG experience the inability to produce forward progression when attempting to walk. This experience can feel incapacitating, which affects both the physical and psychological HRQoL of patients. Due to its unpredictability, FOG can have a larger impact on a patients HRQoL than other symptoms, although it is typically rare in early-stage PD (Walton et al., 2015). FOG can occur in dangerous and stress provoking situations, that significantly impact a patient's safety in public. It is due to these severe symptoms that both patients and caregivers report difficulties with FOG more often than any symptom.

Virtual Reality and other emerging technologies have shown promising results in the treatment of other neurological disorders, and the research findings suggested that majority of clinicians believe there is merit in using these technologies in the treatment of FOG. Due to the age of the intended user group, and the complexity of the diverse range of symptoms, there are limitations to how well technology can be implemented to successfully improve HRQoL in FOG. However, the increasing popularity and use of VR and other emerging technologies shows that there is room for development to overcome these limitations and successfully provide individualised treatment for FOG.

CONTEXT

The target audience for this project creates a unique set of challenges due to their inherent individuality and differing symptoms. The only commonality of the proposed user group being the mean diagnosis age of 60 years, and the cardinal signs of PD experienced by all PWP. PWP come from a diverse range of cultural, and socio-economic backgrounds, and this will need to be considered throughout the duration of the project.

The final solution will be implemented in South-East Queensland and must follow any medical legislation or law within this region regarding product development for the use of rehabilitation.

The solution will be developed to fit within a range of different contexts of use, including public spaces, clinical testing, or home treatment settings.

KEY CRITERIA

To ensure the research aims and objectives are met, a series of design criteria will be created and followed for the remainder of the project. These criteria will be based on both the literature and qualitative research findings to guarantee that the solution developed fits comfortably within its context and creates improvement in the over HRQoL for PWP. It is crucial that the final design is a product of research, rather than assumptions. To ensure this, each criteria created will be linked to findings or literature that further confirms its importance. The justification for these criteria can be found in Appendix 5.

1. User Requirements

a) The solution must cater to a wide variation of FOG severity.

b) The solution should cater to a wide variation of treatment individuality.

c) The solution must service a diverse cultural and socio-economic user group.

d) The design of the solution must be easily understandable and intuitive to those with limited understanding of technology.

e) The solution must not be bulky or uncomfortable.

f) The solution must be easily accessible to PWP who experience FOG.

2. Clinician Requirements

a) The solution must be easy to implement in a range of treatment scenarios.

b) The solution must be backed by research-based evidence ensuring its effectiveness.

c) The solution should involve the use of any of the various cueing techniques.

d) The solution must be easily implemented into existing treatment methods, to ensure a seamless treatment experience.

e) The solution should be more efficacious than existing strategies.

3. Context

a) It may provide comfort when in a public or anxiety inducing scenario.

4. Practical Function

a) The solution must be easy to use, ensuring that button presses, and other small components thought out, due to the limit of strength and movement disability that is present in both old age and PD.

b) The solution must be durable and shock resistant in case of fall.

c) The solution must be fit for purpose.

5. Aesthetic Function

a) The solution must be visually understandable.

b) The solution (If wearable) must be inconspicuous and discreet w hen in use.

6. Safety Considerations

a) If a solution requires VR/AR, limitations must be created to ensure that boundaries occur when patients are completely immersed, to ensure that no injury happens.

7. Maintenance

a) The solution must be easy to maintain, with no complex part changes or setup required.

8. Technology Considerations

a) The technology must be intuitive and easy to implement with limited technological knowledge.

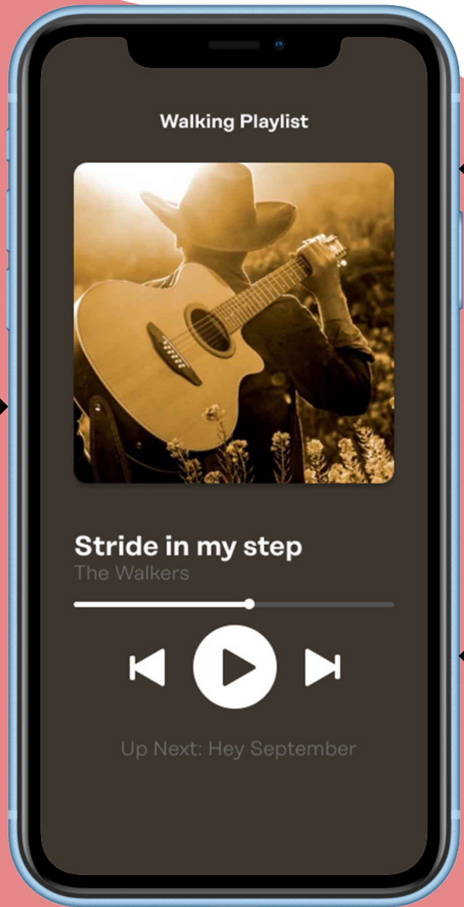
DESIGN OPPORTUNITIES

RECOMMENDATION ONE

The first recommendation for product development is an application that allows users to create personalised music playlists that are curated to the user's tempo-to-cadence. This application adapts audible cueing techniques to provide a simple, easy to use solution for PWP who benefit from audible cues. The application uses smart algorithms to provide users with daily playlists of music that differ from day to day, ensuring that users do not become accustomed to any one song, making the cueing lose efficiency.

The product, illustrated in figure 10 could be paired with a range of existing products, and other cueing devices to provide a more personalised experience, further improving their FOG through the use of music/ rhythm-based treatment.

Key Considerations	Limitations
The system is built into an easy to access application and can be usable with pre-existing audio products. The inherent personalisation means that the application is usable for a range of patients.	Those with limited technological knowledge may not understand how to access or use application based programs. Those that experience Rigidity as a symptom of PD may have trouble using the small buttons and gesture based interface of a modern phone.



Simple and intuitive layout to ensure ease of use

Ability to receive personalised tempo-to-cadence music playlists

Constantly updating playlist to ensure the music never gets repetitive

Figure 10: App Based Solution with Cueing Techniques

Criteria used 8a, 7a, 5b, 4c, 3a, 2, 1a 1b.

RECOMMENDATION TWO

Key Considerations	Limitations
Helps to re-initiate gait by encouraging the patient to “play” with the ball, kicking and chasing it around a clinical or outpatient space. Improves upon existing techniques used for FOG rehabilitation.	Those that are uninterested in chasing around a ball may feel as though the technique is boring or childish. The durability of the device may quickly diminish as it is kicked and abused throughout its lifespan.

The second recommendation is the Robot Ball Gait Trainer (RBGT). The RBGT is a robot ball that can be controlled to help reinitiate gait when freezing occurs. The ball can be controlled by either the Clinician or patient and works by engaging the user to re-initiate their gait through the use of kicking and walking to the robot ball. The RBGT is essentially a more technologically advanced version of an existing treatment method, that will give clinicians more control over the tests they perform. The product, illustrated in figure 11 is a small soccer sized ball that has the ability to roll around while being controlled to engage patients to chase and interact with it, successfully re-initiating their gait in the process.

Figure 12: Context and Scale of Recommendation 2

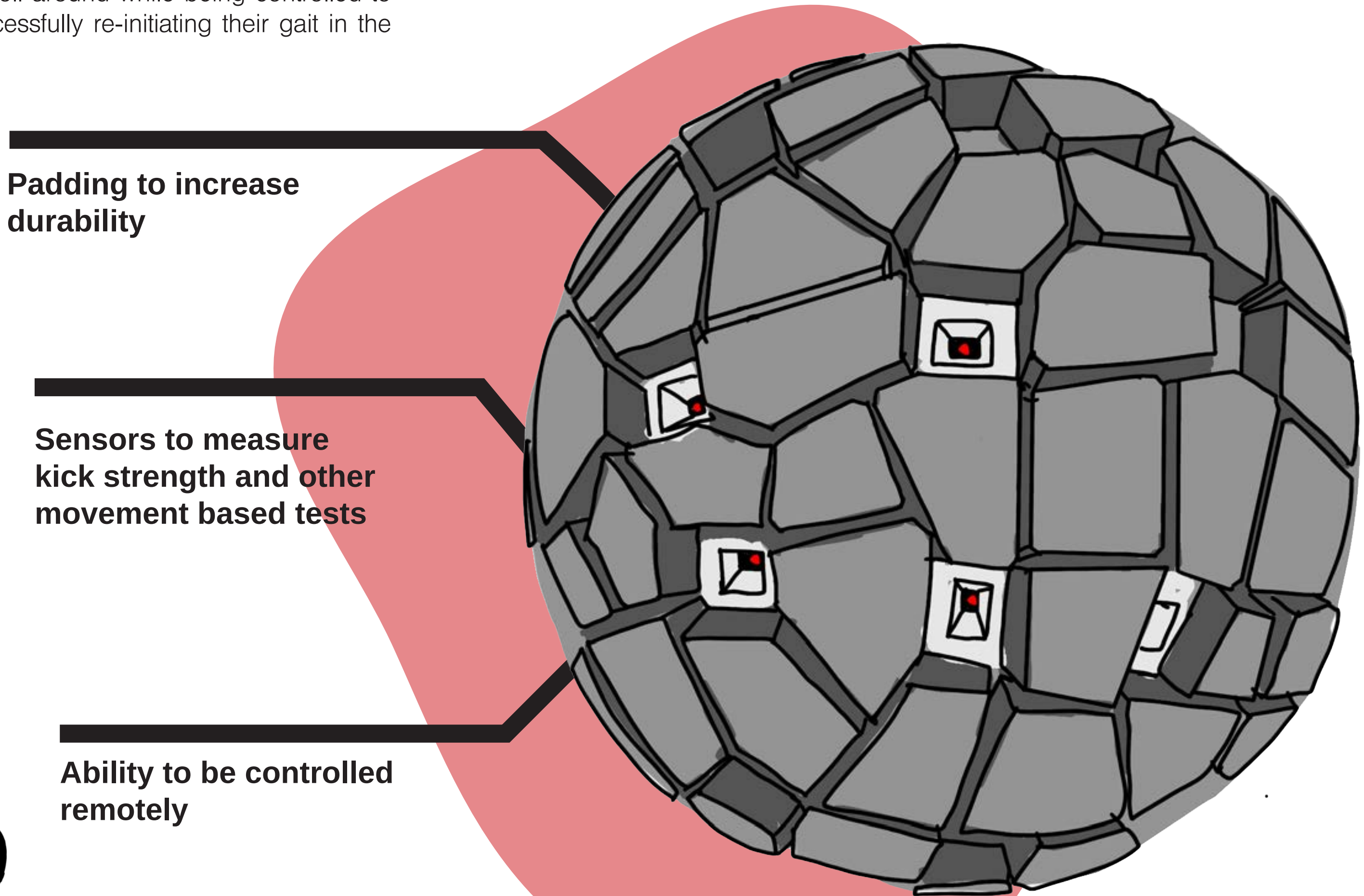


Figure 11: Robot Ball Gait Trainer Concept

Criteria used 5a, 4b, 4c, 2e, 1a, 1b.

RECOMMENDATION THREE

The third recommendation is AR goggles that adapt all three cueing techniques and allow visual cues to be placed in the real world. Along with the use of integrated audio and vibration in the goggles to allow for a mixture of all cueing devices. The AR goggles implement emerging technologies to project lines, and visual cues into a PWP's environment in real time, allowing them to experience visual cueing successfully in public spaces, without the use of external lines or dots on the ground. The goggles, illustrated in figure 13, aim to adapt all three cueing techniques into a normal looking product that works inconspicuously. This in turn allows PWP to feel more normal in public spaces.

Key Considerations	Limitations
Use of all three core cueing techniques that can be changed or adjusted depending on the preference and symptoms of the user. Looks like existing glasses products to ensure incon-spicuous use.	The technology required for the success of the goggles is not currently accessible to the public, however developments have been made.

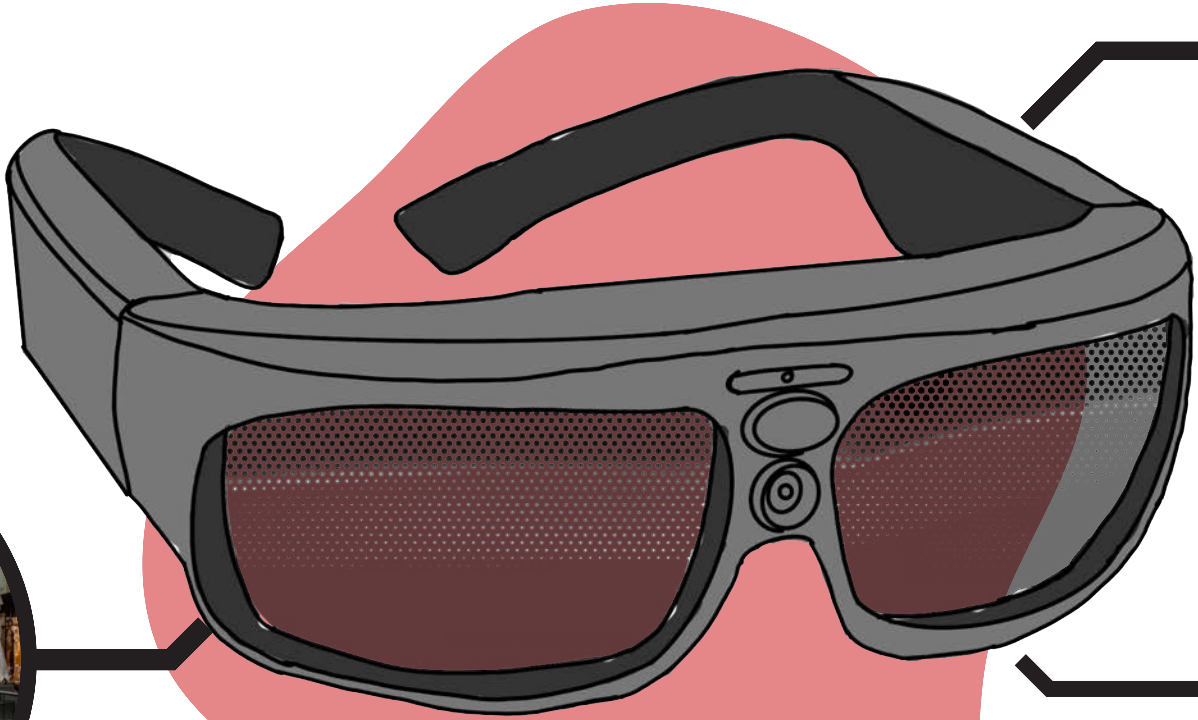


Figure 13: AR Googles with Various Cueing Abilities

Figure 14: AR Googles view with Visual Cueing on ground

Criteria used 6b, 5b, 4, 3a, 2c, 2e, 1a, 1b, 1e

RECOMMENDATION FOUR

A VR headset with built in environments used for rehabilitation that are able to be personalised depending on the specific symptomatic characteristics of each person. The headset is worn during rehabilitation sessions and allows patients to receive catered and individualised care that effectively targets their symptoms for a more enjoyable treatment. The abilities of VR allow patients to be immersed in extraordinary worlds that are explorative and creative, creating a unique and memorable treatment experience.

