Motivating the Unmotivated: Older Adults and Physical activity

BSc Creative Technology

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Abstract

Physical activity is critically important to the health and quality of life of older adults, yet there is a subset of older adults who struggle to conjure up motivation for physical activity. This group is at risk of rapidly declining physical state, loss of independence and dementia. Tools mean to help people with physical activity motivation often miss this target group due to reliance on smartphones or focussing on too intensive exercises. The goal of this study is to investigate what the best ways are to help older adults struggling with physical activity motivation and to develop a system based on these findings that can aid older adults with physical activity motivation.

To find out what methods and tools are available to help these people with physical activity motivation, first a literature review and state-of-the-art analysis were performed. The literature research showed the personal lifestyle intervention as an effective tool to address physical activity demotivation for older adults, however it requires intensive labour investments from health professionals. The state-of-the-art analysis suggested a relation in physical activity motivational health tools between degree of adaptability to the user and amount of work required by health professionals. Then, expert interviews were conducted. These interviews confirmed demotivation to be physically active for older adults as a problem. They also resulted in two further methods to address it: giving the user frequent reminders that they should partake in physical activity and giving the user an external incentive for doing physical activity. Through the creative technology design process a concept tool was created which incorporates these two methods and plays into the personal lifestyle intervention.

The concept consists of an orb which tracks and communicates the user's amount of physical activity over the past four days through an LED interface. The orb features a voice who's mood depends on the user's level of physical activity which the user has to take care of through physical activity. This voice will also give the user reminders to be physically active. The physical activity that the user is reminded to do can be personalised to accommodate the personal lifestyle intervention. Based on this concept a prototype was developed and subjected to user testing to evaluate the concept. Four participants were recruited for the full user testing, additionally one other participant and an Expert gave insight into the concept being used by older adults not familiar with technology.

The evaluation resulted in evidence that suggests the concept can improve physical activity motivation for older adults. Usability was rated positively by every participant and every single participant could see the concept improving physical activity motivation for older adults. Two out of the four would use the concept if it was a real product, possibly due to the other two participants being very active already at the time of the evaluation. The concept in its current form is not suited for older adults who have little to no experience with technology. Further research is recommended into adapting the concept for older adults who do not have such experience. Expanding the evaluation with more participants is also recommended to solidify the results.

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Chapter 1: Introduction

1.1: Context

A healthy lifestyle is of critical importance to a person's quality of life. Getting enough exercise, eating properly and taking care of one's body have a profound effect on both mental and physical health. While many would consider this common knowledge, a large number of people nonetheless struggle with maintaining a basic healthy lifestyle. For instance, going outside once a day poses a significant challenge for many people, not even considering exercise. Often, a lack of intrinsic motivation lies at the base of these issues.

The problems that arise from this are especially harmful to older adults. Both life expectancy and quality of life hinge in large parts on lifestyle [1]. Better health also allows older adults to take care of themselves easier and can prevent or delay an admission into a care home. The care for older adults is strained as it is and is projected to have to take care of more patients with less staff in the coming years [2]. As such, it is paramount to ensure that older adults adhere to a healthy lifestyle. This is especially difficult in a subset of people who completely lack the intrinsic motivation required to achieve a healthy lifestyle. This group tends to fall out of the target audience for many programs aimed at improving the lifestyle of older adults, since these programs often assume an intrinsic motivation. Such people are not included in research and design and hence are arguably the most difficult to reach group.

1.2: Problem Statement

From this situation a challenge arises. How should we elicit motivation for physical activity in older adults who lack intrinsic motivation? This target group is often quite aware that physical activity would be good for them, yet this is not enough to compel them towards such a lifestyle. Thus, a solution is unlikely to be found in providing extra information or the raising of awareness around benefits of a healthy lifestyle. Instead, a less passive approach can be investigated. Such solutions to aid in developing an active lifestyle are plentiful, but do not adequately cover the needs of those who lack intrinsic motivation to develop one. These programs may not reach those people either and as a result the ones who require the most help with developing a healthy lifestyle miss out on the tools to help them. A tailor-made solution to aid this specific target group could help these people grow more accustomed to physical activity and serve as a stepping stone towards more regular healthy lifestyle solutions.

This target group poses a second challenge as well. Since the target group lacks motivation to partake in a healthy lifestyle, they might not be interested in a proposed solution, nor the process of developing one. Finding ways to surpass this barrier will be of upmost importance to the success of this project.

1.3: Research Questions

Based on the previous problem description a main research question can be formulated.

Main Question:

How can demotivation to be physically active be addressed effectively for older adults?

To help answer this main question it can prove useful to formulate some sub-questions as well. These questions will together form a knowledge basis that can be used to answer the main question. First, it is useful to look at the causes of demotivation for physical activity, possibly looking into psychological factors. It is also valuable to consider what methods are used to motivate these people and what projects already exist to make use of them. Then, the approach used should be considered. How commanding should one be when trying to get these older adults more active? What can lead to annoyance with these people? To investigate these factors, the sub-questions listed below were formulated.

Sub-Questions:

- What psychological factors play a role in the demotivation of certain older adults to adopt a healthy lifestyle?
- What projects and methods already exist to aid in the motivation for a healthy lifestyle, specifically for older adults?
- What are things to avoid when working with unmotivated people?
- How commanding should the approach be in persuading older adults?

Chapter 2: Background Research

2.1: Introduction

To investigate the research questions proposed in the previous chapter, background research was conducted through two different methods. First, a literature review was performed to explore research and developments pertaining to the main research question and the third sub-question. Specifically, the literature review is comprised of two sections diving into the causes of demotivation to adhere to a healthy lifestyle and methods to address such demotivation respectively. The second method used to conduct background research is an analysis of the state-of-the-art. Both the literature review and the state-of-the-art will be presented in their respective chapters. This chapter will culminate in a general discussion and conclusion.

2.2: Literature Review

As laid out in chapter 1, a healthy lifestyle is of great importance to one's quality of life, particularly for older adults. Thus, why some older adults are not motivated for physical activity and what methods are used to address it needs to be understood. The following literature review aims to provide insight into the research that has been done concerning healthy lifestyle motivation, in particular for older adults. The obtained information and knowledge can then be used further on in the project .

To provide a thorough exploration of the topic this review will be split up into two sections. The first will focus on the causes of demotivation to adhere to a healthy lifestyle. Section two will dive into the methods used to combat this demotivation. Both sections will focus on older adults, although most findings presented will not specify a specific age demographic.

Additionally, it should be noted that the terms "physical activity" and "healthy lifestyle" will be used interchangeably. These terms are of course not synonyms, but rather physical activity is part of a healthy lifestyle. However, within the context of this review a healthier lifestyle will mean a lifestyle with more physical activity and will not regard the other parts of a healthy lifestyle like for instance food intake and hygiene.

2.2.1: Causes for demotivation

It is possible to divide the causes of demotivation to adhere to a healthy lifestyle into three categories. The first is and most prominent is a lack of personal awareness. Dunn *et al.* [3] show that the personal lifestyle intervention is an effective tool to achieve and maintain a higher degree of physical activity. During such an intervention the subject is explained what effects their current lifestyle can have on their personal situation. They are also given certain methods and exercises tailored to their specific situation to get more physically active. The effectiveness of this personal approach indicates a lack of awareness surrounding the effects of an unhealthy lifestyle upon one's personal situation. Mihalko *et al.* [4] concur with the effectiveness of personal lifestyle interventions, showing their efficacy within independent living facilities populated by older adults. Confronting the residents with the risks they were personally running by maintaining an unhealthy lifestyle significantly increased the attendance to activity sessions. This reinforces the idea that a lack of personal awareness is a major cause of demotivation to adhere to a healthy lifestyle.

A second cause of demotivation is the premature ending of the development of motivation. Maltby and Day [5] describe how motivation develops from extrinsic to intrinsic motivation. When an individual begins improving their lifestyle this is often extrinsically motivated, meaning there is an external factor pushing them towards a healthier lifestyle. This eventually develops into intrinsic motivation, where the individual no longer needs an external motivator and is instead motivated by their own will. Maltby and Day [5] show that the extrinsic motivational phase brings with it a decrease in mental wellbeing. This is rectified once the intrinsic motivational phase sets in, but those who do not reach this phase due to premature quitting can associate a healthy lifestyle with a worse mental wellbeing. Such negative connotations will not improve the stance towards a healthy lifestyle nor the motivation to adhere to one. Similarly, Duncan *et al.* [6] describe integrated regulation as a highly important predictor of regular physical activity. This can be best described as the individual feeling physical activity is an important part of their identity and is congruent with their personal values, akin to the aforementioned intrinsic motivation. If this phase is not reached, an important predictor of physical activity is absent and negative connotations can surround the concept of physical activity.

Lastly, mental wellbeing itself can play a role in demotivation. Fraser *et al.* [7] describe how people suffering from mental illnesses find a lack of motivation to be a major barrier in partaking in physical activity. According to Scarapicchia *et al.* [8] depression and in particular the anhedonia side-effect, where someone has a reduced experience of pleasure, cause the individual suffering from them to partake in less physical activity. When looking specifically at older adults, Narkauskaitė-Nedzinskienė *et al.* [9] explain older adults in general "abandon their personal needs, they are no longer engaged to what previously gave them satisfaction and gradually become lonely" (p.259). The loss of satisfaction in particular is similar to the aforementioned depression side-effect anhedonia and shows this is overly present in the older population, causing demotivation. From this, the link between mental health and motivation for physical activity seems strong, although hard to specify further. No two depressions are the same and the underlying reasons for mental health issues, depression and by extension demotivation for a healthy lifestyle are not well understood nor easy to pin down. However, Zenebe *et al.* [10] show the expected prevalence of depression among old age sits at 31.74%. Almost one third of the older population is expected to be facing depression, making depression one of the bigger plausible causes of physical activity demotivation.

2.2.2: Methods to address demotivation

Unsurprisingly, the methods to address demotivation to adhere to a healthy lifestyle are closely linked to the causes described in the previous chapter of this review, and will be presented as such. To combat the lack of personal awareness personal lifestyle interventions, as mentioned in the previous section, are well supported as being an effective tool. These interventions are performed during a meeting with the subject and a heath professional. Together they analyse the subject's current lifestyle and amount of physical activity. The subject is then explained what effects their current lifestyle is having on their personal situation. For instance, some older adults may face trouble when walking up the stairs to the second floor of their house due to lack of physical activity. The personal lifestyle intervention will pick up on this and explain to the subject how their lack of physical activity is causing this. After the analysis, they create an exercise plan together, consisting of exercises and types of physical activity the subject can do to be more physically active. These interventions are performed by health professionals like doctors, physiotherapists or other movement related experts. Mihalko *et al.* [4] used such intervention methods within an independent living community populated by older adults and found it significantly increased the attendance to physical activity group sessions. Dunn *et al.* [3] more generally describe lifestyle interventions as effective at getting people to adopt a more healthy lifestyle. This is different from a more passive awareness raising approach since personal attention is required. It is the application of the benefits of a healthy lifestyle to an individual's personal situation that is so effective. Dunn *et al.* [3] also note however that the effect of interventions is still small because they are being applied in small groups. They speculate interventions by telephone or mail could aid in this. Kleinke *et al.* [11] elaborate on this discussion by describing how personal lifestyle interventions are very labour intensive. One can imagine how analysing someone's personal lifestyle, health and then providing personalised advice as well as exercises requires a lot of man-hours, especially when performed at a large scale. Kleinke *et al.* [11] examined autonomously generated personal intervention methods as a possible solution to these problems. The results, while promising, were not statistically significant, but this was likely due to a sample that was already exceptionally physically active. Thus, such an approach warrants further investigation.

The second cause of demotivation concerns prematurely ending of the development of motivation. To address this, Narkauskaitė-Nedzinskienė *et al.* [9] identifies a personal responsibility to take action and stay active as an effective tool to motivate older adults. Health professionals but also friends and family conveying the train of though that they, themselves are responsible for their own wellbeing acted as an efficient motivator. This proved especially effective when compared to more traditional, external motivators such as caretakers or doctors simply telling the older adults to be more active. Duncan *et al.* [6] describe a similar concept with previously mentioned integrated regulation, which acts as an important predictor of physical activity. Both personal responsibility and integrated regulation tie into the extrinsic and intrinsic motivation described by Maltby and Day [5], these being clear intrinsic motivators. Thus, finding and applying the most efficient ways to elicit and support these intrinsic motivators can prove very important in increasing people's physical activity.

Last of the found causes of demotivation is mental wellbeing. This is a topic of such sensitivity and complexity that covering it in detail falls outside the scope of this review. There are as many ways to treat mental health problems as there are mental health patients and it is understandably its own field of research. However, when isolating the physical activity within this context there is some

valuable information to be found. Scarrapicchia *et al.* [8] acknowledge the effectiveness of the aforementioned personal intervention methods and advocates for the development of such tools specifically for those suffering from depression. Farholm *et al.* [12] examined those suffering from severe mental illnesses and conclude "...that health care practitioners should emphasise helping people with SMI develop more intrinsic forms of motivation" (p.1). A finding striking in its similarity to the found solutions to the second cause of demotivation as described earlier in this chapter. It appears then, that effect mental wellbeing has on the demotivation to adhere to a healthy lifestyle cannot effectively be treated in isolation. Instead, other methods to address it, possibly modified for those suffering from poor mental health, boost mental wellbeing as a side-effect.

2.2.3: Literature Review Discussion and Conclusion

The goal of this literature review was to provide insight into the research that has been done concerning healthy lifestyle motivation, in particular for older adults. While the people in question might not want to hear it, there is solid evidence that demotivation to adhere to a healthy lifestyle can be effectively treated. Personal lifestyle interventions and their effects on healthy lifestyle motivation are widely supported. More broadly, a focus on intrinsic forms of motivation can have a significant effect as well. Both methods also show effectiveness when applied to older adults specifically. The biggest downside to these methods is the amount of labour and personal attention they require. Both methods require a lot of personalisation and adaption to personal circumstances. This has meant these methods are only being applied on a small scale and have a reduced impact as of yet. If this hurdle can be overcome however, personal lifestyle interventions with a focus on intrinsic motivation can pave the way to a healthier lifestyle and a higher quality of life for more people struggling with it.

While this is a significant result, there is a number of limitations to the research and the conclusions. Most prominent is the use of assumptions in the chapter Causes for Demotivation. While there was sufficient literature available on methods to address healthy lifestyle demotivation, material on the causes proved relatively scarce. Thus, parts of this chapter had to rely on reverse engineering from those methods to find causes. While this does give some insight it is far from conclusive and requires more specific research. The specificity of the conclusions is also limited. Neither methods presented to address healthy lifestyle demotivation has a clear roadmap of how to apply them. This is partly by design. Their high degree of required personalisation and adaptation means the methods can not be too specific. However, when applying these methods in a real world scenario a lot of extra research and testing will have to be done.

This is a major avenue for future literature research. What facets of personal lifestyle interventions focussed on intrinsic motivation are the most important when looking at specific user groups, what needs to be overhauled, etc. This can also open up more distinct sub-categories of methods. Some subtle differences between applications of personal lifestyle interventions or intrinsic motivation techniques were not described in this review because in general these applications would fit the description. However, with more research sub-categories could be defined within personal lifestyle interventions and intrinsic motivation techniques.

2.3: State-of-the-Art

Before going in-depth with the state-of-the-art, it is good to consider an observation from the literature review. Personal lifestyle interventions are an effective tool to address demotivation to be physically active. They fully adapt to the patient, but require a lot of attention from health professionals since they need to analyse every facet of the patient's lifestyle. These two factors, "degree of adaptability" and "attention required by health professionals" will play a key role in analysing the State-of-the-Art. First, a number of tools, programmes, and other ways physical activity can be improved will be shortly described. They will also be scored on these two factors. They will then be plotted into a graph with these two factors on the axis using the accompanying images. This graph will be used to more broadly analyse the State-of-the-Art and identify a possible direction for this graduation project.

2.3.1: Fitness Trackers

Fitness trackers have rapidly become mainstay in the daily carry of many people. While watches are the most popular, there are other formfactors available (see figure 1). They are relatively inexpensive but offer a wide variety of tracking functions, from sleep- and step tracking to guiding users through workout sessions. Some offer social competition functions ("closing the rings" on the Apple Watch [13] for example) but generally they are meant for personal use. Trackers can adapt quite well to the user's activity, but not so much to their particular lifestyle and providing personalised suggestions based on it is practically unsupported. Generally, the user has to adapt to the framework these trackers provide more than they adapt to the user. The data collected by the trackers is not passed by health professionals but autonomously processed to give user feedback.