Key Considerations	Limitations
Ability to implement all cueing techniques while immersing patients in an individualised world, aimed at providing personalised treatment in an exciting and immersive manner. Ability to personalise the paradigm from patient to patient to ensure symptoms are effectively targeted.	Patients must be comfortable being immersed in a VR environment. Patients may experience motion sickness or dizziness if they have had no previous VR experience. Patients may hurt themselves when fully immersed as they become unaware of their surroundings.

Ability to implement different cueing techniques and environments depending on the patient

Improved VR HUD with lightweight material to ensure comfort when in use

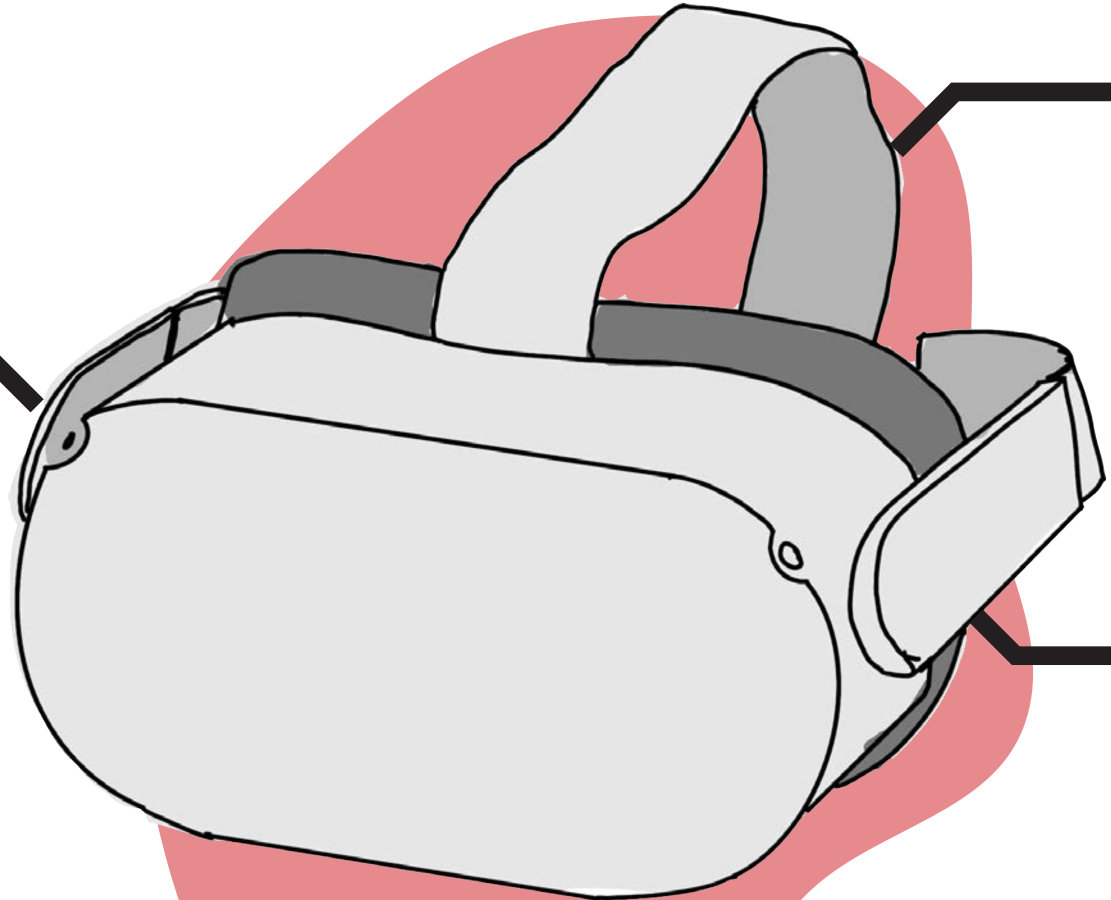


Figure 15: VR helmet for Virtual Based Paradigm

Figure 16: Example VR Environment

Immersion into an engaging and explorative environment

Criteria used 8a, 6b, 5b, 4, 2b, 2c, 2e, 1e, 1a, 1b, 1d

RECOMMENDATION FIVE

A treatment bot that is used by clinicians to assist with a range of diverse patient symptoms by using customisable cueing techniques implemented into the tech-filled ball. The bot, illustrated in figure 17 has the ability to project grids and lines when placed on the floor, it also vibrates and plays metronome noises or music, and different tempos to accommodate for a range of different individuals. As this product will be situated solely within a clinical context, the materials used must be medically appropriate. The bot synthesises the successful cueing techniques into a tangible, non-wearable product that allows clinicians to test and understand how a patient reacts to cueing techniques and allows them to better provide more personalised rehabilitation plans.

Key Considerations	Limitations
Synthesis of a range of successful rehabilitation techniques into a single device for clinician use during treatment settings. Accompanying app to allow clinicians to alter the treatment method and techniques used in the device.	Learning curve for clinicians who wish to implement a new technology into their current rehabilitation practices.

Figure 18: Example Laser Grid on floor

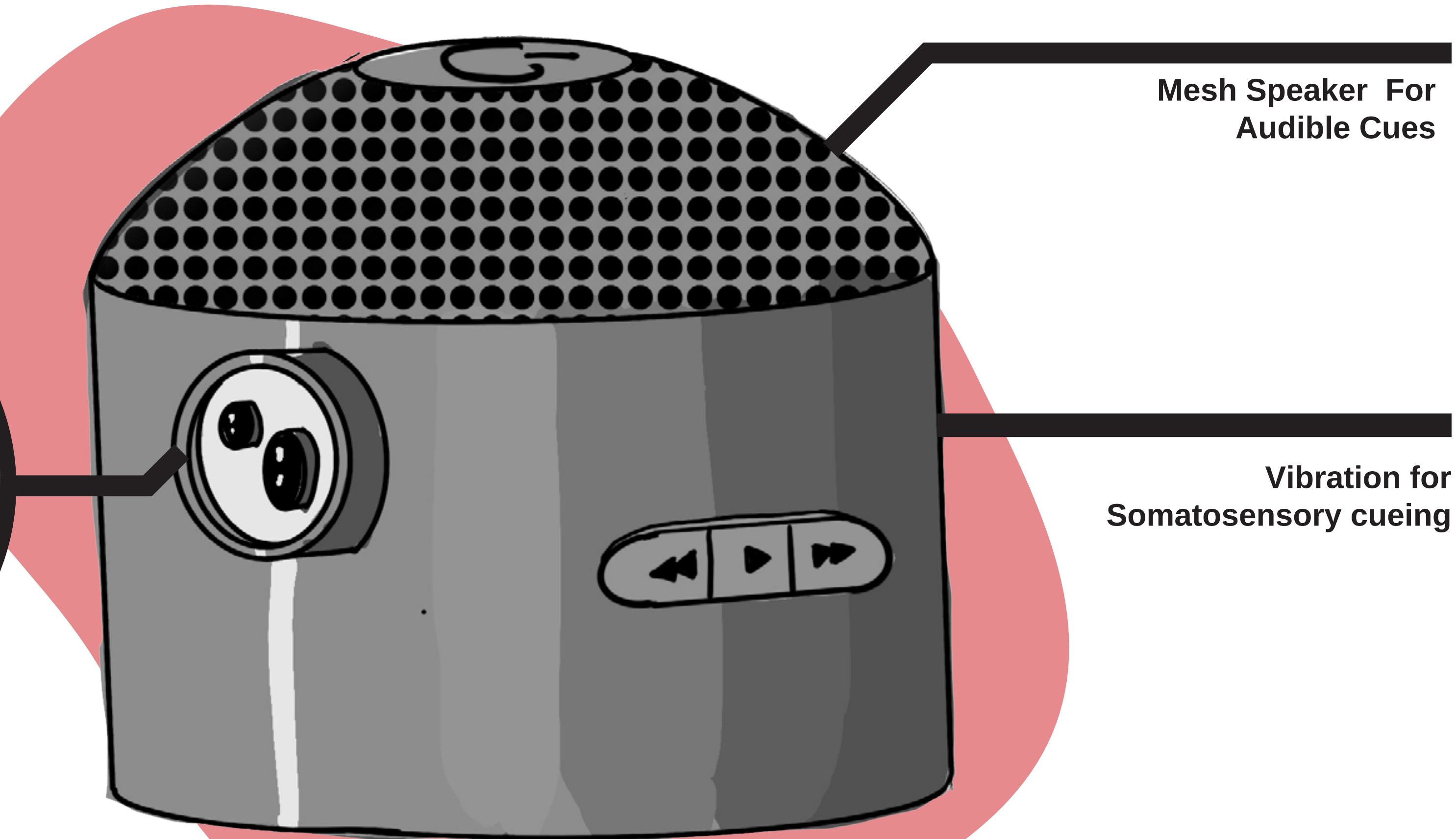


Figure 17: Treatment Bot Concept.

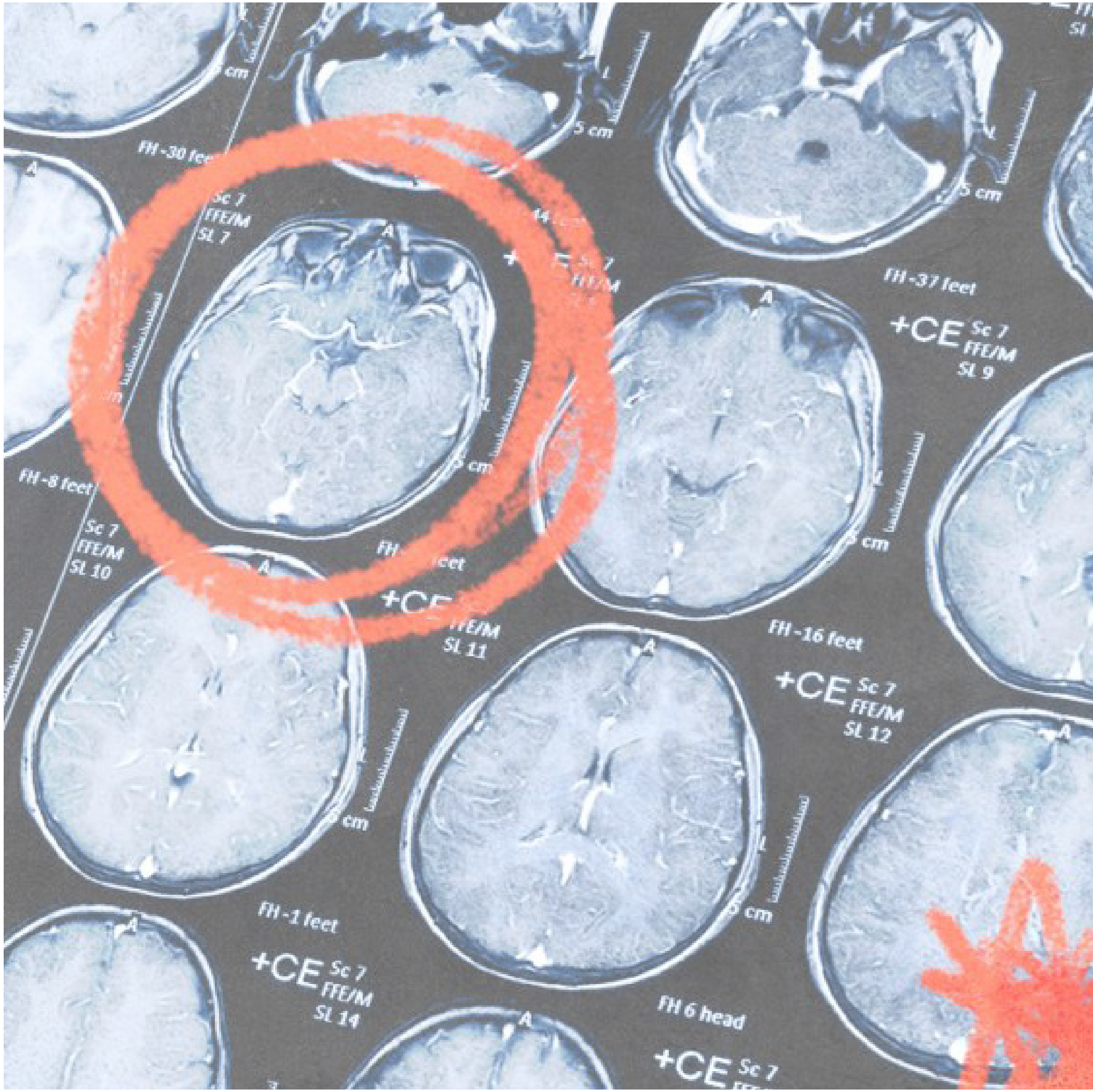
Criteria used 8a, 5a, 4, 3a, 2a, 2c, 2d, 2e, 1a, 1b.