Figure 1: Several Health Trackers [13]-[16]

Degree of Adaptability: Low

Attention required by Health Professionals: Low

2.3.2: Free Workout Apps

Both the Apple app store and the Google play store have a large number of free workout apps available (see figure 2). Generally they offer light workouts that can be done at home without any equipment. Most apps offer some degree of adaptability but it is not tuned to the user specifically. No heath professionals are actively involved with the users, although they may have curated some exercises.

Degree of Adaptability: Low

Attention required by Health Professionals: Low

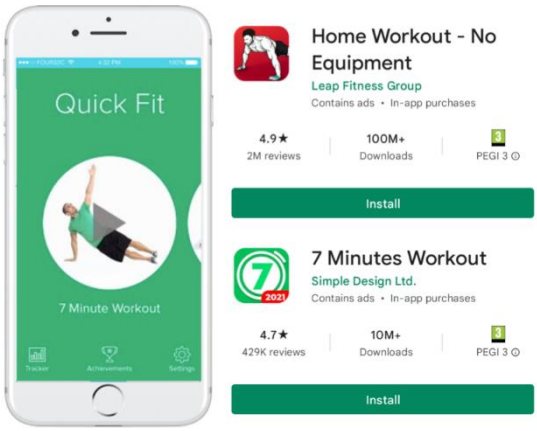

Figure 2: Examples of free workout apps [17], [18]

2.3.3: Nintendo RingFit

The Nintendo RingFit [19] is an accessory for the Nintendo Switch gaming console (see figure 3). It allows the two switch controllers to track the user's activity by placing one in the handheld ring accessory and one in a leg strap. The accompanying game uses the tracking features of the two controllers to offer workouts that can be configured to the user's level of fitness. Similarly to the free workout apps, there are no health professionals actively involved with the users, although the exercises have been created together with health experts. It has proven to be a popular exercise tool, selling 13.53 million units and becoming the tenth most popular game on the Switch Platform [20].

Degree of Adaptability: Low

Attention required by Health Professionals: Low

Figure 3: Nintendo RingFit

2.3.4: Home Exercise Equipment

Broad in their description, home exercise equipment can range from simple items like yoga matts, dumbbells and jumping ropes to full-fledged treadmills for home use (see figure 4). The user can choose what they want to purchase, and in that sense this is very adaptable. However the equipment itself is generally not adaptable and since it is for home use there is no health professional involved.

Degree of Adaptability: Low

Attention required by Health Professionals: Low

Figure 4: Examples of home exercise equipment

2.3.5: Apple Fitness+

Apple Fitness+ [21] is a fitness subscription service offered by Apple (see figure 5). It offers multiple fitness and workout features but the headlining feature is multiple weekly workout sessions. They are hosted by health professionals and have three different levels of exercises in the same session to accommodate users of different exercise levels. They are also adaptable to the time someone has to exercise, ranging from 5 minutes to 45 minutes. Thus, the adaptability to the user is greater than that of just a fitness tracker and the exercises are curated and performed by health professionals.

Figure 5: Apple Fitness+ [21]

Degree of Adaptability: Medium

Attention required by Health Professionals: Medium

2.3.6: Peloton

Peloton [22] (see figure 6) offers a similar service to Apple Fitness+, but it combines it with its own produced and sold stationary bicycle trainers and treadmills. The live-streamed workouts and equipment are deeply integrated and allow the user to cater the workout to their specific requirement. Similarly to Apple Fitness+ these workouts are curated and delivered by health professionals.

Figure 6: Peloton [22]

Degree of Adaptability: Medium

Attention required by Health Professionals: Medium

2.3.7: The gym

One of the most well known ways to increase one's physical activity is to visit the gym (see figure 7). They offer a large variety of workout equipment, have staff on hand to advise and help out and often offer workout sessions similar to the ones Peleton and Apple Fitness+ offer, but in person. However, the user of the gym must adapt to the equipment at hand and the health professionals do not offer full personal attention.

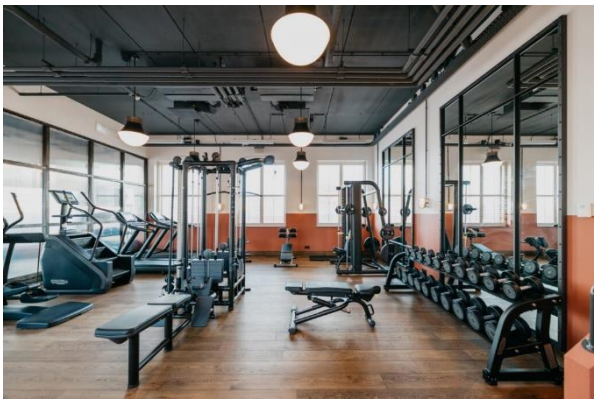

Figure 7: Gym

Degree of Adaptability: Medium

Attention required by Health Professionals: Medium

2.3.8: Personal Trainer

Often found within the aforementioned gym, the personal trainer (see figure 8) offers more personalised services. A personal trainer will work together with the user to exercise in ways best for their situation, lifestyle, and preferences. This is very adaptable, but requires a lot of one-to-one time and thus a lot of work from the personal trainer.

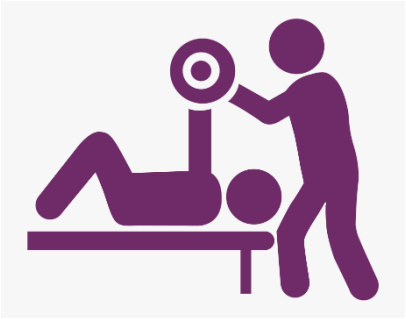

Figure 8: Personal Trainer

Degree of Adaptability: High

Attention required by Health Professionals: High

2.3.9: Personal Lifestyle Interventions

Last to discuss are the personal lifestyle interventions (see figure 9), which were covered in the literature review section. Here, the person sits down with a health professional to analyse their lifestyle and explain why they should be active. They the come up with personalised exercise plans for the person. These are similar to a personal trainer, although personal lifestyle interventions are done more to motivate people to exercise than to help them with doing those exercises. They are infinitely adaptable but require much work to be done by the involved health professionals.

Figure 9: Personal Lifestyle Interventions (PLi's)

Degree of Adaptability: High

Attention required by Health Professionals: High

2.3.10: Plotting the Graph

Having analysed these different tool, methods, etc. they can be plotted on a graph according to their scores on “Degree of Adaptability” and “Attention required by Health Professionals”. This is a subjective plotting since the scores are up for debate, but in general it can serve to give a good overview of the State-of-the-Art. To represent the analysed items the images accompanying their descriptions will be used. For the items were multiple examples were used within the image, the top-left one will be used in the graph, although it represents its entire category.

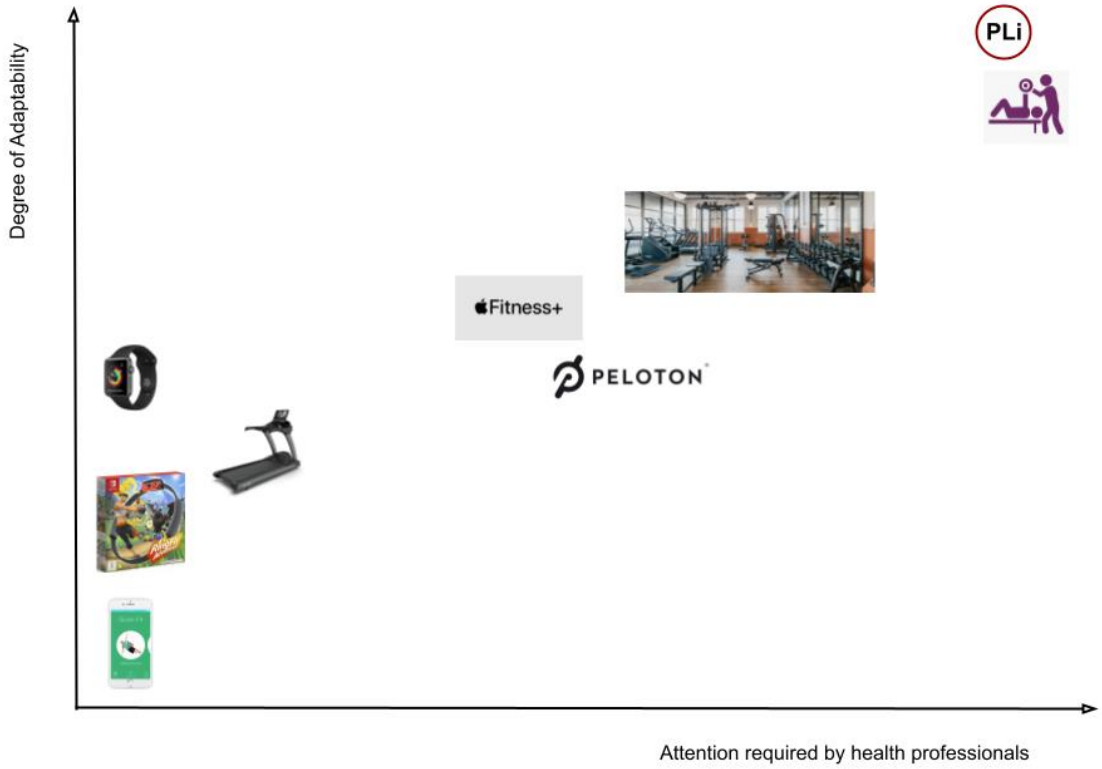

Figure 10: State-of-the-Art Graph

2.3.11: State-of-the-Art Conclusions and Discussion

When looking at the State-of-the-Art presented as a whole it is good to note that nearly all the items analysed are meant to encourage and support more intensive exercise. Personal trainers, the gym, Apple fitness+, and Peloton are all meant to give the user a semi-intensive workout. Many fitness trackers, home workout equipment, exercise apps and the Nintendo Ringfit are also trying to get their user to partake in semi-intensive exercise. This means that these tools are not very effective for the target group of this project. This target group, older adults who lack motivation to be physically active, often struggle with basic exercise, like going for a short walk every day. Tools like the ones analysed here will not appeal to such a group. The outlier is the personal lifestyle intervention. With how personal it is it can accommodate the basic exercise that the target group of this project needs help with. However, with how intensive they are for the health professionals performing them they have not been able to reach as many older adults as would be ideal. This leads into the graph, which shows the relation between “Degree of Adaptability” and “Attention required by Health Professionals” is linear, generally speaking. What would be ideal for the target group of this project would be to break this linear trend and move the PLi in the graph to the left. This region to the left would have a high degree of adaptability, but would require less work from the health professionals so personal lifestyle interventions could reach a wider user base. This area is thus of great interest to this project and will serve as a direction to steer the project towards.

The limitations of this State-of-the-Art are important to keep in mind however, since they place major caveats to these conclusions. The most important limitation is the amount of things analysed.

The commoditization of health technology means there are countless tools out there to aid in one's physical activity. While they can generally be divided into some of the categories presented here, there are many outliers. One such example is the covered Nintendo Ringfit. One could argue it fits into the "Fitness Tracker" category, but when analysing it in detail numerous differences come up which made it worth covering as its own tool. It is no far-fetched assumption then that there are more tools like this that offer their own unique ways of aiding people in their physical activity. This also becomes a limitation to the presented graph since unanalysed tools could reject the linear relation found in it.

2.4: Background Research Conclusions

The literature review's most important conclusion is the identification of the personal lifestyle intervention as an effective tool to address demotivation to be physically active. However, they have a major drawback. Personal lifestyle interventions require a lot of work and attention from health professionals. The State-of-the-Art shows that there are numerous tools to aid in physical activity, but these do not focus on light exercise which would be the most useful for the target group of this project. The State-of-the-Art also suggests a trade-off between "Degree of Adaptability" and "Attention required by Health Professionals". This trade-off could be bypassed which would allow personal lifestyle interventions to become more widely used to address demotivation to be physically active.

Thus, one of the aims of this project will be to deliver personal lifestyle interventions in such a way that it requires way less effort from health professionals but retains the adaptability. To illustrate this as a final note, this can be placed within the graph in figure 10 to result in figure 11.

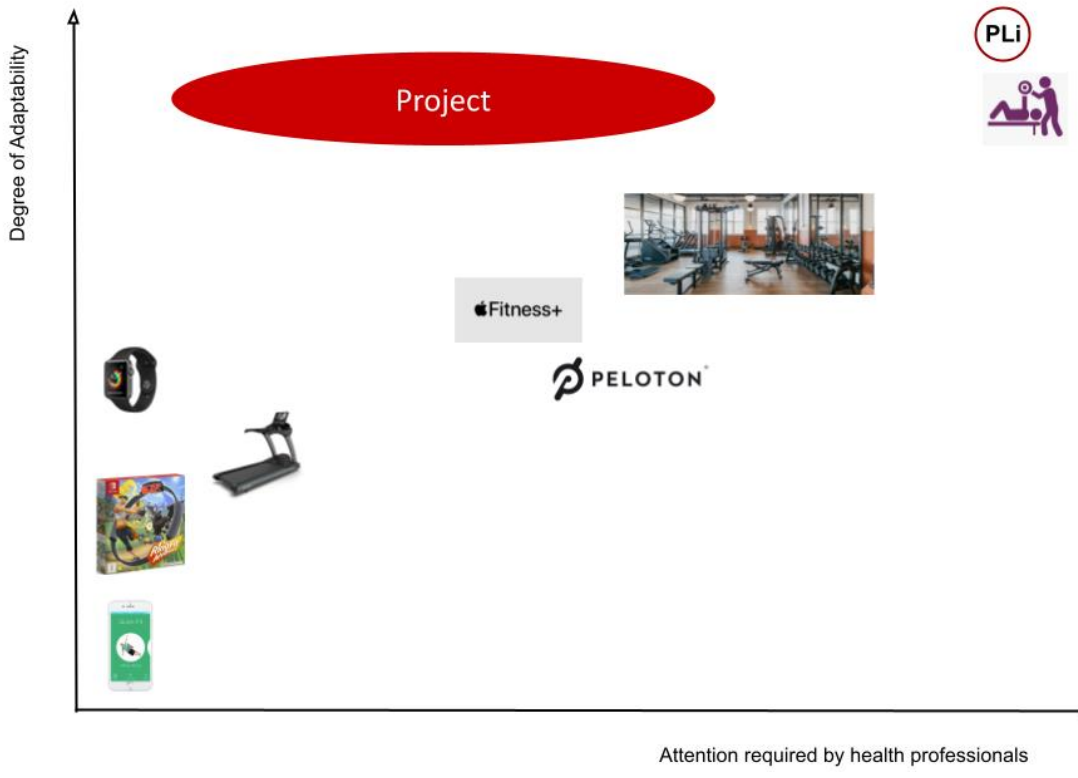

Figure 11: State-of-the-Art Graph with project direction

Chapter 3: Methods

3.1: Introduction

This project will work towards the goal of answering its main research question by adhering to one main design methodology. This chapter will lay out what this methodology is and how it will be used in this project.

3.2: Creative Technology Design Process

This graduation project will use the Creative Technology Design Process (CTDP) developed by Mader and Eggink [23].

An overview of the CTDP is shown in figure 12. The diagram shows how the process proceeds from a design question through four distinct phases: ideation, specification, realisation and evaluation. While these phases seem straight forward and clear-cut, they are in fact very iterative. Specifically the ideation and specification phases incorporate a cyclic, iterative approach.

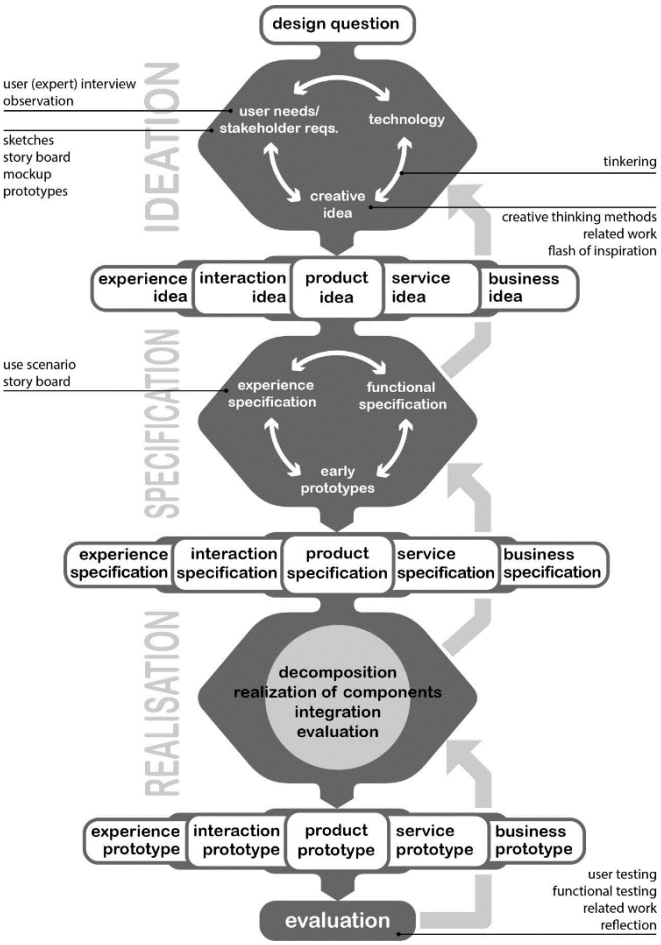

Figure 12: Creative Technology Design Process [23]

The ideation phase is the start of the CTDP. Here, the designers collect user and stakeholder requirements and ideate upon them to create a set of creative ideas. These can be elaborated upon with lo-fi (paper) prototypes but should be kept basic as to not interfere with the ideation process nor the iterative nature of the phase. The end result of this phase are multiple not yet worked out ideas and concepts for a possible solution to the main design question.