08

CONCLUSION OF RESEARCH

CONCLUSION OF RESEARCH

This study set out to explore what rehabilitation strategies were currently being used to treat FOG in a clinical setting, and how emerging technologies could be used to positively improve these strategies. The results of this investigation show that patient individuality has an incredibly over-whelming affect on the ability to provide thoughtful rehabilitation for patients, as clinicians are often required to go through trial and error processes to better understand their patients' symptoms, and what treatments will be most efficacious. The findings of this study suggest that both patients and clinicians are interested in the use of emerging technologies to improve the current strategies that have limited success, with a majority of patients involved in the survey believing that there was a need for newer rehabilitation methods to treat FOG. Due to the small sample size, the data collected cannot effectively represent the entire user group, and this should be considered when doing further research on this subject. The results of this study indicate that there is merit for the adaptation of emerging technologies to be further tested in clinical settings to provide more advanced rehabilitation methods for Parkinson's Disease and other Parkinsonian Disorders. More research using controlled trials is needed to better understand how patients may feel when using the described emerging technologies, and the effect that it may have on their overall HRQoL. Further, more work needs to be done to establish which emerging technologies are best suited for PD rehabilitation.



WEEKLY PLANNER

1-2

Research and Planning
Concept Ideation
Further User Research
Concept Development
Design Direction Confirmation

3-4

Into the Development
Concept finalised
Legibility confirmed
Refinement of concept and aesthetics

5-6

The Development
User Testing
Prototyping and Modelmaking
Manufacturing Research

7-8

The Big DecisionsI
Further User Testing
Design Freeze
Final concept refinement

9-10

The Synthesis
Branding and Logo
In depth manufacturing and development research
Finalise details of the design
Begin final prototype

10-11

The Product
Finish Brand Package
Finalise prototype for presentation
Begin development of presentation

12

The Beautifying
Presentation and Document finalisation

13

AAAAAAA
Practicing Elevator Pitch and Concept presentation

09

JUSTIFICATION

DESIGN JUSTIFICATION

After extensive research and recommendation considerations, a final product was synthesised and developed over a fifteen week period. It was identified through the research, that a core concern of PwP was the need for a discreet wearable, that had the ability to measure and assist with FOG. This product aimed not only to benefit PwP, but clinicians and researchers when it comes to better understanding how FOG affected the users HRQoL.

The following section acts as a justification for the OneStep system that has been developed as a result of the prior research, and details the overall design, its features and how it solves the problem identified in the research.

onestep

FOR THE TREATMENT OF FREEZING OF GAIT

Figure 18: Render of entire OneStep system

Figure 19: OneStep Insole's patterned to show textures

DESIGN ANALYSIS

The **OneStep** for Parkinson's is an innovative wearable that uses emerging technologies to assist with Freezing of Gait (FOG) in Parkinson's Disease discreetly and autonomously. It does this through the use of wearable technology, that accurately measures when freezing occurs, and simultaneously initiates audible cueing techniques. These cues are accessible through any means of audible output, allowing the user to take advantage of whatever output they feel most comfortable with. This allows for techniques to be discreet when in public, whilst providing the option for cues to be played out loud when using Bluetooth speakers in a home or rehabilitation setting.

Cueing was chosen due to its measured effectiveness in the alleviation of FOG.

Currently, cueing techniques are the industry standard in FOG management without medication, however, it is difficult to replicate in a real world setting without hindering the user. User research found that Audible cueing was the most widely requested form of cueing when treating users and was the easiest to replicate at home or in public (Bächlin et al., 2010). However, no products exist that trigger cueing autonomously when freezing occurs, making the activation of cues, entirely dependent on the PwP. Autonomous cueing means that the user is able to re-initiate their gait, before a fall may occur, if they are unable to begin cueing in time.

By measuring the rate and severity of a user's freezing, OneStep also aids clinicians in having a more in-depth understanding into how a person's Parkinson's is progressing. This will further assist when accurately diagnosing FOG and administering the proper dosage of medication. This means that OneStep will be able to not only assist with the alleviation of FOG symptoms when in public or at home but also within clinical or hospital settings. It's ability to track symptoms will also help in further increasing the current clinical knowledge on how FOG and other Parkinsonian symptoms may be mitigated.

PACT ANALYSIS

PEOPLE

The user for this product is people with Parkinson's disease that experience freezing of gait. As this disease more commonly develops after age 60, there are various considerations that needed to be made to accommodate the product for the user. Firstly, as humans age, especially those with Parkinson's, many other age related problems occur that must be considered when creating a product. Age-Related eye problems are a core concern for the user, and this was considered when developing the device charger, and app interface. Older users with PD also experience a decrease in hand dexterity, and this was considered when users were tasked with removing and inserting the insole. The final design accommodated for this, with an easily accessible shape that could be grasped and removed from the shoe if required.

ACTIVITIES

The main goal of the user is to reach their chosen destination whilst overcoming freezing episodes throughout their journey. As freezing occurs randomly and often, users struggle with day to day tasks or errands, especially in public or anxiety inducing spaces. Through the use of instantaneous cueing, the product is able to decrease the amount of time that a user experiences freezing. This allows users in public spaces to discreetly manage their FOG, and continue their journey, re-initiating their gait when required. As the device is constantly tracking the user's movement, there is no requirement for data input on their behalf.

CONTEXT

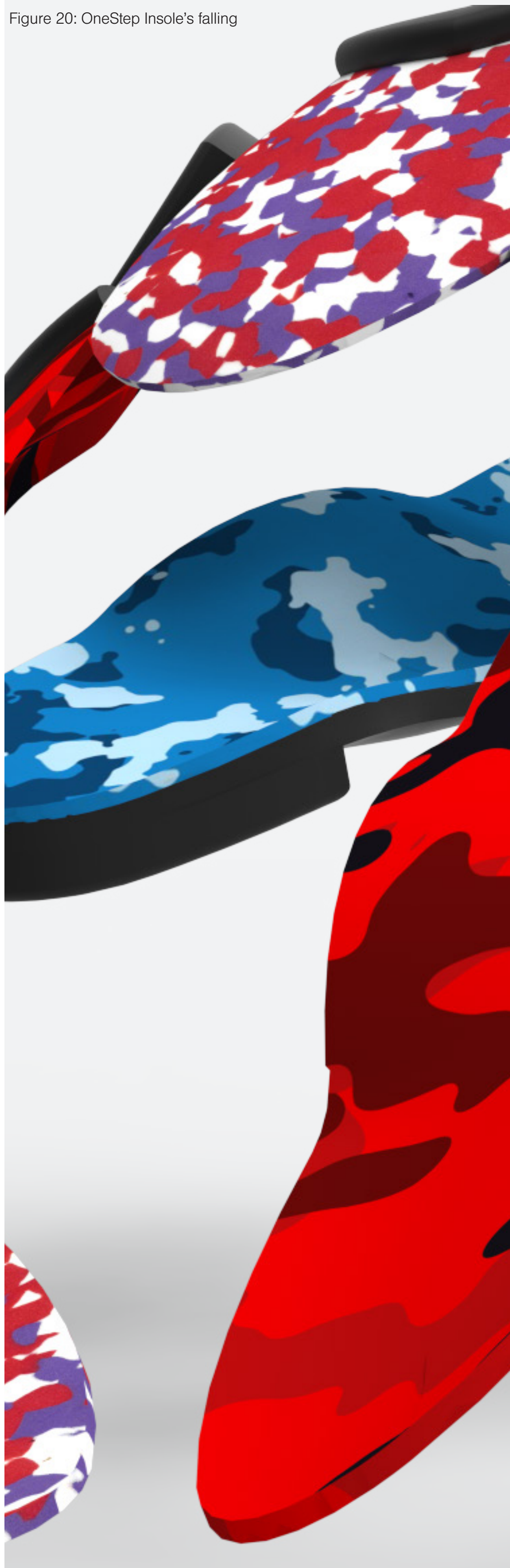
This device was created for use in public, at home, and within a clinical environment. Each of these environments involved different requirements for use. In public, it was ensured that cueing was hidden and discreet to improve user comfort. In a clincial setting, cueing can be played out loud, allowing Physiotherapists or Occupational Therapists to monitor when freezing occurs and observe how the cueing is affecting the re-initiation of gait. As FOG is the leading cause of hospitalisation for PwP, it was important that cueing was instantaneous to limit the risk of falling when in public.

TECHNOLOGY

The technology within the insole is used to measure when a freeze occurs to instantaneously send signal to the connected audio device to begin cueing. This technology is paramount to the success of OneStep. The Insole uses a combination of sensors to understand physical attributes of the user, how they walk, and how they interact with the insole. This data can be synthesised to understand what characteristics are visible when a freeze occurs, aiding the overall system.

The PACT analysis headings will be discussed further within the oncoming document.

Figure 20: OneStep Insole's falling



PRODUCT BREAKDOWN

The OneStep system involves four major pillars that contribute to the success of the design.

The Insole (1)

The Insole is the most important part of the OneStep system, as it is the means for measuring when FOG occurs. It does this through the use of various sensors that are compressed within its heel, and along the base of the foam insert. These sensors allow the device to better understand when a freeze occurs, and what the user does to resist the freeze.

The sensors used to measure this are a combination of pressure sensors, hidden within the EVA insert, and an IMU unit that is connected to the PCB in the heel of the insole. Together, these allow the device to understand gyroscopic, location and foot movement data.

The Audio (2)

When FOG occurs, audible cues are played through the connected hearing device to assist in the re-initiation of gait. The OneStep system allows the user to choose a preferred hearing system, as preferences can vary from person to person.

Hearing Aid

By connecting a Hearing Aid, users can use their aid regularly, with audible cueing occurring briefly when freezing occurs. Hearing Aid connection allows the product to be discreet and de-stigmatised, as many people within the age demographic may already own this device.

Headphone

For those that don't require hearing aids, the OneStep system is able to be connected to headphones or wireless earbuds. This means that when running errands in public, users can use the system discreetly.

Speaker

Speaker connection is beneficial when in a retirement village or clinical practice. By connecting to speakers, you can assist physiotherapists and occupational therapists when completing exercises or classes.

The Application (3)

The Application is a smaller part of the OneStep system, however it is crucial in creating an intuitive and easy to understand product suite. As OneStep is targeted towards the aging population, App Design had to be considered to ensure that it was easy to understand and allowed the device to be connected easily. The application features 4 main screens, the connection screen, which allows users to pair their devices easily, without needing to access any settings or do any complex setup. The Data Screen, which shows users the data that is being measured from their insoles. The Audio Screen, which allows users to manipulate their cueing, And the home screen, which allows users to see at-a-

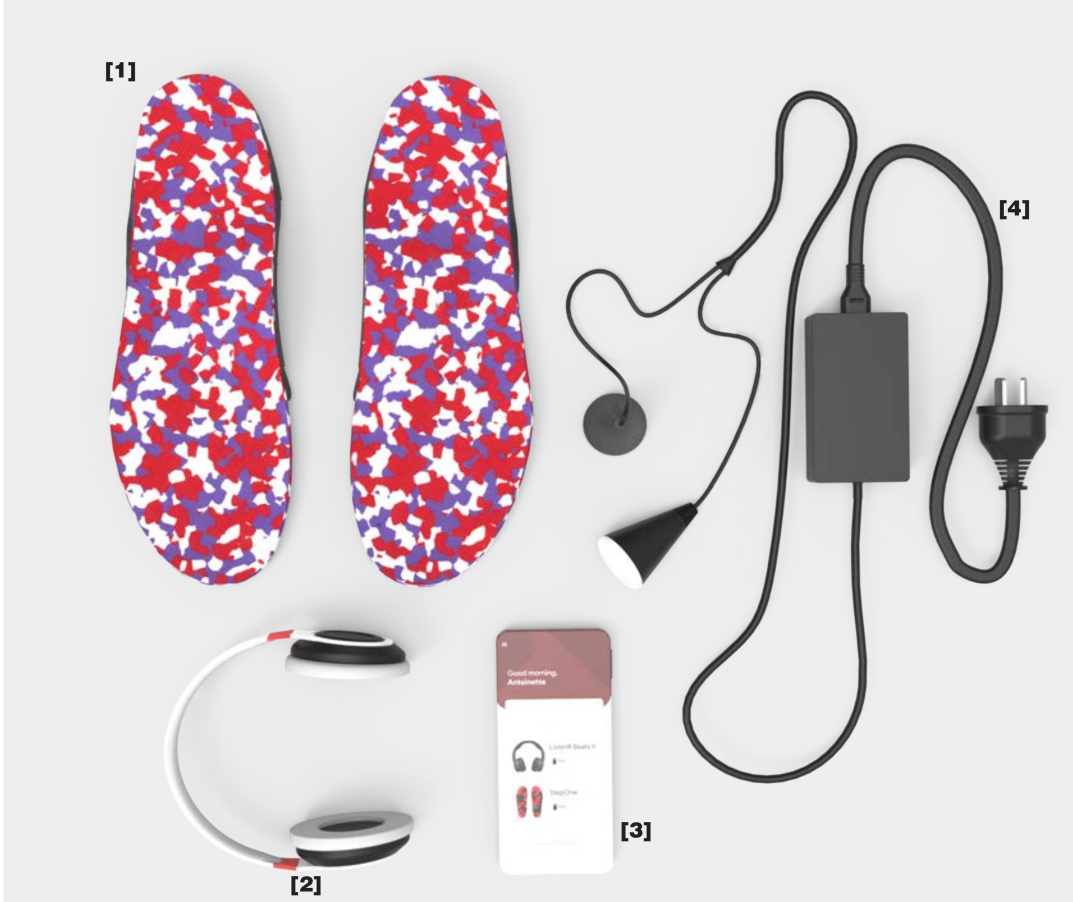


Figure 21: OneStep entire system laid out

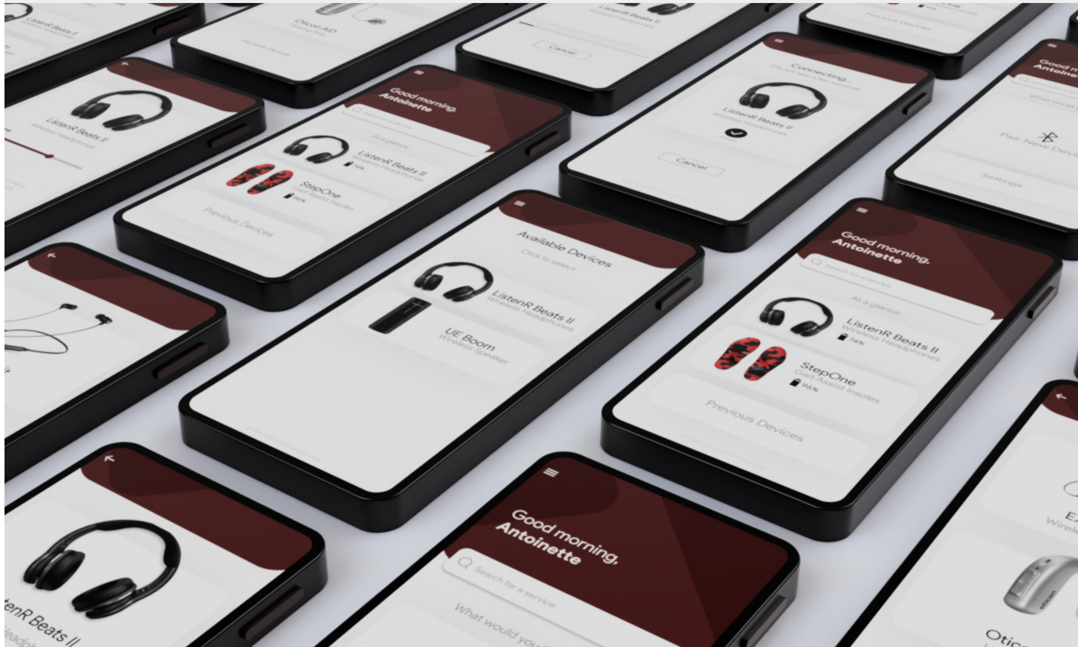


Figure 22: App Design Screen Renders

PRODUCT BREAKDOWN

glance information about the status of their wearables, including battery life and other important information.

The Charger (4)

The charger is a key component within the OneStep system due to its in depth user considerations. The charger has been created to accommodate for the aging population through size, weight, and lighting features. The charging cable involves two magnetically connected chargers, that begin charging when dropped on top of the insole. This allows for users to keep the insoles in their shoes between uses, which is beneficial for those with limited finger or hand dexterity. The charging head also lights up for 30 seconds when it is correctly connected to the insole, to communicate to users who may be vision impaired that the charger is working correctly. This LED also communicates when charging is complete, through the use of low bursts of light.

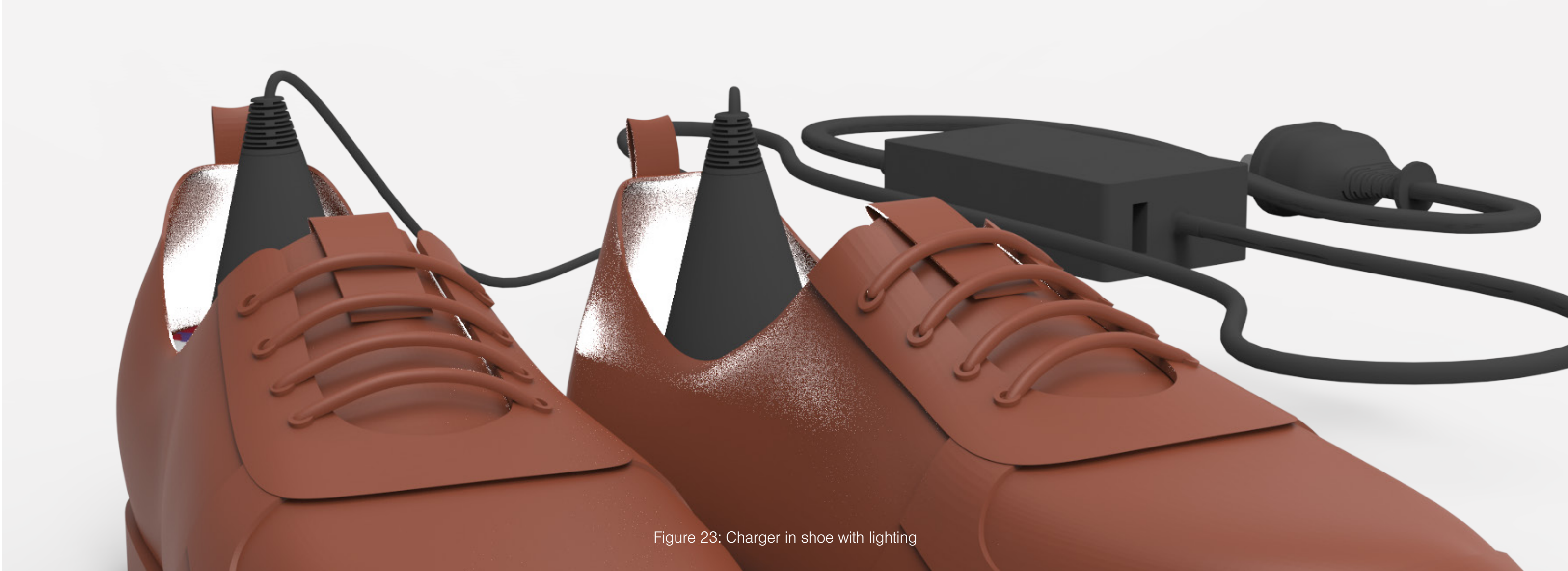


Figure 23: Charger in shoe with lighting

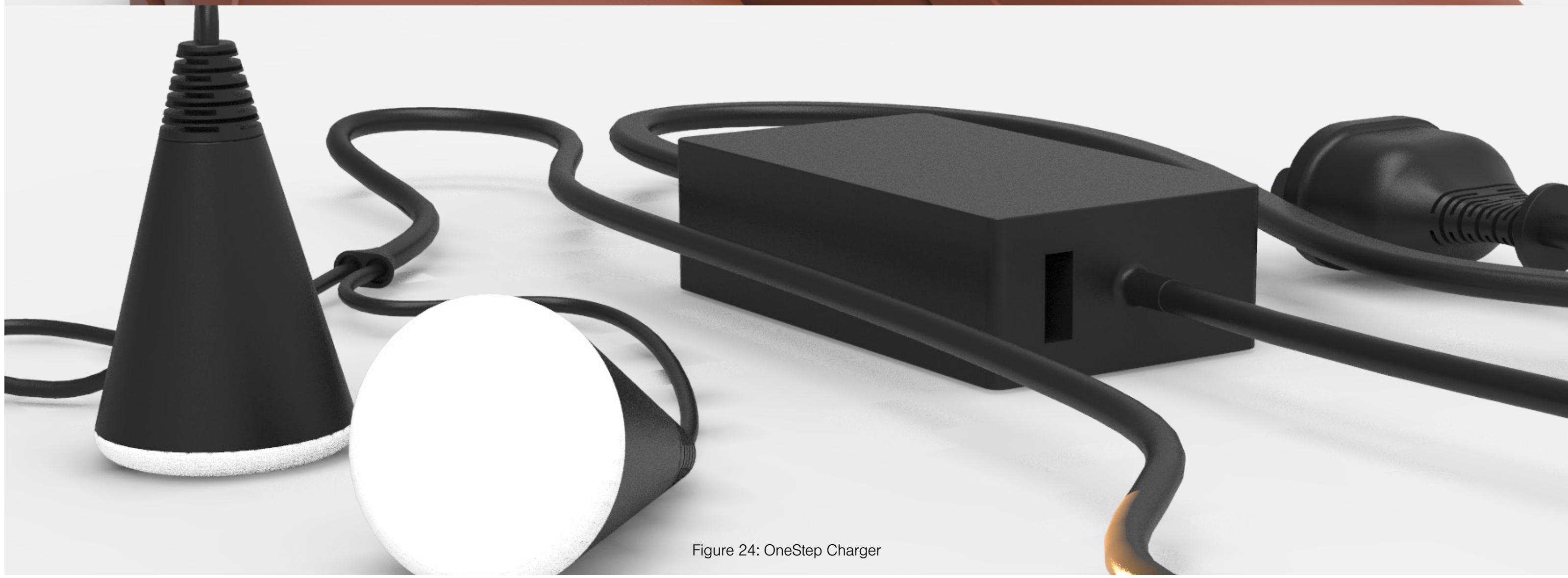


Figure 24: OneStep Charger

PRODUCT USABILITY

OneStep was created to be an intuitive experience, from setup to use.

An issue identified within the research phase; was the individuality each patient had when experiencing FOG (Ginis, 2018). This led to the development of a one week learning period, in which OneStep is provided to the user for a week, to measure what occurs when they freeze. As this is different from person to person, no two measurements will be the same. This data is then taken to a clinician, who can properly diagnose what occurs when they freeze. Once this has been resolved, the OneStep insole is able to determine what a freeze looks like for that individual user and can begin working within the system to alleviate FOG symptoms. Some approaches to accessing the products can be seen in the following scenarios.

Scenario 1 (Figure 25) displays the experience that the user will have when obtaining the product for the first time through a clinician, and how the trial period works to increase product usability.

Scenario 2 (Figure 26) details how a PwP may access the OneStep system through the internet, without a clinician.

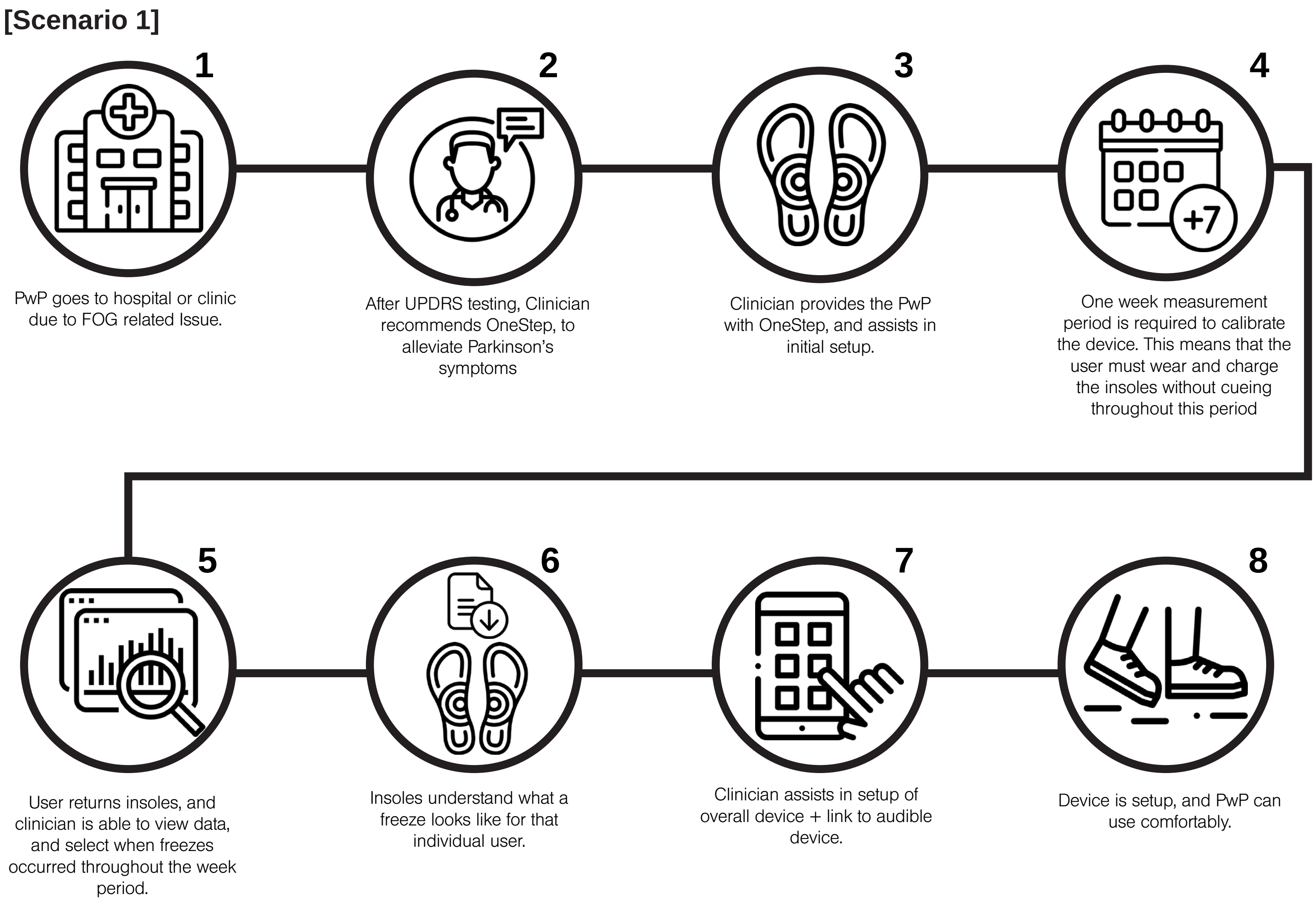


Figure 25: OneStep sequence of use (Clincal)