The specification phase of the CTDP is also iterative in nature. It further flushes out the results from the ideation phase to see how they hold up and ultimately select one as the leading concept. This concept will then be developed into an actual prototype. Good to note is the leading role of the user experience. This means that the prototypes are evaluated with this as the criteria, and not other functionality. This also means that the prototypes can be in the very early stages of development, since their details are second to the user experience.

The realisation and evaluation phases are less iterative in nature and come into play once a conceptual solution has been specified. Realising the one concept into a solution fit for more rigorous evaluating is naturally less cyclical since there is only one concept being worked on.

However, Mader and Eggink [23, p.5] propose the Waterfall Model and the V-Model as possible design models to integrate in this phase and both allow for backtracking if a roadblock is hit. This phase already incorporates evaluation of its own to examine whether the final product meets the specifications laid out in the specification phase.

Once the realisation phase concludes, the evaluation phase starts. The prototype developed in the specification phase is subjected to user testing to see if it succeeds in the goals set throughout the design process and if the user experience is up to par. The user testing concerns both usability and efficacy testing to asses different facets of the prototype.

3.3: Applying CTDP to this project

The ideation phase of this project will consist of two activities: expert interviews and an ideation session. Conducting interviews with people who have expertise in getting older adults to be physically active will quickly offer insight into the methods they use and what problems they run into. While these interviews will be free-flowing, they will be loosely based on the theory-generating expert interview as described by Boger *et al.* [24]. They can also offer their view on possible tools to help get older adults physically active. The information obtained from these interviews will then be used in the second activity, the ideation session. By looking through the information and ideating upon it with fellow creative technology students, product ideas can be quickly generated. Creative and interesting ideas are their strong suit after all. This ideation session will use brainwriting as a brainstorm technique [25].

A brainwriting session proceeds as follows: each participant is given a form where they have to fill in three ideas for possible concepts in 5 minutes or so. When those five minutes have passed, every participant passes the form they were using to the person to their left or right. Everyone reads the ideas on the form they just received, and is then asked to either come up with new ideas or expand on the ideas they have just read on a new page of the form. This is done a couple of times to ensure the ideas pass multiple people and then the session is concluded. The main advantage of this tool is that it prevents certain more verbally active members of the ideation group from having more input than the more quiet, laid back members. Brainwriting also ensures that each idea gets the same amount of attention from multiple different members, meaning at the end of the session each idea will be worked out about equally far and have had expansions by different people with different viewpoints. Thus, no idea is left undiscussed or fully ideated by one person's vision.

The specification phase will take those generated concepts and through assessing their usability and functionality select one as the final concept. This will partly be done as part of the ideation session where the end goal is to end up with two or three concepts. However the final selection will be done by the researcher.

The realisation phase takes that final concept, refines it and develops a prototype. This prototype will be simple, possibly function through some Wizard of Oz prototyping where the researcher controls seemingly autonomous actions behind the scenes. However, it will be functional enough to assess if the underlying concept succeeds in its goals.

The evaluation phase will then evaluate this prototype through user testing with older adults. They will be asked to use the prototype, subjected to an interview concerning the prototype and their

views on physical activity and finally asked to fill in a questionnaire with Likert scale questions to asses the prototype.

Chapter 4: Ideation

This chapter will describe the ideation process of this project through its two components: two expert interviews and the ideation session.

4.1: Expert Interviews

Starting the ideation phase requires certain information on the users and stakeholders. What is currently being done to help older adults who struggle with physical activity motivation? What works well with these people and what does not? To obtain this information two interviews were conducted with experts in the field of older adults and physical activity. They were interviewed in a semi-structured manner of around 30 minutes and asked about their job, how they experience helping older adults, what methods are effective and what are things they avoid. They were also asked to reflect on how technology could aid these older adults. The experts were recruited by email. To preserve the privacy of the experts they will not be mentioned by name or any other personally identifiable information. Only their function will be mentioned and they will be referred to by an number. Before each interview the expert was asked to sign an informed consent form surrounding the recording of the interview, the usage of quotes and their privacy. This form (in Dutch) can be found in appendix A. Expert quotes used throughout this report will be translated to English and as a result involve some form of paraphrasing. Below are descriptions of both expert interviews.

4.2: Expert One: Physical Activity Welfare Worker

Expert One's profession is a physical activity welfare worker. They work in a care home for older adults and have by their own description "Everything to do with movement.". They are fitness instructor, fall prevention trainer and are being trained to handle patients with dementia.

When asked about older adults who are not motivated to be physically active, they explain they see them all the time. Many older adults are not aware of the benefits of physical activity and as a result are not motivated to do it. There is a shift happening, where the younger generations, even within the older adults demographic, often already know that physical activity is important. Thus, Expert One expects this problem to slowly change in the coming years. However, at the moment there are still many older adults who have a hard time generating motivation for physical activity.

Asking Expert One about what they have found to be effective methods to motivate older adults to be physically active, they first mention that "pushing" these people does not work well. What does work and is crucial is to "emphasize the importance". Be very clear to the person in saying:

> "If you are not active, it will have this effect. We work a lot out of the principle use it or lose it, where for instance older adults sit a lot. They don't move their arms anymore and then the functionality disappears.".

This "Use it or lose it" also plays into something else. Expert One mentions how very often when people get admitted into the care home they stop doing activities they did before. If the person was partaking in some sort of sport, this often is not continued fluently when they are admitted. Expert One would like to have a conversation between one of the physical activity welfare workers and the

patient as soon as they are admitted to get a clear picture of their lifestyle and activities so they can be continued into their admission.

Expert One goes on to explain that fall prevention is one of the most important factors of staying physically active:

> "When they fall once, they get a bit scared and that becomes the biggest obstacle why people don't want to move anymore.".

Expert One would be a proponent of giving all the older adults in their care home a step-counter. Mostly to provoke some sort of challenge.

> "They need a challenge that triggers them to think "Oh, I didn't go for my walk today yet.".".

As an example, Expert One mentions the app "Ommetje" by Erik Scherder. However, Expert One wonders if that might be a bit too complex for the oldest of people in their care home. They mention you should "Think small, not think too big with these things", referring to the scope and complexity of such tools. Expert One goes on to describe some possible aspects a tool to get older adults to be more physically active could/should have.

- That they know why they do it, why they use it
- That it is easy
- That it motivates, possibly through a reward system
- That it challenges the user, offers a new incentive to be active

Expert one also mentioned how personal trainers act as people's incentive for being active, namely they will remind you to be active and call you out when you are not. This is an aspect that a tool could use as well.

The topic of the personal lifestyle intervention was also discussed, where Expert One agreed with the findings from the literature research section. They would like to integrate it into their care programmes but can not because of the amount of time that it requires.

Discussing some very early ideas, Expert One showed support for the concept of having to keep up a certain score, possibly to take care of a virtual or real life plant of some sort.

4.3: Expert Two: Geriatric Physiotherapist

Expert Two is a geriatric physiotherapist, a physiotherapist for older adults. They deal more with older adults who are still living at home instead of at a care home or assisted living facility. This is closely linked to one of the main things Expert Two sees as their work, letting people live by themselves for longer.

One of the techniques Expert Two uses to motivate older adults to perform physical activity is to pair them with "Walking Buddies". Here, the older adult gets matched up with another person, could be an older adult but family or friends also work, and they go on walks and perform activities together. This provides incentive since the physical activity is not just for the older adult themselves, but also for their buddy. They keep each other's physical activity in check. Similarly, Expert 2 also guides older adults towards group activity sessions.

Expert Two additionally mentions they try to clearly explain to the older adults why physical activity is important for them, which is once again similar to the personal lifestyle intervention. They are not familiar with the personal lifestyle intervention, but when it was quickly described they do recognize how it is used and that it is a useful tool. Expert Two also explains they often lay out a personal goal with the older adults:

> "One person might want to keep going to the shops by themselves, the other might want to keep living at home, and someone else might want to be able to shower independently. Once someone expresses such a goal, it is good to play into that. This is your goal, and you need to do this and this and this to reach it. In that way that can serve as a very powerful stimulant.".

The conversation then moved to outside incentives for physical activity. Discussing the presence of a device that monitors people's physical activity and relays that information, Expert Two compares it to step-counters and health goals people often get notified about from their phones or smartwatches. While those tools themselves are not ideal for older adults due to difficulties with operating them and overwhelming amounts of health data, Expert Two does believe a different system of monitoring such data and turning it into a score of sorts that is communicated back to the user could work well. As an example, a plant pot was given where the user would have to care for the plant and keep it alive by doing regular physical activity tasks, as was also discussed with Expert One. Expert Two reacted positively to this, saying it could be very good way of motivating people. Expert Two does note this heavily depends on the person as some older adults they run into in their line of work would not be motivated by keeping up a score. Expert Two also mentions that step counting is more common that one might think under older adults. They regularly see older adults who do have a smartphone and use step goals in some way.

When discussing positive and negative stimuli and if not doing a certain task should be met with negative consequences for the user, Expert Two says the following:

> "I think you should mainly look for positive stimuli, I don't think punishing would work. They would more likely just stop altogether.".

This is not always the case, as an example they give a person who is in their clinic once a week and during exercises they often lock up their knee, overstretching it. Saying to this person:" every time that happens, you have to do two exercises" does work well, however generally Expert Two does not believe punishing would prove effective.

4.4: Main Expert Interview Takeaways

The conducted expert interviews have brought interesting information to light concerning the motivation of older adults struggling with getting themselves to be physically active. One major takeaway being that both experts use techniques similar to the personal lifestyle intervention discussed in the literature review section to motivate these people. They explain to the people why physical activity is important for them and then come up with personalized exercises, methods and tools to tackle it is in their experience very effective.

A second method has also become apparent through the expert interviews, namely providing an external incentive. Giving these older adults another reason outside of "exercise is good for you" to be physically active, not necessarily concerning their health. Possibly having the user take care of a

certain entity, real or digital, by being physically active. This specifically was discussed with both experts in the form of a plant with a smart plant pot and was reacted to positively in both instances.

Whichever method used, both experts also mentioned the importance of reminder. The older adults need a very frequent reminder (multiple times per day) that they need to be active, both to diminish postponing and to get physical activity to be a routine.

The final major takeaway from the two interviews conducted is the complexity of the technology and interaction. Both experts see that some older adults get along very well with technology and could benefit from say a smartphone app or a smartwatch with step counters on them, while other older adults have quite some difficulties interacting and living with technology. They are not used to some of the things society has grown accustomed to when interacting with technology, say swiping on screens to perform certain functions. These older adults would have a hard time interacting with a smartphone app and thus need a different solution.

From these takeaways and the earlier background research some requirements can be set up that the concept this project will develop should satisfy:

- The concept should play into the personal lifestyle intervention **and/or**
- The concept should offer an outside incentive for users to be physically active
- The concept should offer users frequent/constant reminders if they have yet to be physically active that day
- The concept should be easy to use and understand, especially for older adults not used to technology
- The concept should not overwhelm the user with health data
- The concept should not heavily penalize not being physically active

These requirements where then taken into the ideation session to base the ideas constructed during that session upon.

4.5: Ideation Session

To form ideas and concepts based on these requirements, an ideation session was hosted between three Creative Technology students, one of which was the main researcher of this graduation project. It was hosted on the 22nd of June 2022 and the chosen ideation method for this session was the aforementioned brainwriting. Since the session was only hosted with three participants, it may seem as if the biggest advantage brainwriting offers, giving everyone equal input instead of the most talkative members doing most of the ideation, does not come into play. Having certain people talk over others does not occur too much in groups as small as the one used in this specific ideation session, brainwriting is really designed for six people or more. However, it was still used in this ideation session with only three member because of another advantage it offers, namely ideas quickly passing multiple people's vision.

The form used for this brainwriting session can be found in appendix B. The session was completed after three rounds, meaning every from passed every member. The end result was 27 concepts or expansions on other concepts. Afterwards, the different created ideas and concepts were discussed and a top three was selected. These three concepts will be discussed in greater detail.

1. Concept one is an expansion of the example that was briefly discussed during both expert interviews. The basis of this concept is a smart plant pot. This pot has a screen on it with an emotive cartoon face that acts like it is the plant within the pot that is speaking. The pot monitors the plant and communicates through the screen what the plant needs. If it needs water, or should be placed in a space with more or less lighting. By doing this relatively often the user already grows accustomed to caring for the plant. It also gets them to move around the room to take care of the plant which is already added exercise. However, the pot also express the plant needs the user to go outside once a day. This has no effect on the condition of the actual plant, however the emotional state of the face on the plant pot which acts as the emotions of the plant gets progressively sadder if the user does not go outside often. Thus, physical activity becomes part of caring for the plant and will trigger the user to do more physical activity.
2. Concept two is very similar to concept one, although it swaps out the plant for a glowing orb. The light within the orb can change from the lowest level, where only the very bottom of the orb is lit up, to fully lit, and multiple vertical steps of lighting in-between. In this way the orb can act as a score meter, where the higher the score, the higher the lighting on the orb will be. This score is tied to the user's physical activity levels for the past seven days, specifically their step count. Either after the user has gone for a walk, or at the end of the day they can bank their steps into the orb through an NFC pad which can interface with a step counter. This will then increase the score displayed by the orb, as well as change the lighting colour of the orb to a more relaxing shade. The score decreases throughout the day and the colour does too to create a bit of agency for the user to go for a walk.
3. The third concept that had the most support from the ideation session borrows heavily from the augmented reality game Pokémon Go [26]. This game is centred around going outside to find and catch Pokémon, and incentivises going outside with special events and rewards. Since its release, Pokémon Go has had a profound effect on physical activity levels, especially of user groups less inclined to interact with more regular forms of physical activity [27]. However, many older adults grew up before the video game era and do not have much affinity for the Pokémon franchise. This concept aims to build a Pokémon GO-like experience but around something more shared by everyone, including older adults, namely plants. By walking around and scanning plants users come by they can collect them, and add them to their digital botanical garden. Users could compete, see who can collect the most of a certain species, or who can find the rarest ones. They can share locations of rare plants or places where loads of a certain plant can be found. To keep the game from getting stale, certain officials or employees of care homes could set out certain special plants for a limited time, or organise events with special rewards attached to them.

Chapter 5: Specification

The specification phase of this report will outline the final concept selected from the ideation phase and flush it out, describing in more detail the workings of the final concept as well as the ideas behind it.

5.1: Final Concept Selection

From the three concepts described in the previous chapter, one must be selected to be worked into a prototype. This can be done by process of elimination. Looking first at the third concept, while the effects of Pokémon Go on physical activity have been immense, replicating it is extremely difficult. App development on such a scale requires a time investment outside the scope of this project, even for a prototype. Same goes for an AI plant recognition tool. App development also is not congruent with the skillset offered by the Creative Technology programme. Finally, there are some holes to poke in the concept itself. What would stop users from photographing the same plants over and over again from a slightly different angle? Eventually all plants in a certain area will be scanned, what will the user do then? Only rely on special events? Will this even reach all older adults, since a subset of them do not own a smartphone and are not well versed in standard technological interaction methods (i.e. swiping)? There are many such problems to point out with this concept so while it may well be the one that could have the biggest influence, it will not be the centre of this project.

Considering the remaining two concepts it serves to consider the primary requirements a concept should satisfy. The literature review section concluded that the personal lifestyle intervention is a very effective method to combat demotivation for physical activity and a tool to alleviate some of the health professional's workload associated with it could be very beneficial. Thus, some way for the concept to play into the Personal Lifestyle Intervention is one requirement. The expert interviews resulted in two more requirements. First, the system should offer a frequent or constant reminder to the user that they should partake in physical activity. Second, the system should offer an external incentive for the user to partake in physical activity. Looking at concept one and two, neither explicitly satisfy the first requirement, while they both satisfy the second and third requirements with varying effectiveness.