[Scenario 2]

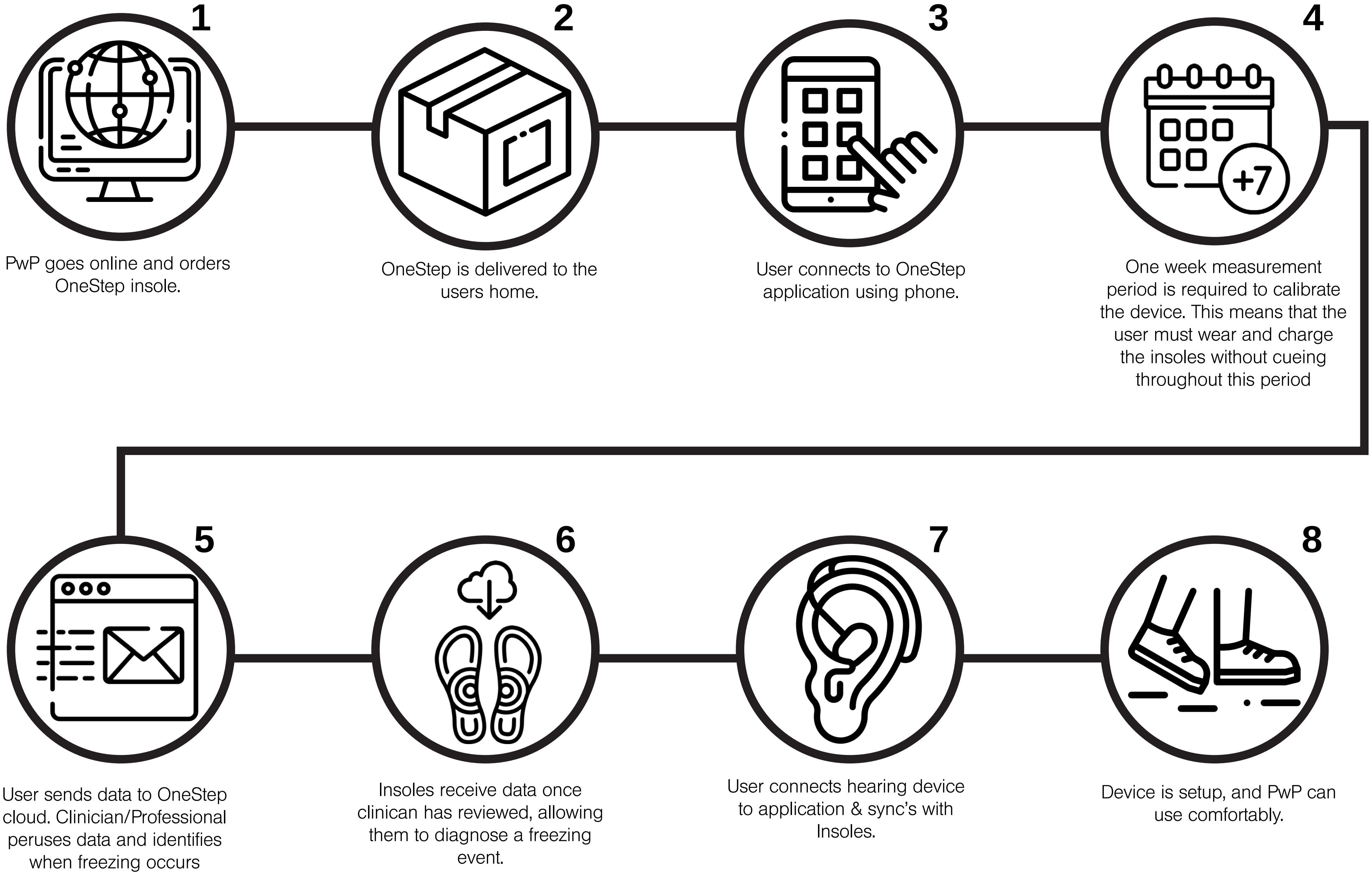


Figure 26: OneStep sequence of use (Home)

DESIGN PROCESS

After completion of Phase 1. Design Development was able to begin on the final product. OneStep is a culmination of 10 months of research and development and has been synthesised from an in-depth literature review and research methods.

The Double Diamond Method was utilised for this project due to its ability to organise a non-linear process. This approach is beneficial when transforming a design idea from research to a tangible product with divergent and convergent processes. The overall process can be seen in Figure 27.

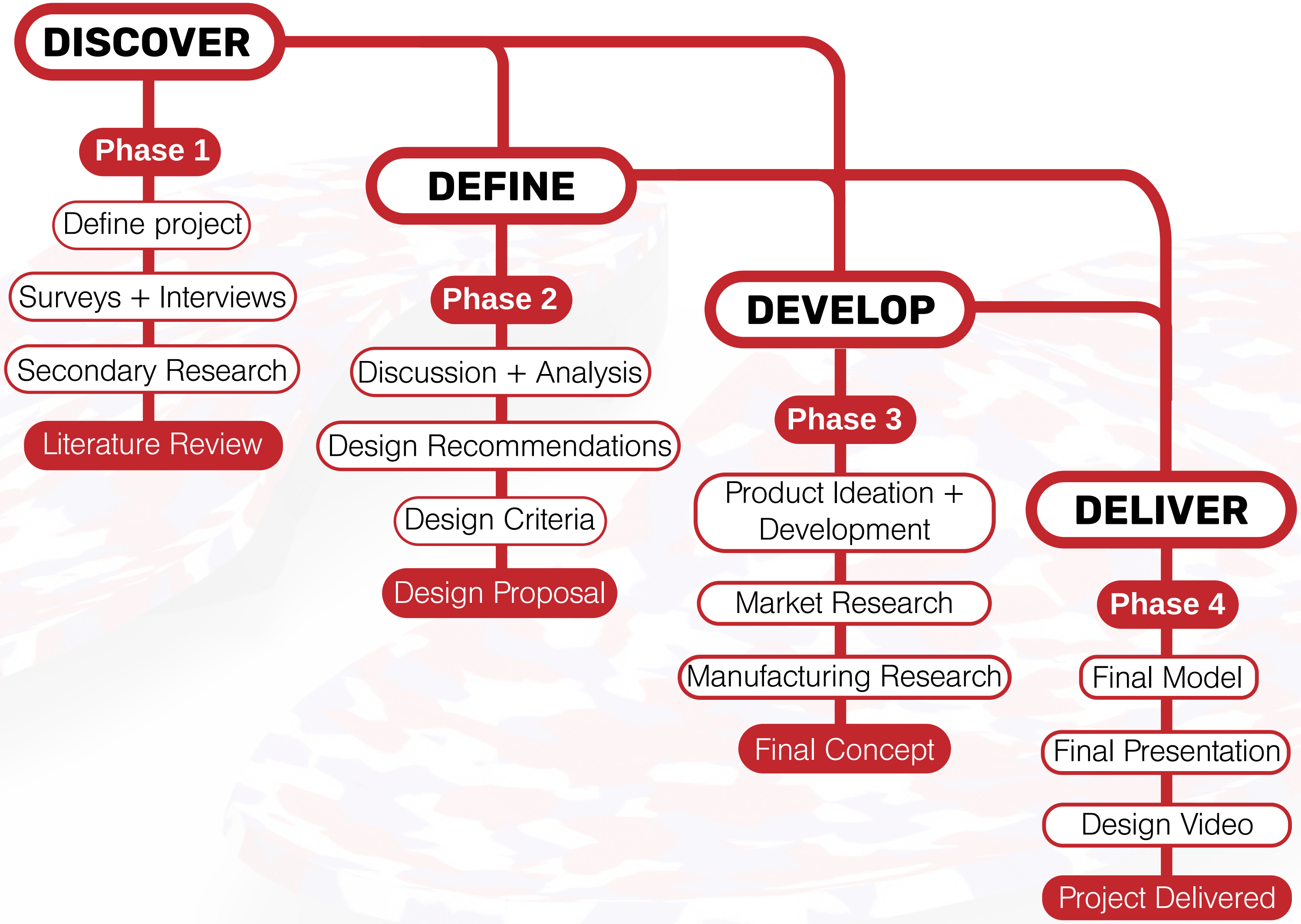


Figure 27: Double Diamond Method. Adapted from https://www.designcouncil.org.uk/news-opinion/what-framework-innovation-design-councils-evolved-double-diamond

PRODUCT VALIDATION

Industry Liaison was a key driver in ensuring the validation of the overall product. The product was created with the help of Industry experts within Brisbane, who were able to inform design decisions and manufacturing, whilst justifying the validity of the overall design. This constant Industry Liaison assisted in ensuring that the design was plausible. The industry experts assisted in understanding how current orthotics are manufactured, and how this could be altered to accommodate for the OneStep system. Industry liaison also assisted in understanding the limitations of the insole, including the maximum height of the heel, and the maximum internal space for any electronics.

Additionally, product usability testing was completed on the insole, to ensure that the tangible products were comfortable, and easy to use. A major challenge presented when developing the insole was understanding how a user may remove the insole from the shoe when they have limited hand dexterity. User testing allowed the testing of various prototypes, to better understand which insole removal process would be the most effective, and whether a removal tool needed to be created to assist with this process.

Figure 28: Meeting with iOrthotics

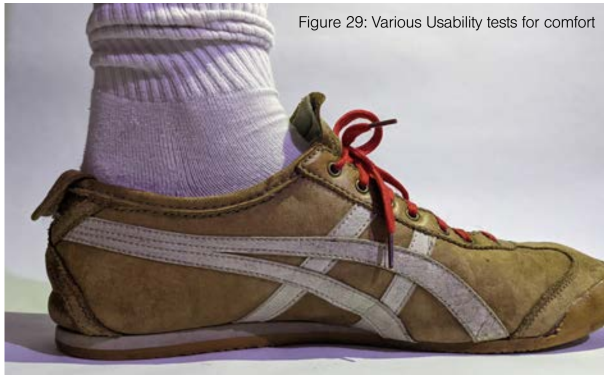


Figure 29: Various Usability tests for comfort

MATERIALS + MANUFACTURING

PA11 Nylon [5]

The hard base of the Insole which houses the electronics, and the base cover will be manufactured using PA11 Nylon. Nylon was chosen due to its strength and resilience, as well as its ability to be manufactured using additive processes. Nylon also contains waterproofing properties, which make it beneficial for use within an insole. Nylon is able to be powder printed, which allows for the elimination of support structures that are used in traditional 3D printing, as the powder layers act as support. This further reduces material waste, making this practice incredibly sustainable.

EVA Foam [6]

The Foam Insert connected to the insole base provides comfort to the user, whilst providing housing for the pressure sensors. This insert is manufactured using EVA foam which is suitable for use in clinical settings, as it features chemical resistance and biocompatibility. It is effective for use within an insole, as it is water resistant for sweat, and can remain resilient long term, withstanding large amounts of stress with little to no damage.

The insert is easily manipulated and cut using CNC machines, making the manufacturing process incredibly efficient. The offcuts of materials are also recyclable, limiting wastage within this process.