Looking at the concepts more broadly, concept two has the least loose ends to tie up. It is most clear in its functions, albeit because it is the most simple. It does lack some incentive for the user however. It may not be sufficiently motivating for users to only see a score. The first concept might be more meaningful to users, because caring for the plant is a more straight forward incentive. Then again, there is a bit of a mismatch because going for a walk does not directly influence the health of a plant. What does one have to do with the other? The plant being real does not match well with the digital nature of health tracking. What would be ideal then, is to combine the two concepts. Take concept two, the glowing orb, and add the elements of taking care of something from concept one. Then integrate a way for the concept to aid in the Personal Lifestyle Intervention. This idea is what the final concept is based upon and it will be elaborate upon in the next section.

5.2: Final Concept Description

The physical presence of the final concept will be as follows. A frosted translucent glass orb of 20 cm in diameter will sit upon three legs of around 10 cm that together act as a stand. The frosted nature of this orb's glass will allow for light from the inside to shine through to the outside while the inner workings of the orb will be obscured. All legs will have lighting integrated. One of these three legs will have an RFID identification pad on it. Figure 13 shows a rough sketch of how the final product may look. The design will be loosely inspired by the Bang & Olufsen Beoplay A9 speaker system [28], namely how the legs will be positioned.

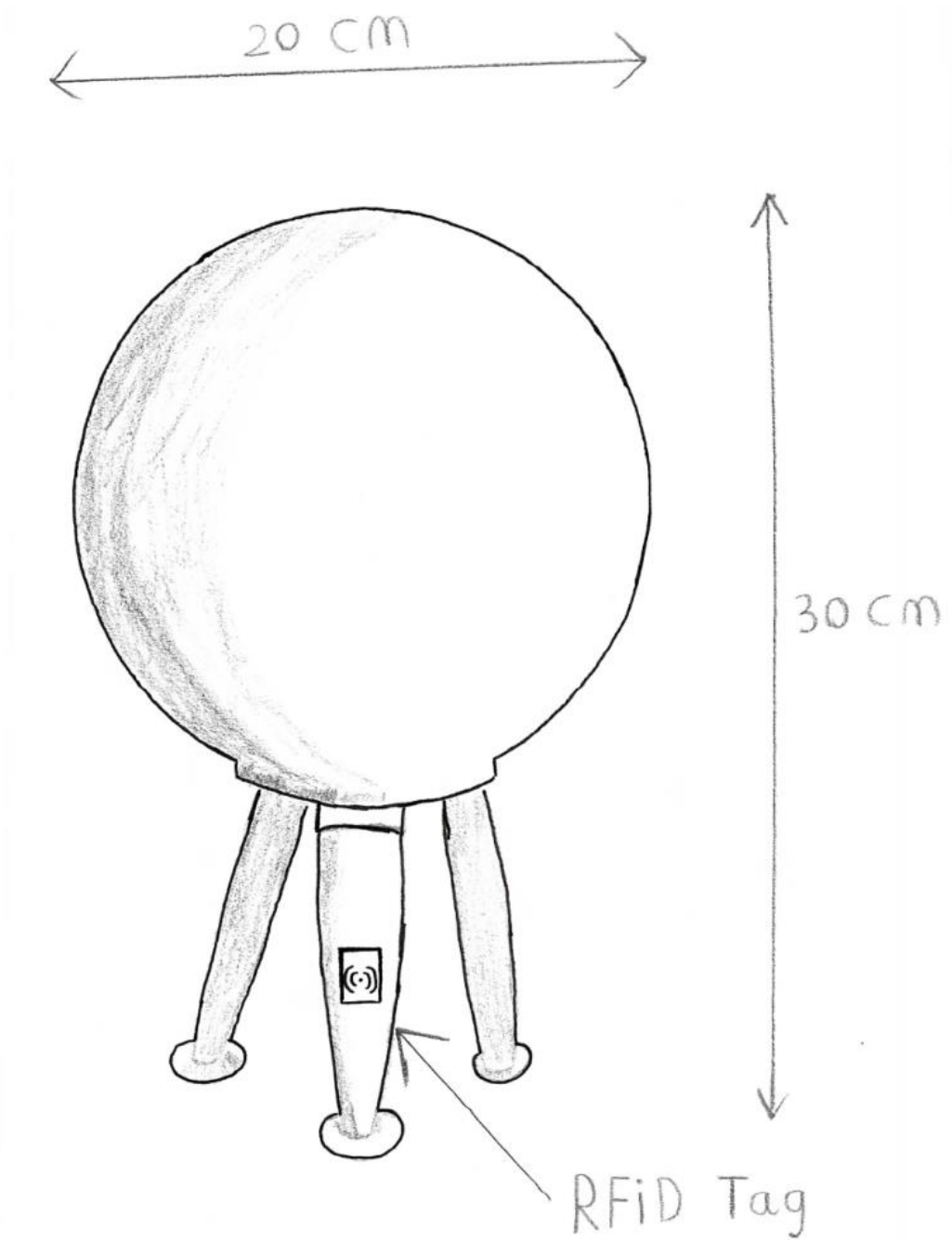

Figure 13: Rough Sketch of Final Concept Design

The orb is hollow, and inside will be fitted with a column where seven LED strips are attached from top to bottom, equally spaced out. The top of this column will contain a capacitive touchpad which will function through the glass of the orb. The bottom of the orb will feature a speaker hole, a proximity sensor and one wire to plug into mains power which can be routed along one of the back legs.

The LED strip interface and RFID pad will function very similarly to the description of concept two in the previous chapter. The user can set a physical activity goal, for instance a daily step goal which will be used to explain the rest of the workings of the device. When they have completed their goal, the user can bank their steps into the machine by scanning their step counter at the RFID tag. The RFID tag will scan the amount of steps which will lead to a short animation being played with the lighting in the legs and the lighting inside the orb. The end result of this animation will be that the lighting inside the orb will move up vertically by the amount of steps banked in relation to the set step goal. In this way, the LED strips in the orb become a graph of sorts, relaying back to the user how they stand in their physical activity goals. The data the LED strips use will be based on the previous four days, so if the user does not do their task one day it will not immediately lead to an empty orb, although the effect will be noticeable. The colour of the lighting will also play a role in activating and rewarding. Research done by Philips [28] has identified how certain light colours can have an effect on the atmosphere of a room. Namely, combinations of blue and cyan coloured lighting can create an activating atmosphere and combinations of green and blue lighting can create a relaxing atmosphere [28]. While the uniformity of the orb's lighting colour is important for aesthetic purposes, having the orb output different coloured lighting would look messy, this can still be used. When the user has not yet banked any activity that day the lighting of the orb will be cyan, creating an activating atmosphere in the room. When activity is banked, a lighting animation will play to signify to the user that their activity was banked and during this animation the colour of the lighting will also shift to a lush green tone to create a more relaxing atmosphere.

The mentioned speaker-hole and proximity sensor lead into the second dimension of the concept, the verbal assistant. The orb will feature a digital assistant which will take up the role of the plant from the first ideation concept, as an entity the user has to take care of with physical activity. The way this assistant will compose itself will be different from standard digital assistants. These tend to be very goal-focussed. Their goal is to help the user with quickly completing tasks or finding information, so they use little unnecessary words and give short, measured responses. This makes them very efficient tools to convey information, but often leaves a lot to the imagination when it comes to personality. The digital assistant for this concept has a different role, in that it mainly serves as an outside incentive for the user to partake in physical activity. Thus allowing for more freedom when designing the personality of this assistant.

All this is to say, the personality of this concepts assistant will be light-hearted, quippy and a bit sarcastic, both to appease the user and to challenge them more. The assistant's overarching narrative will be that it lives off of the score that the orb shows. Thus, the mood of the assistant will depend on the level of exercise of the user. If the score is low, the assistant will sound tired, exhausted, almost begging the user to go for a walk. If the score is high, the assistant will be very satisfied and congratulatory of the user. The assistant can also play into changes in behaviour. If a certain week has been less active than the previous ones, the assistant will be a but disappointed. When the opposite is true, the assistant will be pleasantly surprised. This all functions create a caring relationship between the user and the assistant, giving the user great outside incentive to be active.

This assistant will have two different triggers. First, when the proximity sensor detects that someone walks past the orb. When it detects someone passes by the orb the assistant will remind the user of

the specific activity they are supposed to do at that moment or somewhere during the day. This will not happen every time someone walks past the orb, but a couple times per day. Examples of voice lines the assistant could say when triggered are:

- “Hey I could really use a top-up, so if you could go for that walk that would be great”
- “I can’t see the weather outside, but I bet it’s really nice!”
- “Hey I know I’m one to talk with my legs not being able to bend and all, but those squats aren’t gonna do themselves you know”
- “I propose a win-win scenario, you go outside and enjoy yourself, and afterwards I get to enjoy that activity. Sound good?”
- (When the score is very low, sounding very exhausted) “Listen man, I’m running on fumes here, could you please go outside, just, please, I can’t hold out much longer like this”
- (When the score is very high, the orb is almost fully lit) “Look you’ve been spoiling me so much these past days, why don’t you go for a relaxing walk to unwind...and give me some more juice”

The other trigger for the assistant will be when the user banks their activity. Here the assistant will be very thankful, satisfied and congratulatory, again based on the state of the activity score the orb is displaying. Examples of voice lines the assistant could say when triggered like this are:

- “Oh yes, that was just what I needed”
- “God, this stuff is like coffee to me”
- “Wow that hit the spot”
- (When the meter was very low) “Geez, I thought I was a goner there for a second, you really saved me”
- (When the meter was very low) “Thank you so much, I wasn’t ready to meet my maker yet, heaven for machines is not a fun place let me tell you”
- (When the meter was very high) “If you keep this up I’m gonna have to move to a bigger orb”

Besides going a short walk everyday, the orb will be able to accept and use many different forms of physical activity and exercises to adapt to different users. These can be inputted by the user but also by a health professional. In this way the concept can play a role within the Personal Lifestyle Intervention discussed in chapter 2. For instance, during such an intervention the health professional and user decide it would work best for the user to perform 20 squats every morning because of certain health restrictions. This can be inputted into the orb which will then remind the user to do that specific activity through the digital assistant. The orb will also be able to accept a list of different exercises that should be done throughout the week. Say in addition to those squats, the health professional thinks the user could benefit from yoga sessions, staircase walks, etc. too. This can all be inputted into the orb which will dynamically cycle through the exercises.

5.3: Conclusion

At the start of this chapter three primary requirements were laid out for this concept to satisfy based on this projects previous research:

- Play into the personal lifestyle intervention
- Offer the user a frequent or constant reminder that they should partake in physical activity
- Offer the user an outside incentive to partake in physical activity.

The proposed concept satisfies all three of these primary requirements. By allowing the physical activity that gets tracked and that the user gets reminded of, the concept can help with the personal lifestyle intervention. It takes the workload of motivation the user and issuing reminders/new exercises away from the health professional.

The second requirement is satisfied by the orb being in the room at all times. Its physical presence as well as its lighting system give the user a constant reminder that they need to do physical activity. If they more than glace over at it the seven LED-strip interface also conveys information about their physical activity of the last few days. When the user walks past the orb, they will be reminded more explicitly that they need to do physical activity that day by the assistant.

Finally, the third requirement is satisfied by the LED-strip interface and the assistant. The LED-strips give the user a tangible score to work to maintain and increase through physical activity and the way the assistant's personality and mood change based on this score creates a caring relationship where the user does physical activity to take care of the assistant.

In conclusion, the proposed concept satisfies all three main requirements set by the previous chapters of this report and could prove a valuable tool for older adults who have trouble getting themselves to be physically active.

Below is a scenario which illustrates how this concept can serve to help older adults who have trouble motivating themselves for physical activity.

5.4: Scenario

Irene is a woman of 76 years old living in a small town in the Netherlands. Before her retirement she used to take the bike to work every day and those 30 minutes back and forth kept her active. At work she also got enough activity, acting as a hospital nurse in a neighbouring city. When she said goodbye to the field of healthcare she lost all that activity, but luckily she and her husband Ronald took each other for small walks relatively often. Sadly, two years ago Ronald passed away due to unforeseen complications during a heart operation, and ever since Irene has not felt the same drive to go outside anymore. She is moving less and less and her physical condition has suffering from it. Her kids have offered to buy her an e-bike, but she does not want them to spend so much money on her, especially when she does not see herself using it at all. Where should she go? Cycling around aimlessly does not sound like her idea of fun.

Nevertheless, her physical state has declined to such a degree that she is having trouble with day-to-day tasks. Stairs have become a formidable adversary, her walking is becoming more and more unstable and a trip to the shops, even in the car puts her out of action for the rest of the day. That

combined with joint pain, back problems and the ever-looming threat of a care home hanging above her like the sword of Damocles meant that she finally took up her family's advice and planned an appointment with a physiotherapist.

The physiotherapist is nice, she does not beat around the bush with what her current lifestyle is doing to her, but does not talk down on her either. She warns Irene that it is really hard to gain back physical fitness at her age and she has to start moving more just to maintain her current state and keep her out of a care home. Irene takes in all this information and while slightly scared, she more feels just like she needs to make a change. By the end of their first conversation Irene feels like she at the start of a new chapter. Time to make some changes.

Sadly, it does not quite work out like that. After just two days Irene discovers she just can not get herself to move much at all. She knows she should but that just does not translate into motivation. She discusses this with her physiotherapist and she recommends two things that together should get Irene to move. The first is to enter a more intensive physiotherapeutic track where they will start with something called the personal lifestyle intervention. The second is to take a certain glass orb with her to place in her house.

The first personal lifestyle intervention session goes well, Irene and her physiotherapist come up with some personal exercises and goals she can do, the main one being 3000 steps per day. At the end of the session the physiotherapist gives Irene the glass orb, already loaded up with those exercises they came up with. Irene goes home feeling like something is really going to change and this is the start of something new. At home, she looks around for a good spot to put the orb. Eventually she puts it on a small table standing in-between the kitchen and the living room where she can see it from both places. She plugs it in, the orb flashes in cyan light for a second, and then a voice says: *"Oh hey, sorry I just woke up, I need a second. Could you hold your step counter to my front leg to pair it up?"*. Irene does so, and after holding the counter next to the front leg's indicated RFID-area, she hears a little beep and the lights flash in confirmation. *"Aah so that's you huh. Look I'm gonna finish setting up, could you come by somewhere tomorrow morning? Should be all finished by then."*, the orb says. Irene smiles for a second, *"It really sounds like it is waking up."* she thinks, and then she goes off to make dinner.

The next morning Irene has already lost some of the momentum she felt after the first PLI session. It is back to the daily slog of trying to get herself to go outside. During her morning routine she walks past the glowing orb, which dims its lights for a second and then says: *"Hey good morning, what's the exercise plan looking like for today because I'm hungry!"*. Irene steps back for a second, not being used to having different voices in her house. However, then she thinks: *"Well let's give it a shot."*, and heads for a short walk. She comes back to the house 20 minutes and 2000 steps later. She goes up to the orb and scans her step-counter to its leg. The orb beeps once again, the lights ramp down their brightness, and when they come back up just as quickly there's one more row illuminated as well. Then the orb says: *"Oh good job, that really hits the spot. You're looking to start off good huh."*. Irene thinks: *"Yeah I am actually, thanks."*, and feels a little more accomplished about her walk.

Day two, Irene wakes up again feeling that slog dragging her down. This time however she quickly walks to the orb which notices her and says: *"I'm not sure if you've had breakfast yet, but I won't have mine until you go for your walk so I'd appreciate it if you got on that."*. And that Irene does. This time, she takes the longer route around the neighbourhood and ends up waking for 30 minutes. Once back home, the first thing she does is head to the orb and bank her steps. This time, the orb says: *"Oh boy what a treat, cheers!"*, again giving Irene a bit more satisfaction from her walk.

It goes on like this for the rest of the week. Some days Irene forgets or pretends to forget that she needs to go outside, but the orb always being visible keeps reminder her to get some air. The orb's messages motivating her beforehand and making her feel more accomplished afterwards.

After three weeks she's gone for her walk more days than not. When she did not go, the orb's score got lower and it almost started begging her to go. When she went for longer walks the orb was very happy, thanking and praising her more than ever. Together with the physiotherapist, they decide the exercise goal can be ramped up a bit, going for more steps and mixing it up with some light exercises two days per week. The orb reminds her of those specifically, helping her plan her exercises too. Irene starts noticing the normal daily tasks are less hard now, her walking has become more stable and fluent and she's not so tired all the time. At the end of her treatment, she can walk for miles on end and live independently for many years to come.

5.5: Storyboard

Figure 14 shows a storyboard depicting one morning where Irene uses the orb. Below each frame a short description of what happens in that frame is given.

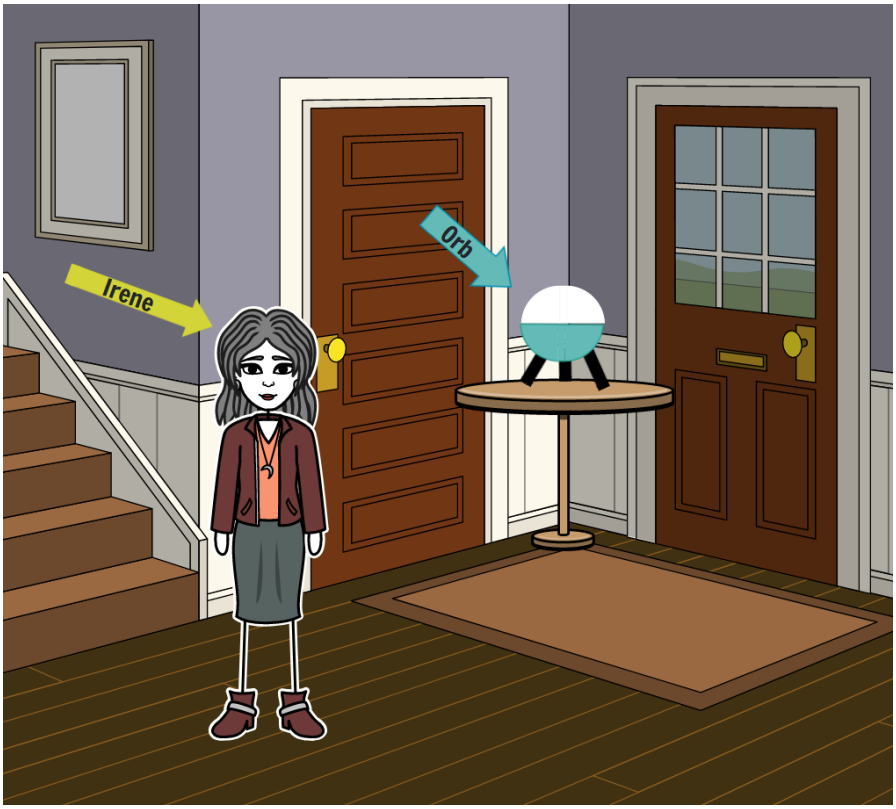

Figure 14a: Storyboard Frame 1

Irene walks down the stairs in the morning, the orb stands in the corner filled a little below halfway.

Figure 14b: Storyboard Frame 2

When Irene walks past the orb to head to the kitchen, the orb says something to her.

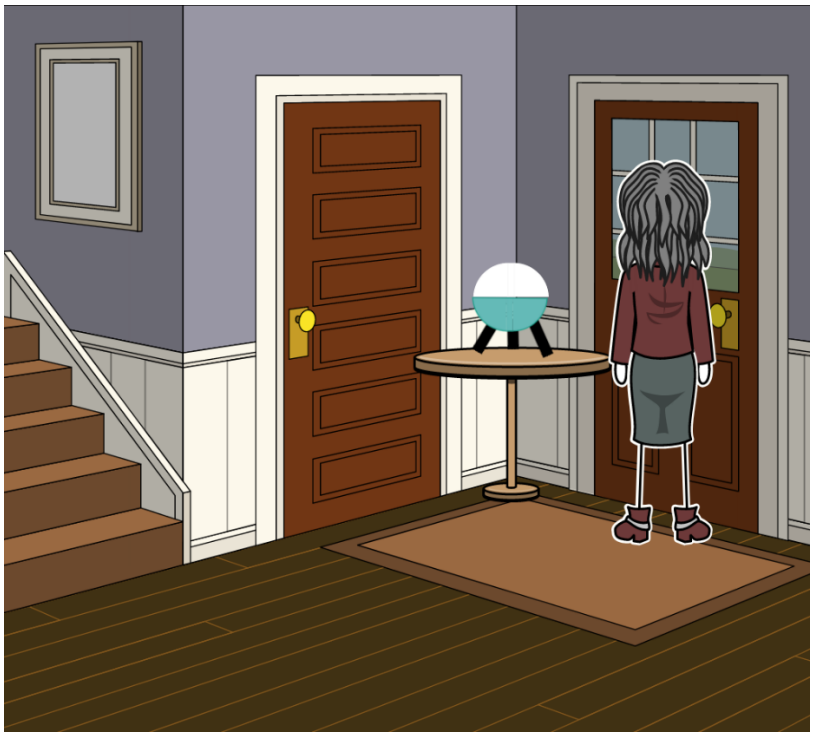

Figure 14c: Storyboard Frame 3

The orb's voice line convinces Irene to go for a walk that morning

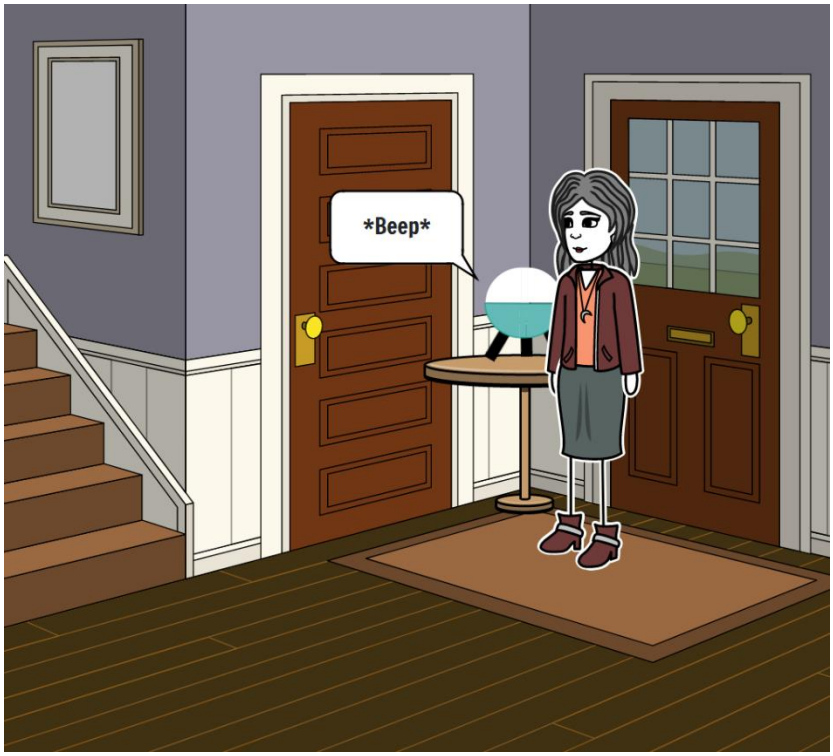

Figure 14d: Storyboard Frame 4

When Irene returns from her walk, she banks her activity into the orb

Figure 14e: Storyboard Frame 5

When the activity is banked, the orb glows up and says another line to Irene

Figure 14f: Storyboard Frame 6

The orb filling up and the voice line make Irene feel accomplished about the activity she just did.

Chapter 6: Realisation

This chapter will describe the process and results of developing a real world prototype to evaluate the concept laid out in the specification chapter. First, some prototype requirements are outlined. Then some prerequisite prototype decisions will be made and finally the execution of the prototype will be laid out.

6.1: Prototype requirements

To evaluate the efficacy of the proposed concept from chapter 5 the concept must be subject to user testing. The best way to do this is through building a prototype which while not a finished product, features the most important aspects of the concept. When building a prototype, the first thing that must be decided is what features it will include and what it will omit, a.k.a. what the prototype requirements are.

Most important to the concept is the experience of “banking” the activity. This is where every aspect of the concept comes together. The orb, the RFID pad, the lighting system and the assistant. Evaluating this aspect will also give the best idea of how effective this concept could be when turned into a real product. Thus, this is what the prototype will attempt to emulate. This also means that the multiple supported exercises and vocal reminders when the user walks past the orb will not make it into the prototype. Instead, the prototype requirements are as follows:

- The prototype must feature a column of 7 LED-strips inside a glass orb.
- The Prototype must feature a working RFID pad
- The prototype must feature a voice that serves as the assistant.
- The LED-strips must change when the user uses the RFID-pad, increasing the amount of strips lit and changing the colour.
- The voice should play when the LED-strips have changed.

These requirements should ensure that the banking experience is as close to the concept as possible and allow for good evaluation of the concept.

6.2: Prototype prerequisites

Before prototype construction can begin, some prerequisite decisions must be made. First, tools that will be used to construct the prototype. Since this prototype will mainly be hardware but require a degree of intelligence, and also because this is a Creative Technology graduation project, it is no surprise this prototype will be built on the Arduino Uno platform. It is an incredibly versatile platform for quick electronic hardware prototyping and has been the backbone of large parts of the Creative Technology programme. The choice of Arduino as the platform the prototype will be built on leaves a large degree of freedom for choosing other hardware components. Three things must be selected: The LED-strips, RFID scanner and music playing solution.

This project will use ws2812b-type LED-strips (see figure 15). These strips have individually addressable LED's and more usefully, allow for every LED in the chain, no matter how many there are, to be controlled from one Arduino pin through the FastLED library [30]. They also run on 5 volts, which means the Arduino can theoretically power these LED's. However, the Arduino can only power a few since each of these LED's can draw a maximum of 50-60mA [31,32], and an Arduino pin can provide a maximum of 50mA per pin [33]. This means if the LED's are not pushed, i.e. only one colour at low brightness, the Arduino can power a few LED's. However this prototype will utilise upwards of 40 LED's which the Arduino is not able to handle. Thus, an external power supply is required. The power supply has to be 5V and have an maximum current of around 3A (since 40 LED's * 60mA = 2.4A). The power supply that will be used in this project is the Voltcraft SPS15-36W [34] since it was on hand at the time of construction and fits the power requirements. A side-benefit of using such a power supply is that it can also supply the Arduino with power, letting those two components operate from one power source.

Figure 15: A strip of 4 WS2812b LED's

Figure 16: RC522 Contactless Reader IC

The RFID-pad used for this prototype is the RFID-RC522 Contactless Reader IC [35] (see figure 16). This is a low-cost RFID reader that is fully usable with Arduino through the MFRC522 library [36].

The voice poses a more significant challenge. Audio playback is a well know drawback of the Arduino platform due to its low memory. There are Arduino specific modules to circumvent this, however they are relatively expensive, take up pins required for the RFID function and would have taken too long to arrive. Thus an alternative solution had to be found. The chosen path was to disassemble an old MP3 player with microSD support. This mp3-player can then have wires soldered to its power button circuitry to allow the Arduino to control it. The player starts playing automatically when turned on so only the wires to the power circuitry are required to let the Arduino have full control over play and pause. This MP3 player also features a 3.5mm headphone jack so any speaker can be connected to it The one downside to this solution is the fact that in this configuration the MP3 player decides what audio it plays. When started up it will always begin with the same audio file, the one at the top of the list and so this solution can only play one audio clip. However because this prototype will evaluate the banking experience only one audio clip is required and so this was considered an acceptable flaw.

One other hardware consideration is the glass orb itself which has to house the prototype. Because of availability a glass ball meant as a lamp cover from Ikea [37] was selected (see figure 17). This orb is slightly bigger than the envisioned concept at 25cm in diameter to the envisioned 20cm, however this will not take away from the user experience. It features frosted glass and a bottom hole big enough to fit components through. It also features a standing base which will act as the three legs for this prototype. This is again, not as envisioned but fashioning legs would have been a significant time investment while adding little to the user experience.

This leaves only the column the LED-strips will be mounted on to be considered. Since this part will be highly custom with both its measurements and overall shape, this part will be designed using the 3D-modeling software Blender [38] and then 3D-printed.

Figure 17: Ikea Fado

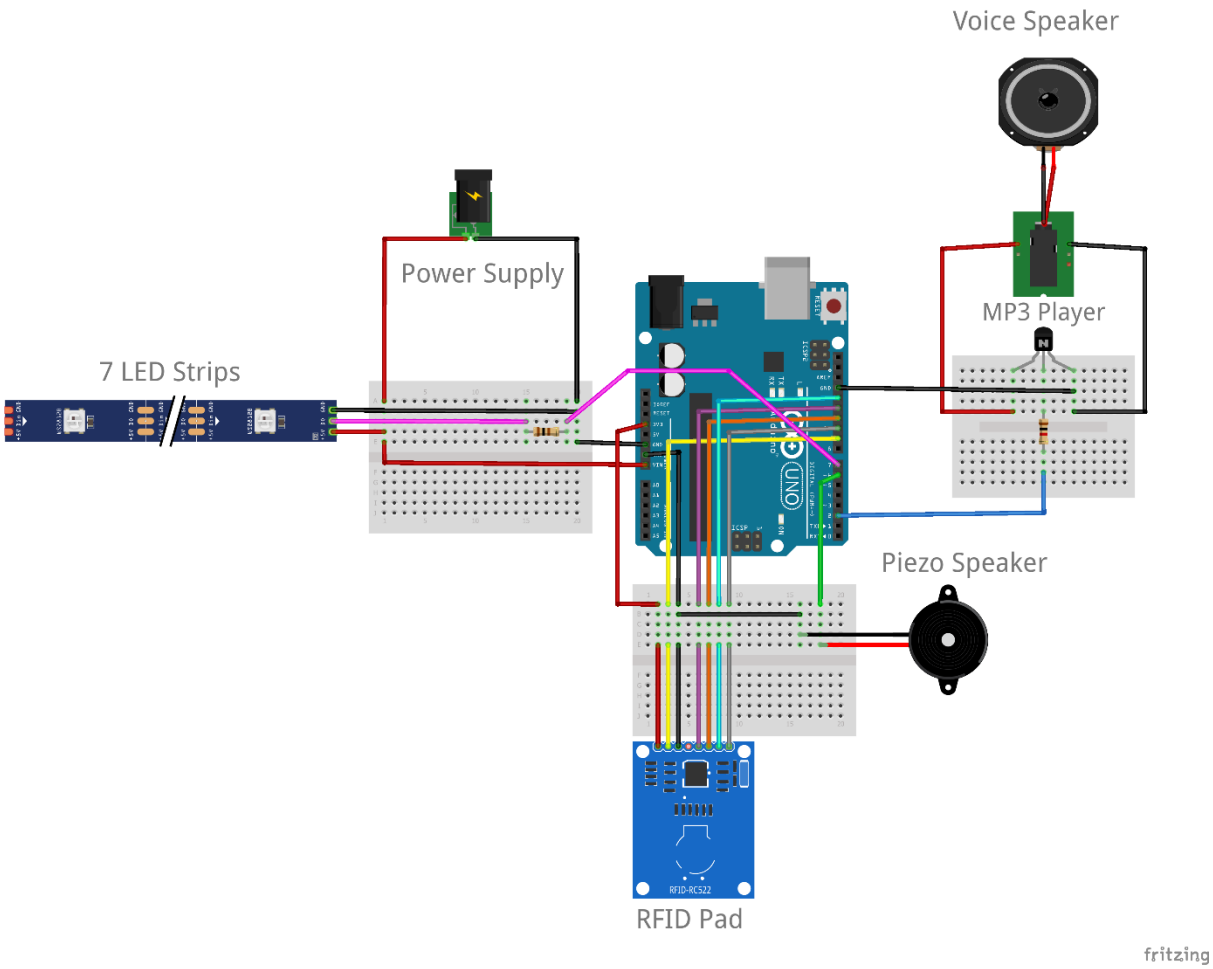

Figure 18: Full prototype schematic

Figure 18 shows the full electronics schematic for the prototype. Three distinct sections can be seen: The LED-strip section, the RFID-pad section and the MP3 player section. Each of these three sections will be highlighted individually.