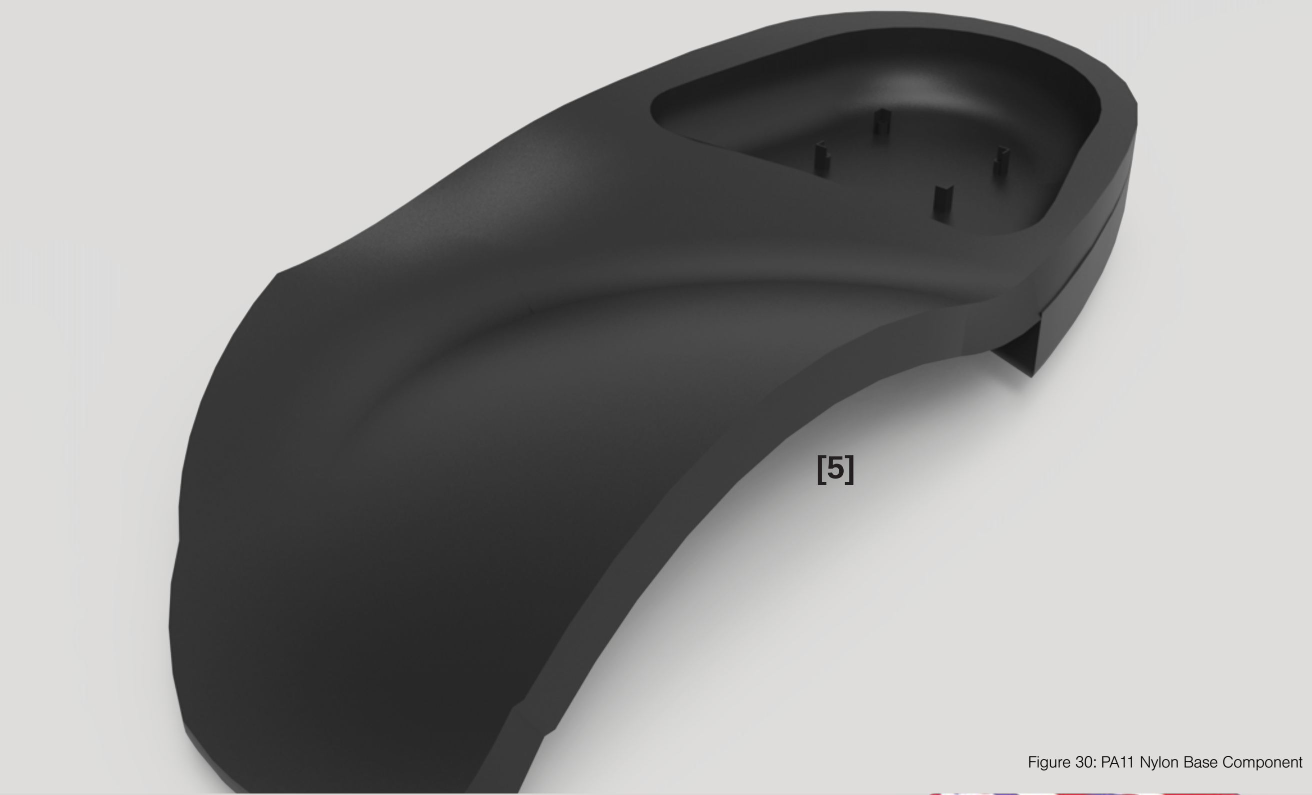


Figure 30: PA11 Nylon Base Component

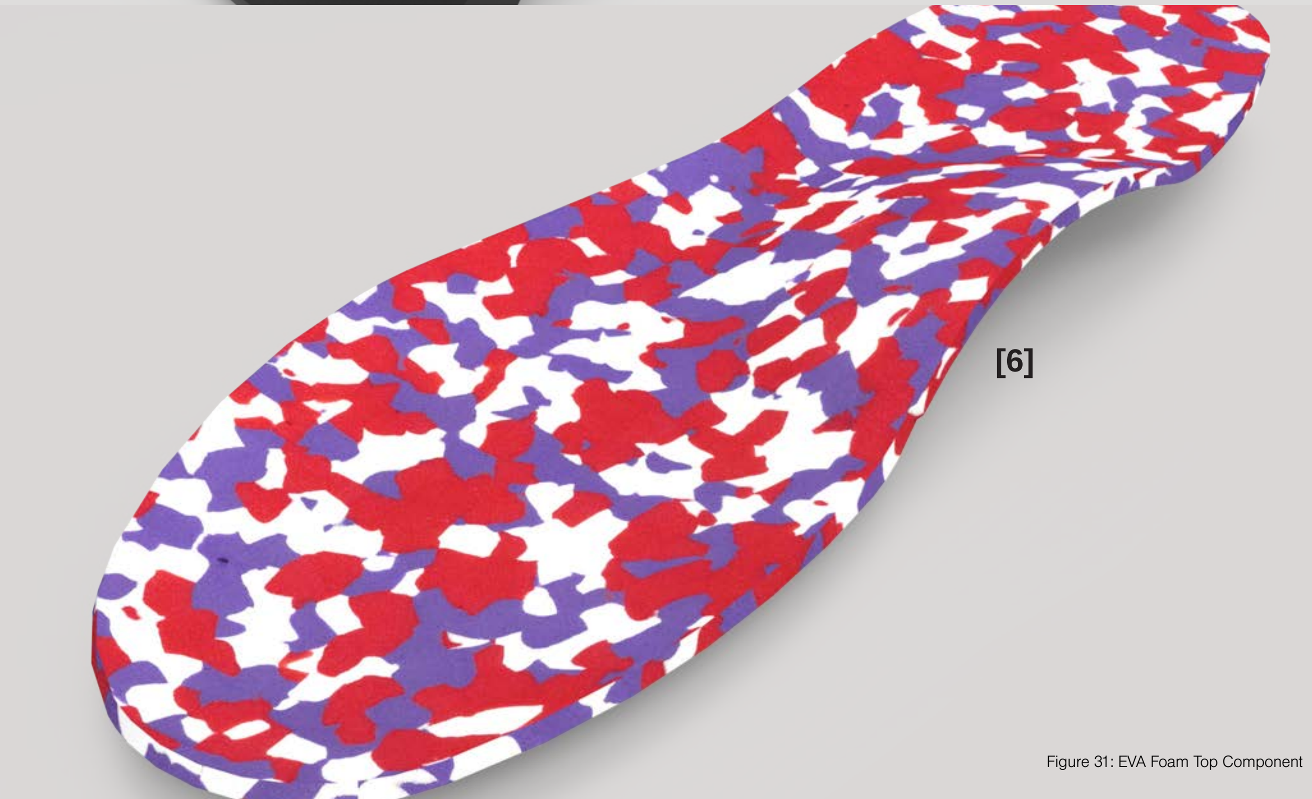


Figure 31: EVA Foam Top Component

MARKET POTENTIAL

People with Parkinson's want to feel as though they are indifferent in society, however current technologies that are visible and uncomfortable force them to avoid social settings, due to fear of judgement and increased anxiety. The OneStep system solves this not only through the use of a discreet wearable insole, but through its use of instantaneous cueing when FOG occurs. This in turn allows PwP to independently manage their FOG in social settings, without drawing attention to themselves.

The autonomy built within the OneStep system puts it ahead of competitors by taking the challenges of managing FOG away from the user, providing them with the cueing techniques necessary to alleviate their symptoms without assistance. As mentioned earlier, current technologies that incorporate cueing techniques are user activated, which can be detrimental to a user. Should cueing not be activated in time, the users' risk of fall increases – which could lead to hospitalisation.

The OneStep system also embraces sustainable design and manufacture, making it an attractive solution. By utilising additive manufacturing and recyclable materials, the OneStep system will have an edge over competitors.

The OneStep insole's ability to link up with various audible outputs gives it an advantage over competitors as it allows users to personalise their experience and gives clinicians the chance to link the insoles with their own speaker systems during treatment.

VALUE PROPOSITION

Customer Jobs

Charge Insoles daily to ensure maximum efficiency.

Connect their preferred hearing output.

Clinician liaison.

Customer Pains	Customer Gains	Pain Relievers	Gain Creators
Individuality of Symptoms means there is no single solution. Feeling uncomfortable in public when freezing occurs. Current products require self-initiated cueing. Current products are indiscreet and visible. Unable to implement most cueing techniques in a public setting	Ability to navigate public spaces freely, without feeling uncomfortable. Ability to manage their freezing discreetly and quickly. Better measurement of FOG for clinician use.	Weeklong trial period allows for clinicians to measure what an individual's freezing episode looks like and can program the insoles to recognise this. The autonomous system allows for instantaneous cueing when FOG occurs. The insole is discreet and invisible when in use. The ability to connect to any Bluetooth device gives users the opportunity to use whatever they feel comfortable with. Cueing can take discreetly in public.	Simple system means that aging population is not overwhelmed with understanding new technologies. Industry standard of FOG management incorporated into final design, meaning the device would be usable during treatment sessions. Materials used are medically appropriate and can be used in clinical setting.

Figure 32: Value Proposition Canvas

BUSINESS PLAN

Key Partners

Funding:
NDIS or iORTHOTICS

Additional:

- iOrthotics Manufacturing
- Material suppliers
- PCB Supplier
- Software Development Team
- Clinicians who are able to understand the insole readings

Key Activities

Once:
- Development of website
- Development of app

Regular:
- Packaging
- Hospital Shipment + Delivery
- Warehouse Storage
- Providing customer support
- Maintenance of website and app
- Promotion

Outsourced
- Manufacturing
- Delivery

Key Resources

Physical
- Storage Facility
- iOrthotics Manufacturing Facility
- Materials for device
- Packaging

Intellectual
- Branding
- Design rights
- Trade mark

People
- Engineer
- Customer support
- Website development + maintenance
- App development + maintenance
- Packaging and postage
- Clinicians + Physiotherapists

Value Proposition

User:
A usable and discreet system that allows them to traverse public landscapes without feeling anxious.

Simple and intuitive device that assists with the alleviation of FOG symptoms.

Clincian:
New device capable or being used in the alleviation of FOG in various settings. New abilities for treatment and exercise.

Ability to bulk buy assets and resell at consumer price.

Customer Relationships

Multiple OneStep devices can be bought by hospitals to use for treatment, or bought online using the OneStep website. Users are able to commincate with OneStep through their clinicians, or directly via the internet.

Channels

Health appointment
Clinicians or health experts are able to recommend and supply the product directly from a clinical practice or hospital if the user has been hospitalised as a result of or stuggles with FOG.

Clinicians can also purchase their own pairs for clinical use, leaving at the hospital to use of various patients.

Mentioned in resources about PD
Product can be advertised and mentioned in Articles about PD, and avaible through the NDIS as part of a users insurance scheme.

Website
Website allows the user to buy, purchase and setup their device without the use of a clinician.

Customer Segments

Niche market due to targeted neurological disease.

Primary Users:
Early-Mid stage Parkinson's Disease patients who suffer from FOG symptoms.

Secondary Users:
Physiotherapists & Clinicians who may assist with FOG during clinical sessions.

Cost Structure

Value driven cost structure

Costs:
- Paying employees
- Intellectual Property
- Delivery
- Website and app maintenance
- Medical testing and approval

Income:
- Funding from investors and partners
- Purchasing of the device and suppliers upfront
- Users and Clinician purchase through website.

Revenue Streams

Upfront User Purchase:
Users can purchase the product directly from the website, which includes instruction manuals for installation and all necessary items for successful product use.

Upfront Clinician Purchase:
Clinicians, Hospitals or Physio/OT practices are able to purchase stock to resell at a discounted rate. This stock can be kept at the hospital or distributed to users as the hospital requires.

CONCLUSION

The research concluded that there was a need for a discreet wearable to assist with the measurement and alleviation of FOG in PD.

The OneStep system is a design that addresses this incredibly debilitating symptom, and solves this complex problem through its ability to alleviate symptoms whilst remaining discreet throughout use. The integration of the OneStep system into day-to-day life could be paramount to understanding the way that PwP experience FOG.

OneStep has the potential to explore in-depth how Parkinson's Disease progresses and shows promise in the evolution of design for the aging population. The wearable specifically, has limitless potential in it's use, and could be adapted for use in a range of scenarios, from Diabetes Management to the mitigation of other movement based disabilities. The final design assists with the alleviation of FOG, and successfully follows the design criteria synthesised from the exhaustive research phase.

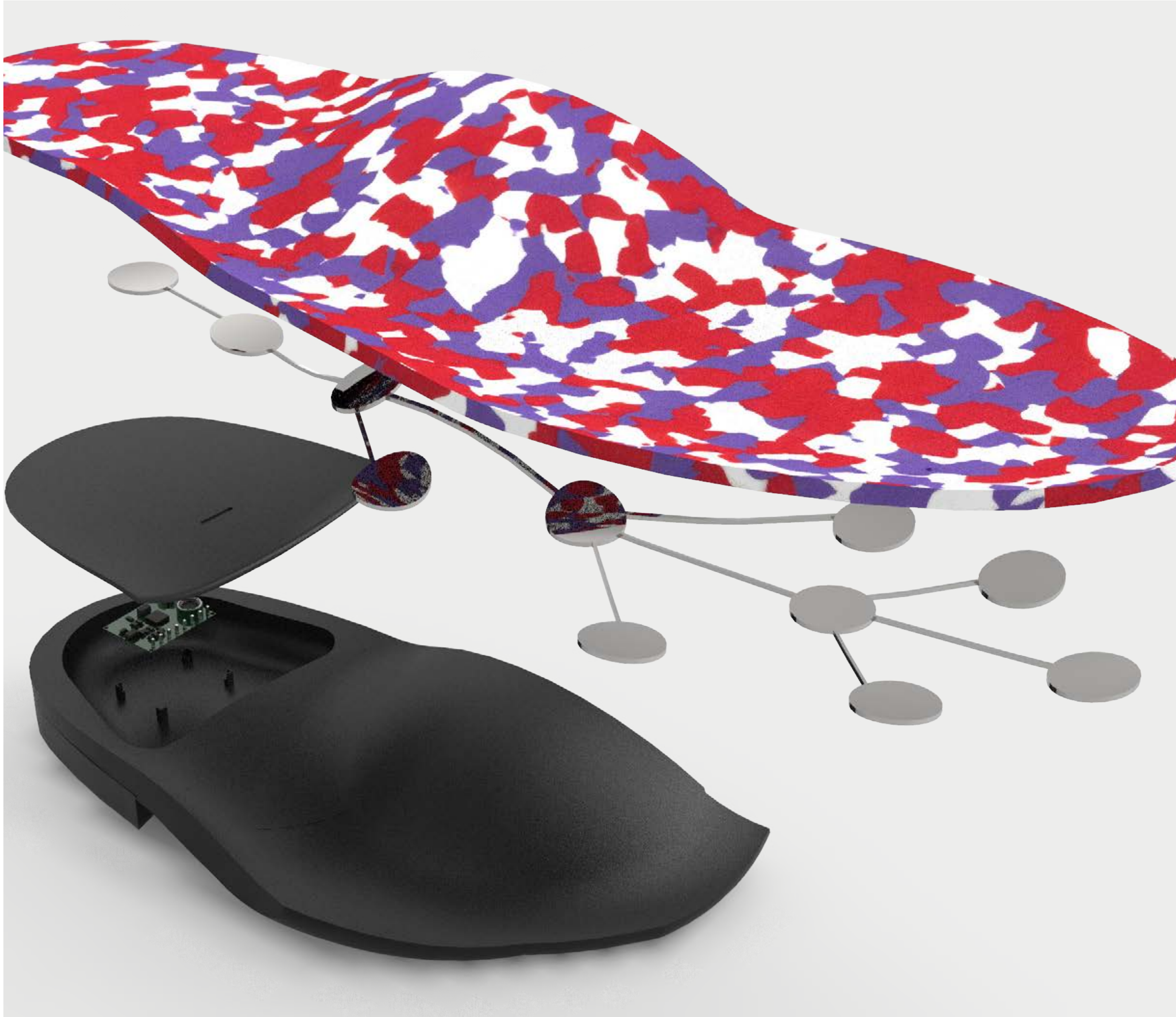


Figure 33: OneStep Insole Exploded View

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A

APPENDIX

Appendix 1

Likert Survey Questions

1. What is your relation to the PWP?
2. How long have you been diagnosed with PD?
3. FOG has the greatest impact on my overall QoL
4. FOG impacts my confidence and self-esteem
5. My FOG gets worse in social or anxiety inducing situations
6. Current rehabilitation methods are difficult to keep track of at home
7. I often find that current rehabilitation methods are unhelpful, or do not suit me
8. I find it difficult to understand new technology
9. I believe there is a need for newer rehabilitation techniques for FOG
10. I have had experience with Virtual Reality Technology
11. I would consider Virtual Reality as a way of rehabilitation

Appendix 2

Short Response Survey Question

1. Which Technology do you find most appealing
2. Please elaborate on why you selected your chosen technology

Appendix 3

Generic Interview Questions

1. What is your Job Role?
2. How long have you worked with People with Parkinson's?
3. What do you find are the largest concerns for PWP, apart from their condition?
4. What do you think are the most effective strategies you have personally implemented that assists with FOG?
5. How does FOG affect your ability to provide personalized assistance for patients with PD?
6. Have you used any emerging technologies (Provide definition) to treat FOG or other symptoms of PD?
7. IF YES. Were the tests effective in their specified use?
8. IF NO. What is stopping you from using such technologies? Economic? Stigma?
9. Do you find that PWP are open to experimental treatments?
10. What are limitations when working with PWP in clinical settings?

Appendix 4

Example Coding Excerpt

B 03:01

Definitely not that works for everybody (PID). But I would say I have a pocket full of tricks that I try that most usually within my pocket full of tricks (PTS). So I definitely use rhythmic and verbal cueing (CAC). I use visual, I use visual cueing (CVC) and different things work for different people (PID). So some people do really well (PPS) with like lines on the floor (CVC). And I've seen that there's technology around with laser lines that provide something just step over (TET). Others need a continuous 3d, something to step over. So if I put hurdles, they can step over (CVC, PID, PPS). I have somebody who even if I put a foot in front of him, it looks like I'm trying to trip him but he can step over that (ITP). So it helps. And the verbal cueing that I use, I try to teach some consistent verbal cueing so that when people are freezing (CAC), they can learn to self-regulate to stop and stand up straight. And then to start again with a big step (PDS). So they learn a series of verbal commands (CAC), that hopefully they unfortunately, as Parkinson's progresses, we get cognitive dysfunction as well (PDP). And then they have more trouble using this (DRI). What else do I use. I occasionally use music or metronomes (CAC). But if I have a group of people, the rhythm tends to be different from one person to the next (PID). So when I'm one to one with people, I can find rhythm that works (SRS). I get them to verbalize and to count (PDS). Sometimes I use distraction techniques (RBS). So I'll say, you know instead of focusing on what's happening, but almost always I will start with a verbal postural cue (CAC). And then because like most physios I'm a dick I make I make them practice the things that are difficult for them (ITP) so that in the real world (LPS) they can manage them. So we do I do a lot of stop starts change direction,

Appendix 5

Criteria Justification

1a	The solution must cater to a wide variation of FOG severity.	A common theme throughout the research was the evidence of patient individuality in both symptoms and treatments that are effective, because of this, it is important that the product caters to the vast user group
1b	The solution should cater to a wide variation of treatment individuality.	A common theme throughout the research was the evidence of patient individuality in both symptoms and treatments that are effective, because of this, it is important that the product caters to the vast user group
1c	The solution must service a diverse cultural and socio-economic user group.	The research suggested that there is no commonality between those with PD, apart from the mean age of diagnosis being 60+/-5 and the cardinal PD symptoms. It is important that the solution accounts for this diverse user group.
1d	The design solution must be easily understandable and intuitive to those with limited technology understanding.	All Clinicians interviewed stated that it was paramount that the solution be easily understandable to PWP, regardless of their experience with technology.
1e	The solution must not be bulky or uncomfortable.	The Short response question within the survey had many responses exclaiming that the users would near wear a wearable technological device if it were bulky or uncomfortable
2a	The solution must be easy to implement in a range of treatment scenarios.	Clinicians and Patients both made it obvious that many treatment methods are only available whilst in hospital, and cannot be replicated outside of this. Because of this, it is important that the final solution can be used effectively in a range of settings.
2b	The solution must be backed by research based evidence ensuring its effectiveness	Interviewee C and D both stated that for a solution to be invested in by a government hospital, research based evidence on its effectiveness is required.
2c	The solution should involve the use of any of the various cueing techniques	All interviewees stated that cueing techniques were the most effective way to alleviate FOG symptoms. It is important that the solution implements and improves upon these techniques.
2d	The solution must be easily implemented into existing treatment methods	Clinicians interviewed exclaimed that new technology can often be confusing or misunderstood by PWP, and a product that fits seemlessly into existing strategies would be beneficial.
2e	The solution must be more efficacious than existing scenarios	For the solution to be successful, Clinicians interviewed stated that it must be more efficacious than existing strategies. Otherwise there is no reason for its implementation.
3a	It may provide assistance when in a public or anxiety inducing scenario.	Both the literature and Interviews hinted at the existence of anxiety induced FOG, although it was found to be not a main cause for solution development. However, it would be beneficial for the product to be able to provide assistance in anxiety inducing scenarios, to potentially limit the amount of falls experienced by PWP

4a	The solution must be easy to use, ensuring that button presses, and other small components thought out, due to the limit of strength and movement disability that is present in both old age and PD.	Interviewee A (A PWP) repeated the importance of products that are made with the abilities of PWP in mind. It is important that any buttons that must be pressed or other moveable parts must not require any force, to ensure that the product is usable.
4b	The solution must be durable and shock resistant in case of fall.	Interviewee A also discussed how important shock resistance was when creating wearables for PWP, as they can experience falls and slips due to the FOG. This means that should a wearable be developed, it must be able to survive, and potentially protect the user from a fall.
4c	The solution must be fit for purpose.	Interviewee A explained that products created for PWP must be fit for purpose, and that sometimes alternative approaches must be taken. A product they used involved blowing to turn on, as they are unable to press buttons with their hands with reasonable force
5a	The solution must be visually understandable.	Clinicians interviewed stated that a product must be visually understandable to both themselves and their patients, as it can often be a steep learning curve when experiencing new technologies, making treatment sessions even more difficult.
5b	The solution (If wearable) must be inconspicuous and discreet when in use.	The user survey determined that any wearable products used must be inconspicuous and discreet to make them feel more comfortable in public spaces.
6a	If a solution requires VR/AR, limitations must be created to ensure that boundaries occur when patients are completely immersed, to ensure that no injury happens.	Clinicians interviewed also explained the importance of patient safety, and that the implementation of VR systems comes with many risks, especially when patients are completely immersed and unaware of their surroundings.
7a	The solution must be easy to maintain, with no complex part changes or setup required.	Interviewee A stated that it is difficult for PWP to deal with difficult maintenance in products that require battery replacements or other part replacements. This means it would be efficacious for the solution to require no maintenance during its lifetime.
8a	The technology must be intuitive and easy to implement with limited technological knowledge.	Of the clinicians interviewed 2/3 said that they lacked the technological knowledge to implement VR into their practice. This means that any technological solution created must be easy to use and understand for both clinicians and patients.

Appendix 6

Short Response Survey Answers

	If you can, elaborate on what you find appealing about your selected technology
1	Looks normal
1	Eyesight only in one eye. Others look cumbersome. Watch is easy to wear.
2	I think he would be more likely to do it.
1	smaller, more comfortable.
1	Unobtrusive and blends well with any apparel.
1	Wearable, less conspicuous
1	looks discreet
3	I have a U-Step Walker that has a laser light and I walk to cross my feet across the red light. I guess I have wondered how two lasers would work?
3	If that's a buzzer or similar the stimulation to the left foot for me would help me lift my foot
1	It is not conspicuous
1	I already wear a watch so It won't be any different
2	Visual and neural
1	Less intrusive
4	assuming it helps with vision, hearing and eyesight
2	I already use VR to help manage some symptoms. Mostly for cardio with VR boxing though.
1	Easily worn
1	It is subtle
1	I can monitor my daily steps
1	Not conspicuous
4	Easy and not bulky or too visible
1	Easier to wear at night when he get up to use the restroom
1	Would be easier to wear
1	I guess I would need more information. 2 looks neat but I get dizzy easily so VR might not be great. I do not understand what 3 and 4 are. 1 seems like something that would be easy to use more often.
1	Only using excessive, gives me a sense of control
1	Does not stand out as different
1	Portable. Not obstructive or cause distraction that could lead to a fall.
2	When I have FOG episode I can step over some obstacles
1	Not visible/ not restrictive
1	The watch is not obvious and easy to put on. Would not need to be adjusted or would not fall off.
1	Discreet

Appendix 7

Themes and Codes

Inductive Codes

Theme	Sub Theme	Codes	Abbreviation	Description
Gait and Movement	Overall Disease Issues	Disease Progression	PDP	Mention of a symptom of disease progression
		Disease Related Issue	DRI	Mention of an Issue that is directly caused by PD
		Disease Duration	DUR	Mention of a patient's disease duration
	FOG Related Issues	Start Hesitation	FSH	A patient or physio experiences/mentions Start hesitation FOG
		Turn Hesitation	FTH	A patient or physio experiences/mentions Turn hesitation FOG
		Tight-Quarter Hesitation	FQH	A patient or physio experiences/mentions Tight quarter hesitation FOG
		Destination Hesitation	TDH	A patient or physio experiences/mentions destination hesitation FOG
		Open Space Hesitation	FOH	A patient or physio experiences/mentions open space hesitation FOG
		FOG Episode	FGE	A patient experiences a FOG episode
		Stuck in place/shuffling	FSS	A patient or physio experiences/mentions shuffling
		Focusing on the Task at hand	LOF	A patient or physio experiences/mentions Difficulty focussing
		Thinking to overcome – battle within their head	TTO	A patient or physio experiences/mentions thinking to overcome
	Movement/Health Related Issues	Movement Issues	MNI	A patient or physio experiences/mentions movement issues
		Balance Retraining	MBR	A patient or physio experiences/mentions balance retraining
		Reinitiating gait	RIG	A patient or physio experiences/mentions reinitiating gait
		Movement based drills	MBD	A patient or physio experiences/mentions movement based drills
		Readjustments to movement	MRA	A patient or physio experiences/mentions readjustments to movement
		Unsuccessful Body Movements/ Weight Shifts	UBM	A patient or physio experiences/mentions unsuccessful body movements
		Deterioration of gait during walk	GDE	A patient or physio experiences/mentions deterioration of gait

		Anticipation of Movement	MAM	A patient or physio experiences/mentions anticipation of movement
		Unusual Gait	MUG	A patient or physio experiences/mentions unusual gait
		Health Related issue combined with FOG	HUG	A patient or physio experiences/mentions health related issue combined with FOG
Successful Rehabilitation Techniques	Type of Cueing	Visual Cueing	CVC	A patient or physio experiences/mentions Visual Cueing
		Auditory Cueing	CAC	A patient or physio experiences/mentions Auditory Cueing
		Vibrational/ Somatosensory Cueing	CSC	A patient or physio experiences/mentions Somatosensory Cueing
		Mixed Cueing	CMC	A patient or physio experiences/mentions A mixture of cueing methods
	Existing Rehabilitation Methods	Medications/Levodopa	RML	A patient or physio experiences/mentions taking, or the effects of, medication
		Successful Rehabilitation Strategy	SRS	The strategy was successful
		Rehabilitation Strategy	RBS	A currently used strategy
		Strategy Recommendation	SRD	A Physio recommends the strategy
		Unsuccessful Rehabilitation Strategy	URS	the strategy was unsuccessful
		Medical Products	RMP	Usage of medical products in treatment
	Physiotherapist Specific Treatment or Emotion	Physiotherapist Treatment Preference	PTP	Physio treatment preference when rehabilitating
		Physiotherapist driven strategy/ strategies	PTS	Strategy that is driven by or requires a physio
		Physiotherapist Interest	PHI	Physiotherapist interest in topic
		Limitation of treatment method	LTM	Limitation of discussed method
		Teachable to spouses, carers, friends.	TSC	Discussed method is teachable
		Strategy using Technology	SUT	The implemented strategy uses technology
		Potentially unsuccessful strategy	PUS	The physio does not see merit in using a proposed strategy
Implementation of Technology	Use of Technology	Wearable Technology	TWT	Use of wearable technology during treatment
		Consoles	TCO	Use of console technology during treatment