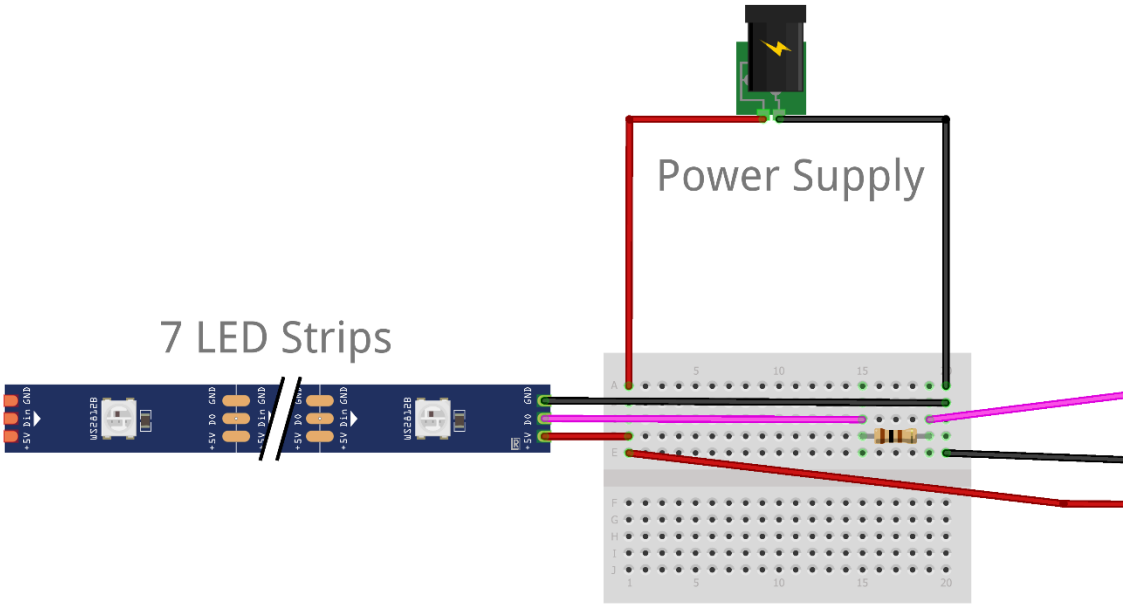

Figure 19: LED-strip section of the prototype

Figure 19 shows the LED-strip section of the prototype. While only two LED's are shown, these represent all 7 LED-strips. These strips are soldered together in series which effectively makes them one long strip. This possibility is one of the advantages of the WS2812B type of LED strip. Each of the 7 strips is equal in length and contain 7 LED's, making for a total of 49 LED's. These LED's are powered by the power supply also depicted in figure 18. This power supply powers the LED-strips through the red and black wires attached to the strip and the Arduino through the red and black wires that go to the right. The pink wire is the signal wire for the entire LED-strip. The resistor placed in-between the pink wires serves to reduce noise on the signal line and stabilise the signal. In reality the breadboard used here is smaller, with only 11 channels and 5 holes each to reduce the footprint. The colours the LED's had to display were cyan and green. The WS2812B strips work with RGB colour commands and these colours will be displayed as RGB (55, 235, 255) and RGB(55, 235, 25) which can be seen below.

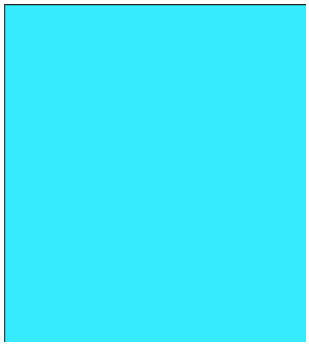

Figure 20a: Cyan RGB(55, 235, 255)

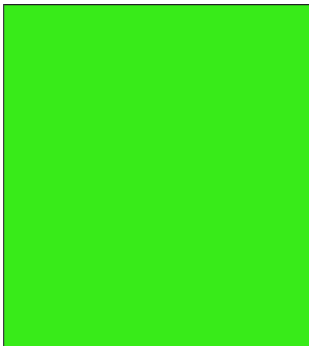

Figure 20b: Green RGB(55, 235, 25)

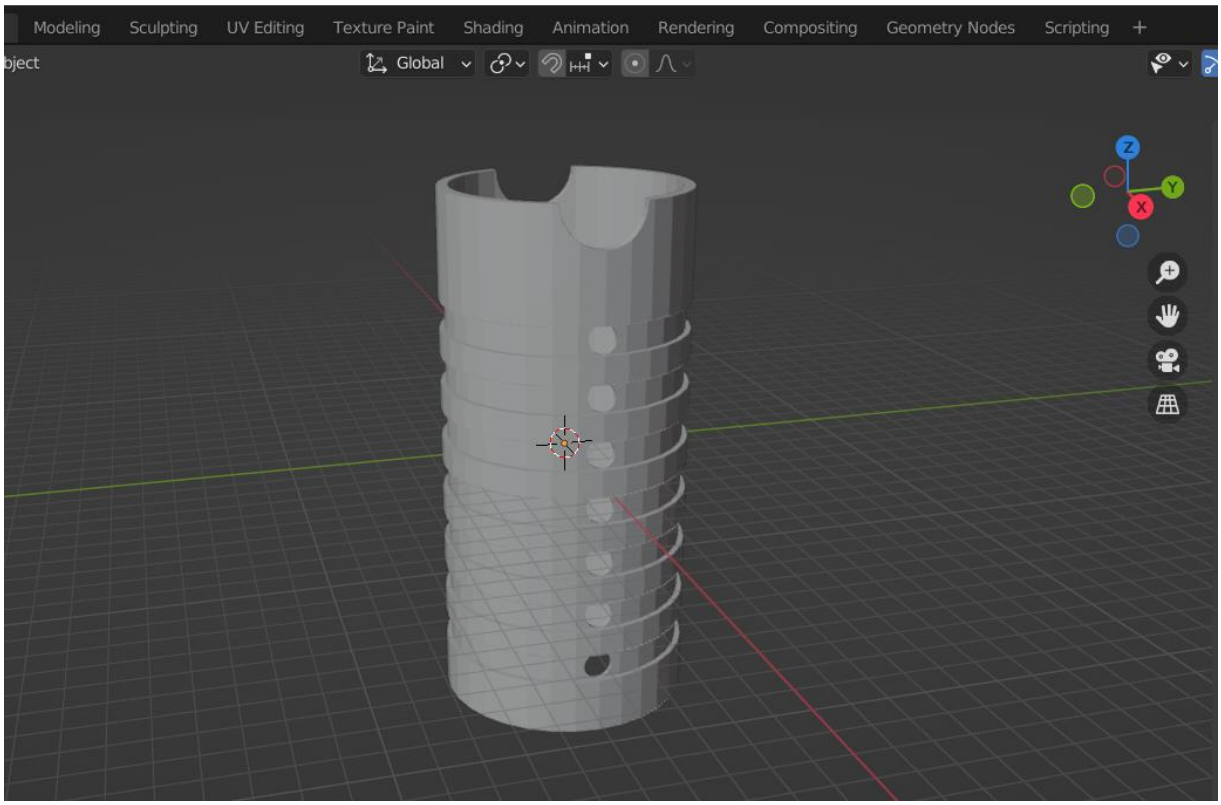

Figure 21: LED-strip mounting Column 3d-model

The mounting column for the LED-strips was designed in Blender and then 3d-printed. The 3d model can be seen in figure 21. The column is 19cm high and 9cm in diameter to fit through the hole at the underside of the glass orb. The model in figure 20 is upside down from how the column will be implemented. The half-circles at the top are designed to clear two clasps on the standing base the comes with the orb. The seven channels are 1 cm high and 2mm deep so the LED-strips fit in snuggly and the holes in each groove are for cable management. The 3d-printed column can be seen plain and with the LED's installed in figure 22.

Figure 22a: Plain column

Figure 22b: Column with LED's installed

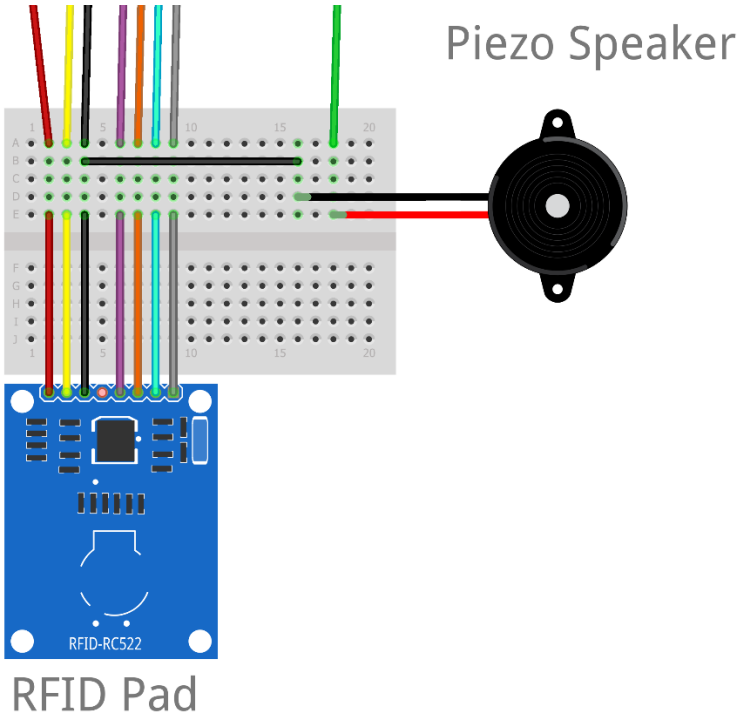

Figure 23: RFID-pad section of the prototype

Figure 23 shows the RFID-pad configuration of the prototype. In reality the short wires that connect the RFID-pad to the breadboard are straight pin connectors soldered to the pad. Notable is the one unused connection point fourth from the left of the RFID-pad, this is the IRQ connection and is used

to alert the controlling system of RFID tags that are not in readable range yet. Since this is not of any use for this project is was not used. The other part of this section is the Piezo speaker. This is not the speaker used by the assistant voice, as mentioned previously the Arduino is not able handle that. Rather this piezo speaker can output high-pitched chiptune noises and is used to confirm a RFID-chip has been read correctly by the reader. This is done with a 100ms tone at 400Hz followed by a 120ms tone at 900Hz. This entire assembly is built on a breadboard and will live outside the orb, with the eight wires at the top of the image going into the orb through a hole at the underside of the base.

The idea the concept works with is that this RFID pad can communicate with a step counter/activity tracker. The user testing will not use one of these but instead a RFID keychain. This came bundled with the RFID pad and will place the role of the step-counter in the user testing phase. The keychain can be seen in figure 24.

Figure 24: RFID Keychain

Figure 25 shows the MP3 player section of the prototype. The headphone jack in this picture acts as the MP3 player. This player is powered by its own internal lithium-ion battery because the Arduino can not supply the current it requires. The two wires coming off of the MP3 player have been soldered to its power switch. When this switch is flipped normally, two contacts make contact, closing a circuit that powers the whole player. These two contacts have had the red and black wires soldered to them, which means if these two wires make contact, the same circuit is closed and the MP3 player turns on without the switch having to be flipped. This allows the Arduino to control when the player turns on by closing the circuit between the two wires. This switching circuit is set up with an NPN transistor acting as a switch. The base is collected through a 1k ohm resistor to an Arduino pin with the collector being connected to the positive terminal and the emitter being connected to the negative terminal as well as Arduino ground. When the base is turned on the transistor becomes saturated and lets current flow from collector to emitter, closing the circuit and turning on the player. This player then starts playing the first song from an SD-card automatically and the Arduino turns it off again once this audio clip is over. The speaker is a small active speaker which was used because it was already in possession of the researcher. The breadboard used to house these electronic is once again smaller than the schematic to save space.

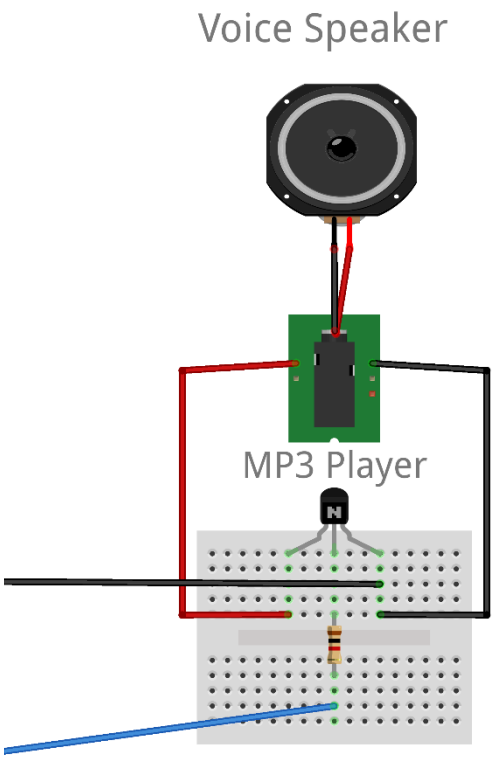

Figure 25: MP3 player section of the prototype

This covers the electronics part of the prototype, leaving only the orb to be discussed further. Initially, the Ikea orb was used for measurements and testing. However it quickly turned out the glass was in fact too frosted and diffused the LED light too much. There was no visual way of distinguishing between the two bottom strips being on and the bottom five strips being on because the LED's lit up the orb in full. Luckily, Ikea sells the same orb with transparent glass as well. This is far from ideal, since the inner workings of the orb are clearly visible and the effect of the LED-strips is not as clean as envisioned. However it is a quick solution since nothing has to be resized or replaced, the footprint is exactly the same. The final prototype look can be seen in figure 26.

Figure 26: Final prototype look with transparent orb

The full Arduino code that runs the prototype can be found in appendix C. The Arduino, MP3 player breadboard and LED-strips + power supply breadboard are all stored inside the LED tube, with the Arduino being taped to the side and the two breadboards taped to the base. The power supply cables, MP3 player cables and RFID cables all run through two holes in this base. The MP3 player has been taped to the underside of this base to allow easy access to the 3.5mm jack and charging port. An underside view of the prototype can be seen in figure 27.

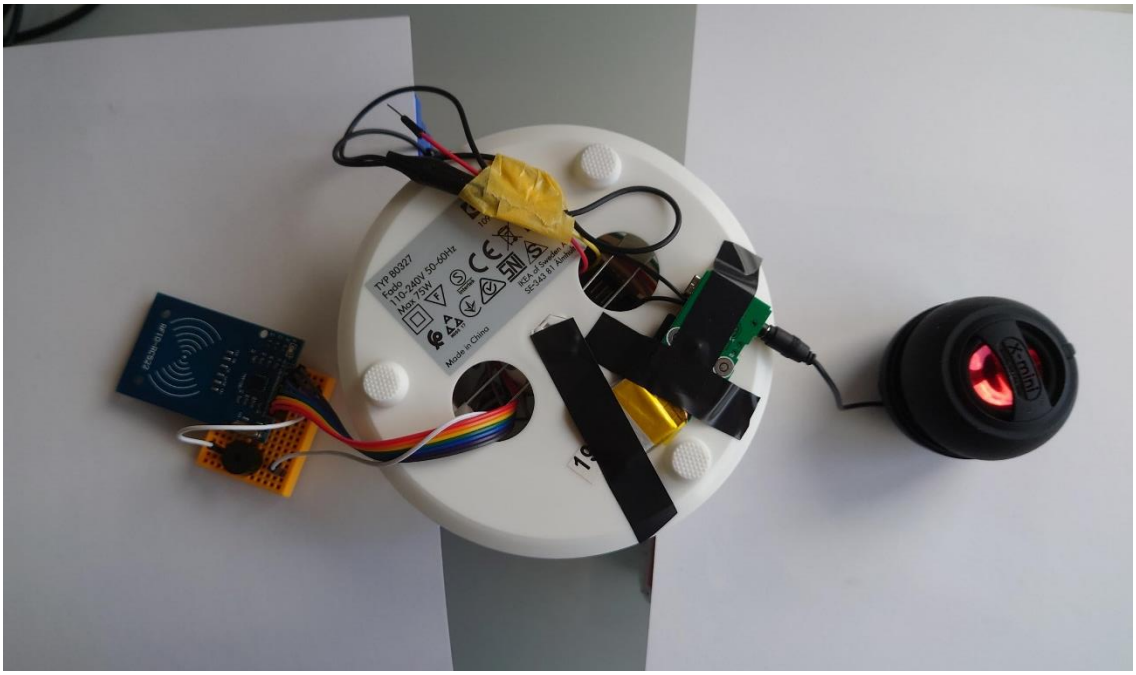

Figure 27: Underside of prototype with RFID-board on the left, power cables on the top and the MP3 player + speaker on the right

The speaker used can be seen in more detail in figure 28. It is a small active speaker with built in audio cable and battery. This means it does its own amplification which makes it a good fit for using with a small MP3 player. The audio fidelity and general quality is subpar, but for a prototype this is not an issue

Figure 28: Small active speaker

Chapter 7: Evaluation

This chapter will lay-out the full evaluation phase, from recruitment to procedure to results. Finally, two concluding statements will be made.

7.1: Recruitment

Participants were recruited through the experts interviewed in chapter 4. Expert One, the physical activity welfare worker works in a relatively large elder care organisation and thus has access to a large number of older adults. While Expert One was not available during the evaluation time frame themselves they organised a meeting with a colleague of theirs, also a physical activity welfare worker, who would show the head-researcher around the place and act as a guide during the evaluation sessions.

Expert Two, the geriatric physiotherapist, set up a meeting with one of her patients who they noticed had trouble completing the exercises that she would prescribe him. Not due to physical limitations, but motivational ones. The patient corroborated this, noting that he does struggle to conjure up the motivation to do those exercises or to go outside.