		Wearable Sensors	TWS	Use of wearable sensors during treatment
		Phone Usage	TPH	Use of mobile phone during treatment
	Limitations or Difficulties to Tech	Technology Difficulty	TTD	Difficulty with technology during a previous treatment
		Tech Accessibility	TTA	Limited access to technology
		Online Website/App	TWA	Use of a website or Application during treatment
		Ease of Use	TEU	The technology is easy to use for the proposed user group
		Emerging Technology	TET	Mention of Emerging technology
		Lack of Technological Understanding	LTU	The patient or physio lacks the technological understanding of a proposed product
		Technology Limitation	TEL	Limitations of technology implementation
Patient Individuality	Anxiety, Stress, Stigma	Social Stigma	SSS	A patient experiences social stigma
		Product Centred Stigma	PCS	A patient experiences product centred stigma
		Social Anxiety	SAA	A patient experiences social anxiety
		Anxiety Induced FOG	AIF	A patient experiences Anxiety induced FOG
		Disconnect from life before Parkinson's	SDP	A patient experiences a disconnect from their life before they were diagnosed.
		Experiencing Anxiety	EXA	A patient experiences Anxiety during treatment
		FOG related Stress	STA	A patient experiences FOG related stress
	Patients	Individual treatment plan	ITP	A patients individual treatment plan
		Patient Success	PPS	A patient experiences success during a discussed treatment
		Patient Individuality	PID	A patient's individuality in their condition symptoms
		Patient Driven Strategy	PDS	A rehabilitation strategy that is patient driven
		Aging Population	PAD	Mention of the aging population
		Patient Confusion/ Misunderstanding	PPC	A patient feels confused or misunderstand a treatment or technology
		Patient Understanding	PUN	A patient understand the treatment or

				technology
		Patient Challenge	PCH	A patient is challenge by the treatment or their symptoms
		Patient Improvement	PIM	A visible improvement is seen in patient during treatment
		Group Session	PGS	Patients experience a group session
		Patient Interest	PIN	A patient is interested in a treatment or technology
	Testing Procedures	Practicing for test	TPP	A patient practices for the diagnosis test
		Lack of proper diagnosis	LPD	There is lack of proper diagnosis for the mentioned problem
		Untrustworthy test	TUT	A test used on the patient is untrustworthy
		Testing Opportunity	TOP	An opportunity to improve testing
	Patient Quality of Life	Improved Quality of Life	GQL	The patient's quality of life will improve
		Poor Quality of Life	BQL	The patient's quality of life will deteriorate
		Lack of Motivation	PLM	The patient experiences a lack of motivation
	Cost/Funding	Funding Limitations	TFL	Funding limitations when buying a product related to PD
		Free to use	FTU	Free to use products that assist with PD
	Potential Design Criteria	Easy to use	DCE	A discussed product is easy to use
		Easy to Hear or See	EHS	A discussed product is easy to hear or see
	Product	Product Recommendation /Idea	PRI	A patient or physio has a product recommendation or idea
		Fit for Purpose	FFP	
		Usability Considerations for PWP	UCP	A product involves usability considerations in relation to Parkinson's disease
		Lack of Research Based Evidence for Implementation	LRE	The proposed product lacks research based evidence
	Location	Open Gym	LOG	The rehabilitation takes place in an Open Gym
		Hospital	LHS	The rehabilitation takes place in a Hospital
		Public Space	LPS	The rehabilitation takes place in a public space

		Home	LHM	The rehabilitation takes place in a home
	Manufacturing	Development and Production of a product	DPP	Discussion related to the development of a product
		Design Considerations	DCM	When design considerations are made
		Design Regulations	DSR	When design regulations and law is mentioned

Appendix 8

Code Frequency Table

Codes	Abbreviation	Frequency				
		Interview 1 B	Interview 2 D	Interview 3 C	Interview 4 A	Total
Disease Progression	PDP	4	1	2	0	7
Disease Related Issue	DRI	3	1	1	0	5
Disease Duration	DUR	0	0	0	0	0
Start Hesitation	FSH	0	0	0	0	0
Turn Hesitation	FTH	1	0	0	0	1
Tight-Quarter Hesitation	FQH	1	0	0	2	3
Destination Hesitation	TDH	2	0	0	1	3
Open Space Hesitation	FOH	0	0	0	0	0
FOG Episode	FGE	1	3	0	0	4
Stuck in place/shuffling	FSS	1	1	0	0	2
Focusing on the Task at hand	LOF	0	0	1	0	1
Movement Issues	MNI	4	0	0	0	4
Balance Retraining	MBR	0	0	1	0	1
Reinitiating gait	RIG	3	3	1	1	8
Movement based drills	MBD	6	0	0	0	6
Readjustments to movement	MRA	1	0	0	0	1
Unsuccessful Body Movements/ Weight Shifts	UBM	4	0	0	1	5
Deterioration of gait during walk	GDE	1	0	0	0	1
Anticipation of Movement	MAM	3	0	0	0	3
Unusual Gait	MUG	1	0	0	0	1
Health Related issue combined with FOG	HUG	1	0	0	0	1
Visual Cueing	CVC	8	3	1	1	11
Auditory Cueing	CAC	12	2	5	6	25
Vibrational/ Somatosensory Cueing	CSC	2	0	0	1	3
Mixed Cueing	CMC	1	2	0	0	3
Medications/Levodopa	RML	1	0	1	1	3
Successful Rehabilitation Strategy	SRS	6	3	4	0	13
Rehabilitation Strategy	RBS	4	3	1	0	8
Strategy Recommendation	SRD	7	2	3	1	13
Medical Products	RMP	1	0	0	0	1
Physiotherapist Treatment	PTP	0	1	0	0	1
Preference						
Physiotherapist driven strategy/ strategies	PTS	11	3	2	0	16
Physiotherapist Interest	PHI	2	2	1	0	5
Limitation of treatment method	LTM	0	1	0	0	1
Teachable to spouses, carers, friends.	TSC	1	1	0	0	2
Strategy using Technology	SUT	2	0	0	0	2
Potentially unsuccessful strategy	PUS	1	0	0	0	1
Wearable Technology	TWT	5	0	0	2	7
Consoles	TCO	1	0	2	0	3
Phone Usage	TPH	1	0	1	1	1
Technology Difficulty	TTD	1	0	1	0	2
Tech Accessibility	TTA	1	1	1	0	3
Online Website/App	TWA	1	0	2	0	3
Ease of Use	TEU	0	0	1	1	2
Emerging Technology	TET	4	1	2	1	8
Lack of Technological Understanding	LTU	1	2	0	0	3
Technology Limitation	TEL	1	0	0	5	6
Social Anxiety	SAA	0	0	0	0	0
Anxiety Induced FOG	AIF	2	0	0	0	2
Disconnect from life before Parkinson's	SDP	2	0	0	0	2
Experiencing Anxiety	EXA	3	0	0	0	3
FOG related Stress	STA	2	0	0	0	2
Individual treatment plan	ITP	8	3	1	0	12
Patient Success	PPS	4	2	0	2	8
Patient Individuality	PID	14	2	2	0	18
Patient Driven Strategy	PDS	3	4	3	4	14
Aging Population	PAD	0	0	3	0	3
Patient Confusion/ Misunderstanding	PPC	0	0	0	1	1
Patient Understanding	PUN	2	0	1	0	3
Patient Challenge	PCH	14	1	2	9	26
Patient Improvement	PIM	3	0	1	3	7
Group Session	PGS	2	0	0	0	2
Practicing for test	TPP	1	0	0	0	1

Lack of proper diagnosis	LPD	1	0	0	0	1
Untrustworthy test	TUT	2	0	0	0	2
Testing Opportunity	TOP	1	0	0	0	1
Improved Quality of Life	GQL	0	0	1	0	1
Poor Quality of Life	BQL	1	0	0	0	1
Lack of Motivation	PLM	0	2	0	0	2
Funding Limitations	TFL	0	0	2	0	2
Free to use	CFU	0	0	1	0	1
Easy to use	DCE	0	0	1	1	2
Easy to Hear or See	EHS	1	0	0	1	2
Product Recommendation /Idea	PRI	3	0	0	0	3
Fit for Purpose	FFP	0	0	0	7	7
Usability Considerations for PWP	UCP	0	0	0	10	10
Lack of Research Based Evidence for Implementation	LRE	0	0	1	0	1
Open Gym	LOG	1	0	0	0	1
Hospital	LHS	0	0	1	0	1
Public Space	LPS	3	0	0	0	3
Home	LHM	0	0	0	1	1
Development and Production of a product	DPP	0	0	0	4	4
Design Considerations	DCM	0	0	0	13	13
Design Regulations	DSR	0	0	0	3	3

Mentioned over ten times.

Mentioned in all four interviews.

Mentioned in 3 out of 4 interviews.

Leadership Initiative 1

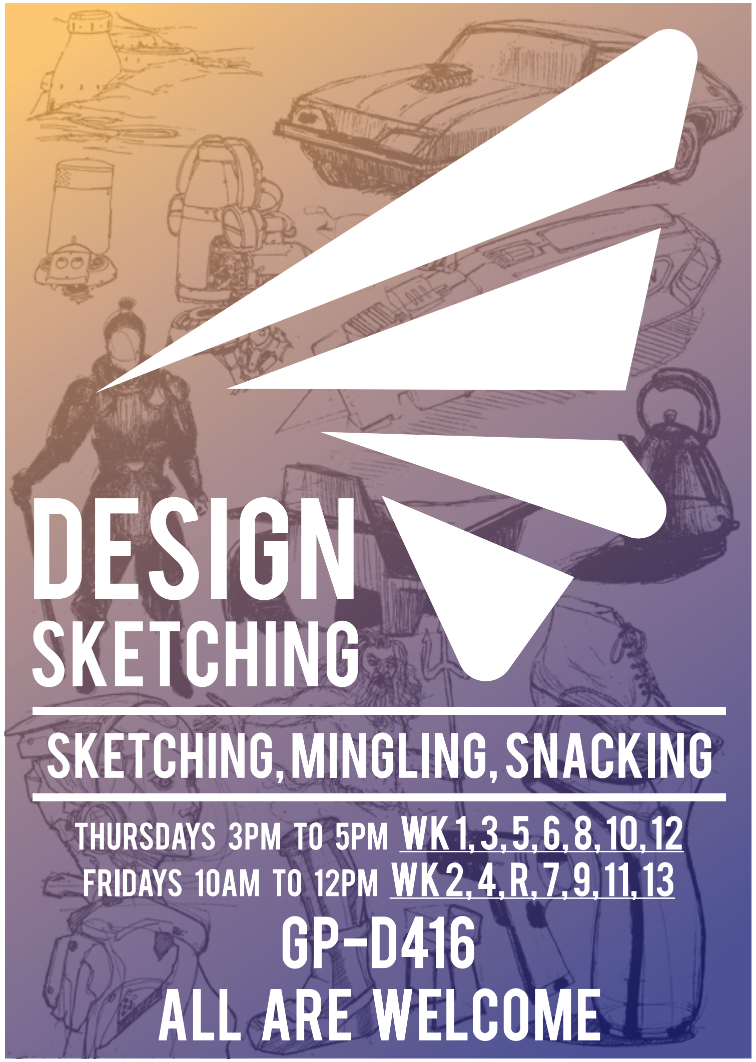
For my leadership initiative, I continued to perform as a Design Pilots Peer Mentor – primarily assisting with event advertising and the Adobe help sessions. By being a design pilot, I aim to develop my digital and analogue design skills, whilst constantly improving my overall leadership skills.

Being a design pilot is an effective way to work on leadership roles, through event planning, and guidance during sessions. By correctly guiding students and helping them learn crucial skills, I am also constantly learning and building upon my design skillset.

By being a design pilot, I am investing in myself, and holding myself accountable for continuously improving on my design and leadership skills.

One challenge I face as a pilot, is my occasional lack of knowledge during help sessions. I often must adapt the role of a leader and teach a process that I am learning as I go. As much as I have a strong background in the adobe suite, I very often get questions on topics that I have never had to solve, or learn about before, and I very commonly find myself learning on behalf of other people, more than learning for myself. However, by being a Design Pilot it is my responsibility to ensure that I can assist and act as a leader to ensure pilot sessions run smoothly and questions get answered.

I also owe my success in the Design Pilots, to the other members in the team, as the Design Pilots teaches us not only how to lead, but how to work collaboratively as well.



Leadership Initiative 2

For the latter half of the semester, my leadership initiative remained consistent. This initiative involved being a part of the Design Pilots Peer Mentoring program. My primary roles as a design pilot was attending all on-campus and zoom events run by the pilots, assisting with the decision-making process in meetings, and deciding what programs we would run for the remainder of the semester. As a pilot, I attended every Adobe help session both in person and on zoom and assisted other pilots in generating attendance for the sessions.

One suggestion I made to increase session attendance was to contact the Unit Coordinator of first year graphic design, Jeremy Kerr. This suggestion was successful, and Jeremy expressed his interest in advertising our sessions (Shown in L1).

I also assisted in running the Eat & Sketch Event (Shown in L2) along with Emily Boehmer and Damian Noviello, Damian and I were tasked with organising the pickup of food for the event, along with partaking in and assisting with all activities, and other event setup. The design activities used assisted in increasing communication and sketching skills in an engaging way.

The roles I undertake as a design pilot coincide with skills needed as a successful designer, and by attending these sessions, I am improving my teamwork skills, organisational skills, and communication skills, which all assist me in becoming a more proficient designer. The process of learning through teaching is incredibly obvious when mentoring as a pilot, and I often find myself learning how to correctly implement strategies as I teach them.

Becoming a Design Pilot has positively improved both my analogue and digital design skills, whilst allowing me to act as a role model and leader to younger/less experienced designers.

The sessions I attended throughout the semester required me to act as a leader; Coordinating with other pilots to ensure the sessions ran smoothly, and all students were satisfied with their assistance. The event coordination improved my collaboration and teamwork skills. Additionally, working with a group of talented pilots was paramount to the success of the program, and I sometimes found myself and other Pilot's trading information or design skills, further improving all our skillsets.

Throughout the semester, I also took the initiative to attend all student run concept development sessions on campus. There were a total of two sessions which involved design related games and challenges to work on concept sketching and idea development for the proposal. These sessions were effective in helping to brainstorm concepts, whilst getting feedback from peers on potential design directions. Attending these sessions increased my project management by allowing me to prematurely work on idea generation, which was beneficial when deciding concepts later in the semester.

L1

Jeremy Kerr <jeremy.kerr@qut.edu.au>
Wed 21/04/2021 4:58 PM
To: Damian Noviello
Cc: Emily Boehmer; Bradley Stevens

Hi Damian,

This is exactly what I've been waiting for!! My DVB101 students would love to have the opportunity to come to these sessions. Have you been operating Design Pilots already this semester? I was under the impression it hadn't started.

I have 600 students in my unit and they are all being introduced to Illutsrator, InDesign and Photoshop - and they are about to start Assessment 2 - so having you around doing this is perfect. Is it possible to have *weekly* sessions over this coming period? I will definitely advertise things in my next lecture (which I plan to record tomorrow). Can you send me details of where your sessions are at - do you have flyer? Also, I have around 150 online students - are any of your sessions blended - can students Zoom in & share screens etc?

best regards,

Jeremy

...

L2