7.2: Evaluation procedure

The full information about how the user testing sessions were set up can be read in the “Brochure and Research Procedures” and “Informed Consent form” in appendix D1 and D2. Before the research began the participant would be explained what it was about, how it would go and asked to sign the informed consent form. The gist is that the evaluation of the prototype and concept is set up in three sections. During section one the participant would be asked to interact with the prototype. The interaction consists of scanning a small RFID keychain on the prototype’s RFIS scanning area and observing what happens. During this interaction the participant will be asked to talk aloud about what they think the prototype is trying to communicate to them.

Section two follows immediately after this which is a small interview about the prototype and the concept. It is unstructured, as it serves as an open discussion about the concept. The last section asks the participant to fill in a form about the prototype and the concept. This can be found in appendix E. It consists of Likert scale questions and open questions, together accounting for 21 questions.

The evaluation takes place at the participant’s place of living, which for the care home residents means somewhere in the care home and for the physiotherapist’s patient meant at their home.

7.3: Evaluation Session 1: Care home

The first evaluation session was the one set up by Expert One inside the care home on the 12th of July 2022. Here, the head researcher was met by a colleague of Expert One, who will be referred to as Expert Three. Together with Expert Three, the evaluation session was performed.

Before the evaluation was started, the prototype and concept were shortly discussed with Expert Three. Expert Three explained that in their opinion the concept would not be suited for patients with dementia. However, it could improve physical activity motivation for older adults who suffer less from such cognitive impairments. After this short discussion the first participant was found.

The first participant was an elderly woman living in the open ward and still the daily household tasks by herself. The research was explained to her and she understood everything expected of her and what her rights were. She gave informed consent and then the evaluation was done, although the questionnaire was not filled in since she did not wish to fill it in. The participant had a hard time understanding what the prototype was doing exactly. The link between the RFID-keychain and her supposed physical activity was one hard to make and scanning the keychain on the RFID-pad did not make enough of an impact for her to notice. When asked how she felt about the prototype she said:

> "I can't see the usefulness of it, I don't get it."

In general the participant had a hard time understanding what exactly the prototype was doing and was meant to do. She did mention that it was possible some other people in the care home would like it, but:

> "I'm too down-to-earth for something like this. I learned that from my mother."

After the interaction with the participant was wrapped up Expert Three explained that this would most likely be the response from most people in the care home. Expert three specifically identified the RFID-keychain as a point of great confusion for the care home residents and said it may not be fruitful to attempt a test with more people there. The residents of the care home generally have very little experience interacting with technology and that would make it very hard for them to understand the concept and prototype. Instead, an interview with Expert Three was conducted to obtain their view and recommendations on the concept and the prototype.

First, some extra inquiry was done into the RFID-keychain. According to Expert three it was the main reason the participant had such trouble understanding exactly what was being asked of her and what it meant. They recommend that for future evaluation sessions it should be made abundantly clear that it is meant to represent a step-counter. When asked about this step counter and if the older adults in the care home would be open to wearing one, Expert Three said that a lot of older adults would be happy to wear one, although some are quite stubborn when it comes to such things and would probably not like it. Expert three went to theorize that the step-counter or orb activation key could be integrated into the emergency help button that nearly all older adults in the care home carry at all times. While this would introduce some risk of accidently causing false alarms, it would mean the older adults in the care home would not have to be introduced to a new device or thing to carry around, which is better for older adults not used to interacting with technology.

The conversation then shifted to the concept in a broader sense. Expert Three was interested in the concept, and they believes that a finished version could definitely help older adults get more motivated for physical activity. Expert three imagines it can very well give the final push to get people to go outside. However, they note that it works best for those not burdened by dementia since that quickly leads to misunderstanding what the orb is supposed to do. Even for those who are not hampered by dementia it should be very well explained however. This is in Expert Three's view the main thing that made the user test go awry.

Expert Three really liked the idea of the voice. Many older adults in their care home spend a lot of time alone in their room, and an orb that sometimes says something funny could help alleviate some

of the loneliness. Expert Three was also asked about the voice's personal characteristics, mainly customizing the voice for the user. Expert Three was very interested in the idea to change the accent to one the user knows or may know from their life, say an Amsterdam's, Twents' or Flemish' accent. They believe this could really aid the adoption of the concept by more older adults.

7.4: Evaluation Session 2: Elderly man living at home

The second evaluation session was hosted with another participant, a client of Expert Two who arranged the meeting. It was held on the 13th of July 2022 at the participants house. The participant was an elderly man living at home with his wife poses. Daily activities pose no significant challenges for them, they can take care of themselves well. They had no plans of moving into a care home soon, since there is no real need. The participant was familiar with the use of technology, owning a smartphone and operating it frequently.

After the informed consent form was signed and the concept, prototype and goal of the research were all explained to the participant, the first phase commenced: prototype interaction. The participant had used a step counter before which greatly helped with understanding what the RFID keychain was meant to represent. After that, the interaction with the prototype went well, the participant said he understood what the prototype was trying to say, and that the voice, while quiet, was a nice conformation. This was mostly discussed during phase two, the short interview. Here the participant was also asked for some more informal thoughts on the concept. When asked if he would use it he said: "Yeah sure, it could fit right next to the google home we have.". The participant compared it to their Google home, which is a logical comparison considering both have digital assistants of some sort. In general the participant saw themselves as tech-savvy for his age. To ask about this further he was asked if similarly aged people would in his view also benefit from using it. Here he said: "Sure, although it depends on the person, not everyone will like it but I see many people using it.".

It was then on to the final phase, the questionnaire. The participant was asked to fill it in, but the open questions could be skipped or said out loud to the researcher. This section will present the biggest take-aways from the questionnaire.

Concerning the usability of the prototype, the participant picked answer 4 for every Likert-scale answer. This was always the positive but not overwhelmingly positive answer, so the participant thought the prototype was relatively easy to use and clear in its communication. For question 6, the participants noted: "I get it, the lights could be more spectacular.". This was also mentioned during the interview and refers to the light animation that plays when activity is banked.

The scenario section of the questionnaire saw the first three questions again answered with the "positive" answer 4. Question 10 was answered with answer 3, neutral, however, indicating that for the participant the LED-strips on their own are not enough of a motivation to go outside.

For the last part of the questionnaire, all Likert-scale questions were once-again answered with the "positive" answer 4. Most notably this means the participant would use the concept if it was a real product. Most of the open questions were left blank in but question 20, asking what the participant would change to the voice (accent, personality, etc.), the participant answered: "It's good like this.".

In conclusion, the participant was intrigued by the concept, liked it and would use it if it was available. He also thought many people of his age demographic would like it and benefit from it. His

main point of critique/improvement was the calm nature of the lighting, it could be a bit more spectacular.

7.5: Additional evaluation session recruitment

Evaluation session one did not go as planned. It was not anticipated that the technological inexperience of the care home inhabitants would have such an effect on understanding the prototype. The expectation going into this session was to perform the user testing with four participants, however only one was performed and not in full. Because this would mean the evaluation chapter would hardly have data to draw conclusions from, two additional evaluation sessions were planned. Since they had to be done on a shorter timeframe, the recruitment did not go through the experts but through the familial circles of the main researcher. No family was recruited to avoided biased results, but rather their social contacts. This time, the recruitment focussed on younger people within the overarching older adults demographic. Namely, people between 64 and 75 years of age. While describing a 60-year-old person as an “older adult” may seem excessive, its important to realise that the concept being evaluated here will take years of development to become a full-fledged product. By the time it could make it to people’s hands these people will have aged and fallen more squarely into the older adults category. Thus, these are the people this product is being developed for. This was made clear during the evaluation sessions and the participants were asked to imagine themselves five to ten years in the future. The requirement of the participant having trouble getting themselves to be physically active did stay, although it was slightly less strict due to time constraints. Through recruitment, three participants were found split up over two evaluation sessions.

7.6: Evaluation Session 3: Elderly woman living at home

The third evaluation session was performed with a woman in her late sixties. She lived at home with her husband and takes part in a Pilates session once a week. Outside of that, she gets exercise going through the motions of daily life which places her somewhat out of the demographic for this user test, however she indicated she may struggle with getting enough exercise later in life. Thus, while not ideal, her input can still be very valuable. A picture of the test setup can be seen in figure 29.

Figure 29: Evaluation Session 3 test setup

Informed consent was obtained and the proceeding interaction with the prototype went well. Everything was clear to the participant and when the voice spoke she chuckled. The prototype and concept were discussed more afterwards during the interview. The participant said that currently, she would not use the concept. However, a number of years in the future that could change and she did like the concept. She also though that in general, older adults could benefit from using the concept, getting them to be more physically active. She did note that they had to be older adults that were at least a bit familiar with technology. She believed older adults who have not every interacted with technology before would struggle to understand and use the orb. She had a number of ideas to improve/change the concept, most of which aimed at the assistant. The prototype does not feature an animation while talking and while that is planned in the concept, the participant would like to take it one step further. She would like the orb to feature some sort of pixilated face when talking. Not a full human face, just two eyes and a mouth in a cartoony fashion. This would add to the connection the participant would have to the assistant. Continuing on that, the participant also thinks an orb may not be the best shape for the concept. During the discussion she was shown an image of a Beoplay A9 speaker [26] to indicate what the final design would borrow inspiration from. She then said:

> "Well why not make it flat also, that would be easier to show animations on."

She also wondered if the LED interface added anything of value, since the score being communicated was not very clear to her. She also mentioned how she could see the assistant being very valuable to lonely older adults.

The questionnaire was filled out in full. It should be noted that the participant was asked to fill out the questionnaire from her perspective in five to ten years. All four Likert-scale questions in the usability section were answered with the fourth option, namely the positive option. Thus, the participant thought the prototype was easy to use, although not overwhelmingly so. In the open question sections the participant did add that it was clear what the prototype was trying to communicate, but only with an explanation. She notes the importance of a usage guide for users. She also noted the voice could sound happier when banking the activity.

The scenario section offers interesting results. Question 7 and 10 ask the participant whether the LED-strip interface showing the physical activity level of the past few days would motivate them when it shows a low score. Here the participant answered with the negative option, so "no, it would not motivate me". However questions 8 and 9 ask in a similar vein if the voice would motivate them to be more active. Here, the participant answered with the positive option, i.e. "Yes, it would motivate me." This means that for this participant the LED-strips add very little while the assistant adds a lot.

In section three, first the aesthetic of the orb is discussed. The participant answered that yes, she would like to have the orb in her room if it would have the frosted glass look. Here, she mentions again how she would prefer it to have a face with animations affirming her activity, possibly an animated thumbs up or figure jumping and cheering. When asked if she would use the product if it was a real product, she's unsure. In the open question she answers:

> "I'm not sure, maybe if I was older or lonely. I would use it if it would look like a very nice lamp and if I could turn the exercise banking into a game."

When asked if she would find then ball pleasant to use, she answered with the neutral option. The open question explains this as follows:

> "I would use it to stimulate me to go outside more. I wouldn't use it because I could find it complex, I may find it a bit of a strange device."

The next question asks if the orb would motivate the participant to be more active. This was already partially answered in the previous open question so its no surprise that she chooses the positive "yes" option. She elaborates on this as follows:

> "I would use it if I could turn it into a little game or if someone else like a friend, family member, physiotherapist would stimulate it. I would not use it if I was some old slowpoke.

That leads to the final two questions. The participant answers that she would like to hear the voice multiple times per day, but only if it would be in for a joke. Different accents like a Surinamese or Flemish accent would be a fun way to spice things up according to her. Finally, asking if there are any other comments about the prototype the participant says:

> "In rest mode it should look like a nice looking lamp, and it shouldn't be too expensive (around €25 or so)."

7.7: Evaluation Session 4: Two elderly women living at home

The fourth and final evaluation session was held with another woman of older age (mid-sixties) who lives at home and does everything by herself. She goes outside often, and thus does not fit entirely

into the target demographic of this project. However, similarly to the participant in session three, in five to ten years when this concept would theoretically come to market she would fall into it more, meaning her input now is also valuable. She also brought a friend along. This friend was in her mid-fifties and thus falls out of the demographic entirely. However, she was eager to anticipate and works as a general practitioner meaning she often sees older adults who struggle with physical activity motivation. She was asked to give her opinion on the prototype and fill in the questionnaire from that lens. The lady in her mid-sixties will be referred to as participant one while the general practitioner will be referred to as participant two. Informed consent was obtained from both parties and then the first testing phase began.

During the prototype interaction the audio failed to work, however the participants still got to hear the audio because the MP3 player's on-off switch was still accessible as a back-up option. Discussing the prototype and the concept, a first take-away from the participants was that the advantage towards smartphone apps was unclear. This was followed up by the participants saying that they were younger than the target demographic and that there are large amount of older adults right now who either do not own a smartphone or are not comfortable with the usage one. However, by nature of their old age this is a dying breed and it is worth considering if in five to ten years there will be enough of these older adults who could benefit most from the concept.

Continuing this discussion, the participants did note that the concept is simpler than a smartphone and more purpose built, and they could see people using even when they are also familiar with the smartphone. They went on to note that the concept should use as few interactions as possible, possibly by syncing the steps automatically. This would forgo the "banking" experience, but would integrate more seamlessly into someone's life.

Both participants agreed that the concept could prove very valuable for certain older adults, although neither thought they would use it themselves right now.

Discussing the voice, the participants were explained that the voice would get very sad when the score inside the orb got low. The voice would be begging the user to go outside, almost like a drug addict asking for one more hit. The participants mentioned how they thought this might not work well since that sad attitude might rub off on the user who may already be feeling bad about themselves that they did not exercise. The participants suggested more positive reinforcement may work better for these lower scores.

They were also asked about an animated face on the orb, as suggested by the participant in evaluation session three. Neither participant liked this idea mentioning they would find it more annoying that motivating. Annoyance was also brought up in relation to the colour of the LED lights, but in a motivational way. The participants suggested that if the colours could be personalised to a colour the user may find ugly or annoying when no physical activity was done that day it could further motivate the user.

Lastly, the social aspect of the orb was discussed. Participant two, the general practitioner mentioned that other people are often a great motivator for people she sees struggling with physical activity motivation. She sees how the voice in the orb attempts this, but imagines how more real social interaction could improve the impact. By letting family or friends record the voice the orb uses or letting them see each other's progress.

Then the questionnaire was handed out. The most merit will be given to the answers of participant one, who actually does fall into the target demographic. Participant two's answers will also be noted but carry less weight. The Likert-scale questions of the usability section were rated with the positive

or very positive answers by participant one, meaning the prototype was experienced as being easy to use. Participant one answered question three, what the prototype was trying to make clear to her, with:

> "Well done/you're on the right track."

This is close to what the orb is intended to make clear to the user. She does note in the open section that:

> "It's necessary to hear different voice lines, and negative voice lines should be avoided."

Participant two gave very similar answers to all questions expect question four, where she answered with the neutral option. This means it was not entirely clear to her what the prototype was communicating.

The scenario section shows some interesting differences between the two participants. Participant one says that seeing the LED-strips at a low level would motivate her to go outside while the voice would not motivate her. Participant two answers the other way around, where the LED-strips do not motivate but the voice does. Both participants answer that banking their activity with the LED animation and the voice would make them feel accomplished, but neither participant answer that seeing the LED-strips lowering the next day would motivate them to go outside.

Section three begins asking if the participants would like to have a finished version of the orb in their house. They both answer "yes", with participant two noting she would like to make it slightly smaller. However, both participants also answer that they would not use the orb if it was a real product. Participant one answers:

> "I don't need it, I go outside often enough and get enough exercise."

While participant two answers:

> "Without internal motivation I can't be stimulated to do something that I don't feel like doing."

Both participants answered neutral when asked if they would like using the orb. Participant one elaborated that she does not need it right now. Both participants also "no" when asked if the orb would motivate them to be more active. Participant two adds that they would like to be able to personalise the colours. Neither participant would enjoy hearing the voice multiple times per day, although participant one would change some things about the voice:

> "An Amsterdam accent or something funny, not too serious."

Lastly, participant two adds that they would not be motivated by a sad voice, referring to what the voice would sound like if the score in the orb would be low.

Chapter 8: Discussion

This chapter will first summarise and discuss the findings of the project. Then, some of the limitations of this project and its research will be discussed and it will make some recommendations for future avenues of research. Finally, it will conclude this graduation project report.

8.1: Findings

At the start of this project a main research question was formulated:

> How can demotivation to be physically active be addressed effectively for older adults?

State-of-the-art analysis of current systems and methods to get people more active suggests that there is a relation between the adaptability of such a system to the user and the labour required by health professionals. Through literature research the personal lifestyle intervention was identified as an effective method to address demotivation to be physically active. A method which fully adapts to the patient but requires much labour from health professionals. Two expert interviews revealed two more methods they use to address physical activity demotivation:

- Provide frequent reminders that the user should be physically active
- Provide an external incentive to be physically active

In an effort to create a system that could decrease the amount of labour needed by health professionals for a personal lifestyle intervention as well as integrate these other two methods a concept was created. An orb that tracks the user's physical activity goal with a voice that the user has to take care of through completing that physical activity goal. This physical activity goal can be adjusted based on the personal lifestyle intervention. A prototype of this concept was then created to be used for evaluating the concept with user testing to see if this concept could be proposed as an answer to the research question.

The first result from the evaluation that should be discussed concerns first evaluation session. Expert Three explained that the concept would not be suited for users with dementia due to complexity. The evaluation done in this session together with comments from Expert Three also showed that the concept in its current form is too hard to understand for older adults not familiar with using technology.

The results from the other evaluation sessions will be used for the rest of this evaluation. The participants from session two to four will be considered. Looking at these results, the usability of the prototype was rated high across the board. Every Likert-scale question was rated positive or very positive apart from one answer.

The rest of the evaluation sessions examined the efficacy of the concept. Every participant, including Expert Three said that they believed the concept could increase physical activity motivation for older adults. Two out of the four participants answered that they would use the concept if it was a real product. All four participants indicated they would feel accomplished after banking their activity into the orb. All four participants also answered they would like to have the orb in their home, meaning they enjoyed the look of the orb.

Thus, the results of the evaluation sessions can be summarised in two conclusions:

- The current concept is not suited for use by users who are not used to interacting with technology
- There is evidence that older adults of good cognitive ability could benefit from the concept in a finished form.

Placing these results in the context of the reviewed literature, this project could be suggested as a solution to the problem that occurs during motivational development as described by Maltby and Day [5]. They explain how lifestyle motivation develops from external motivation to internal motivation over time, where the external motivation phase is often experienced as unpleasant. This makes some people quit improving their lifestyle within the external motivation phase and end up with negative connotations towards physical activity and lifestyle improvement. By providing a more fun external incentive, this concept makes the external motivation phase more bearable for the user. The concept can make it so this development from external to internal motivation proceeds more pleasantly and as a result allows more people to go through with it and become more physically active.

Furthermore, this concept also plays into the personal responsibility to take action and stay active as described by Narkauskaitė-Nedzinskienė et al. [9]. This responsibility is not placed on taking care of the person themselves however, but on the wellbeing of the voice. Taking care of the voice instead of themselves brings that responsibility into play in a different way, giving a different reason to the user to be physically active while still calling upon that feeling of responsibility.

Finally, this project conducted similar research compared to Kleinke *et al.* [11], where both studies looked at decreasing the work load required for the personal lifestyle intervention by delivering some parts of it autonomously. Both studies conclude similarly that there is evidence using the personal lifestyle intervention in this way can work, although neither study finds statistically significant results.

Considering the state-of-the-art, more specifically the graph plotted at the end in figure 11, this concept is does succeed in decreasing the amount of labour required by health professionals when performing the personal lifestyle intervention. By taking the job of reminding their patients out of their hands they do not have to check up on their patients so often. They also can be more sure that the patient does the exercise. It also remains fully adaptable, the exercises can be fully personalised. In that extent, this concept does move the personal lifestyle intervention ever so slightly over to the left of the graph in figure 11, into the red area marked for this project. This means it does bypass the suggested relationship between degree of adaptability and amount of labour required by health professionals.

What has become clear at the end of this project is that the older adults in question, those who struggle to motivate themselves to be physically active, can be helped. As much as they may not like to hear it due to a negative disposition towards physical activity, there are methods out there that can get them to go for a short walk each day when they have a hard time getting themselves to go for that walk right now. Through the personal lifestyle intervention, reminders and outside incentives, these older adults can become more physically active. This project provides a concept of a tool that can do this and finds evidence of its effectiveness. In that way, it provides some perspective for the older adults who struggle with physical activity motivation as well as for the health professionals. The former can find that motivation, and the latter can have its workload

decreased. Either way, for the sake of the older adults in question it is critical that we investigate this. That we look for ways to apply these methods and get these older adults active. To keep them on their feet both mentally and physically for as long as possible.

8.2: Strengths & Limitations

The largest strength of this project lies in the expert interviews. These interviews provided insight into the workings of health professionals and how they approach older adults struggling with physical activity motivation. Their methods acted as a cornerstone for the concept and gave it real potential to help older adults. They also reaffirmed the personal lifestyle intervention as an effective but labour intensive method, lending further credibility to the literature review conclusions and showing that problem does really exist in the real world and experts run into it.

One more strength worth mentioning is the graph at the end of the state-of-the-art section (figure 11). It suggest a novel relation between two factors that offers a unique way to analyse the state-of-the-art and shows where the goal of this project was going to be.

Discussing the limitations, it would be appropriate to begin with the evaluation chapter. While there is evidence for the statements at the end of the chapter, the relatively low amount of participants means the conclusions are not based on much data. The conclusions are not strong in that sense, although the evaluation was qualitative in nature as apposed to quantitative.

A similar limitation can be seen in the expert interviews. While the interviews resulted in two requirements that both experts independently agreed on, it is only two experts. Speaking to more experts may have solidified certain requirements, brought up new ones or put in question others.

The prototype could have also tested more of the envisioned features. It only focussed on the banking experience which is the most essential interaction part, but it did not incorporate the feature where the assistant would say something when the user would walk past. This would have resulted in a more well-rounded evaluation of the concept.

Another prototype limitation was the audio implementation. While the dissected MP3 player served its purpose, it limited the audio output to just one track. If a more robust solution had been used for this multiple audio clips could have been played and that could have given the participants a better feel for the vibe the assistant was going for. It also proved unreliable. During the first and last evaluation sessions it refused to play the audio, although during the last session the participants did get to hear the audio through a back-up switch. It seemed the MP3 player was not getting activated properly. This possibly has to do with the transistor setup since the transistor does not act as a perfect switch in this resistor configuration. The correct resistors were not on hand and it did work in closed testing scenarios, but apparently not reliably. Looking at using a relay as a switch instead could alleviate this issue and achieve galvanic separation in the process which is always better for audio setups. This could also be heard in the current prototype, where the speaker produced a low hum whenever the prototype was turned on.

The prototype limitation that proved the most confusing for the older adults in the care home turned out to be the use of the RFID-keychain as a placeholder for the step counter. This proved too complex, possibly using a dummy smartwatch for this purpose would have gotten the point across better.

Then, the personal lifestyle intervention should be mentioned. While the final concept does have the ability to integrate into it and reduce its labour intensive nature, it has also brought on other tasks.

The focus on the personal lifestyle intervention was lessened and as a result it does not have the impact on it that health professionals may desire.

8.3: Recommendations for Future Work

The mentioned limitations leave some explorable research avenues on the table for future research. The most notable being a more thorough user test. Testing the prototype with more participants could lend some more credibility to the conclusions. Furthermore, by either adapting the prototype with less complex features the concept could be tested for older adults inexperienced with technology or even older adults suffering from dementia. To expand on this, it could prove valuable to set up a sister study looking exclusively at what patients with dementia need to get them to be more active. This information could then be used to adapt the concept laid out in this report or create a new one altogether. One possible solution suggested during the presentation of this project was to make the orb sync physical activity data in the background and have it serve as an activity meter for health personnel in care homes. Showing how much the person in question has moved that day could help care-takers get a better understanding of what a person needs on a given day.

If new tests for the current concept are to be done, the prototype also needs some refinements. The audio needs a more robust implementation. This may mean switching the prototype over to the Raspberry Pi platform since it offers more options and capabilities in the area of audio. The glass orb should also be looked at. As described at the end of chapter 6, initially the prototype was built using a translucent glass orb. This is also what is envisioned for the final concept. However during prototyping this orb fractured the light so much it became impossible to see what light sections were lit. The orb became one large RGB lightbulb instead of multiple layers of lights. Thus, for the prototype the switch was made to a fully transparent version of the orb. This worked for the prototype, but made it look less complete and did not accurately represent what the concept was going to look like. Instead, for a new version of the prototype a new orb could be selected with translucent glass but which does not dilute the light as much. Alternatively, one could look at placing dividers in-between the LED ‘strips inside the orb that reach almost to the end of the orb. This would give each LED-strip its own distinct light channel and might keep them from contaminating other light channels. A rough sketch of the prototype with and without these dividers can be seen in figure 30.

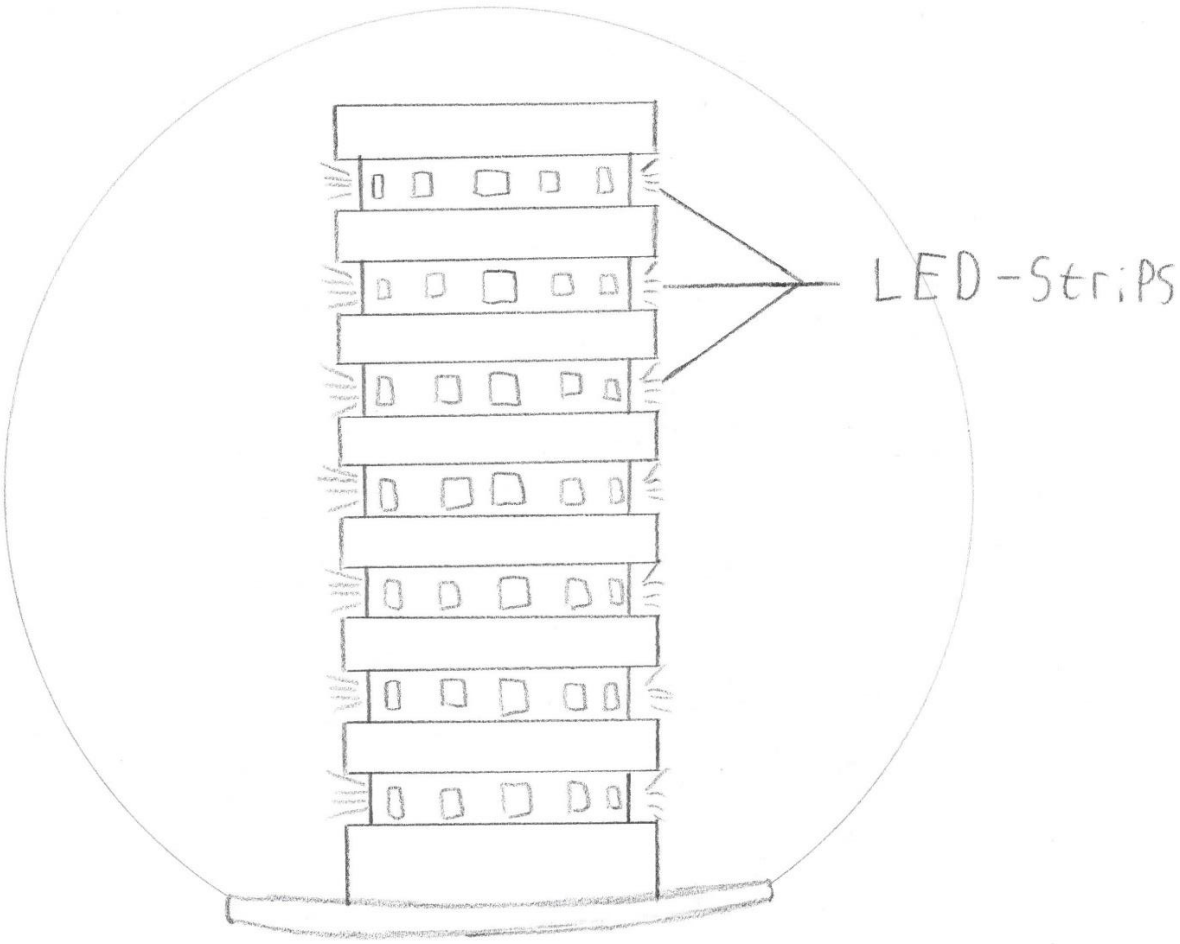

Figure 30a: Prototype without dividers

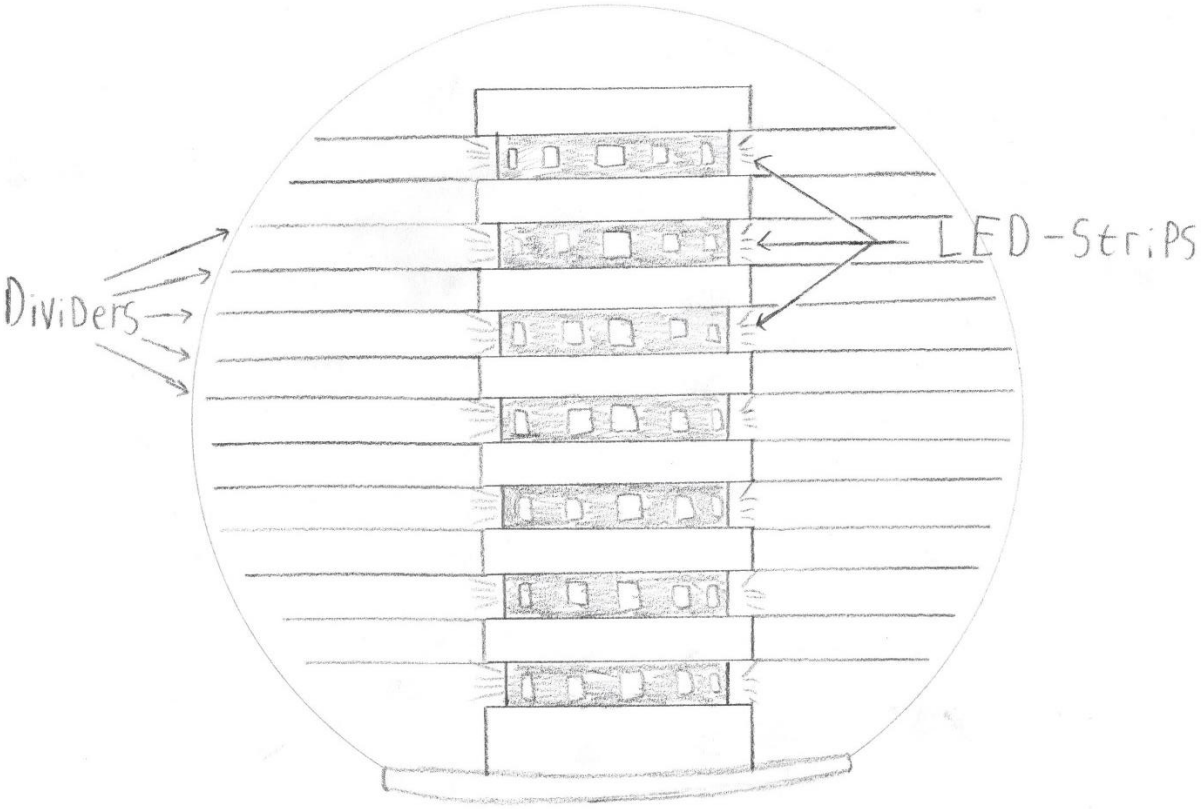

Figure 30b: Prototype with suggested dividers

In this way the dividers channel the light so the LED-strips are projected onto the inner surface of the orb and possibly give off the desired effect. While in figure 30b these dividers are razor thin, they can be made thicker. The challenge here would be to get them into the orb since the hole at the bottom of the orb is smaller than the diameter of most of these dividers. This means fashioning them out of a flexible material, for the prototype this could be paper discs.

It could also be possible to apply the concept to different age groups. While the subject of this project was older adults, the end concept is by no means exclusive to them. It does not feature anything that caters specifically to older generations in such a way that it becomes unusable for younger people. Every generation has members who struggle to get themselves active and this concept may well work for different age groups too. Possibly adapting it by introducing smart integration with smartphones or smart home platforms since these technologies are more common in younger generations.

One more avenue of future research that could end up being very informative is the verification of the two requirements that came out of the expert interviews (giving reminders and offering an outside incentive). Possibly by asking more experts what they think of these requirements and if they have any others to share a refined list of requirements could be made that solutions to help older adults motivate themselves for physical activity. This could then be used to develop different concepts based on these requirements to see what forms of solutions older adults prefer. The orb used in this project is only one possible permutation of the combination of the two requirements and the integration of the personal lifestyle intervention, but there are many more.

Lastly, the personal lifestyle intervention is also good to mention. This project picked up other tools and methods along the way to create a concept more focussed on motivating physical activity than

just the personal lifestyle intervention. While this project does play into it, looking into a solution based entirely on the idea of making the personal lifestyle intervention less labour intensive for health professionals could make a big difference. This would also need interviews with experts who regularly use it to get a good idea of what costs them the most amount of time.

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Appendix A: Expert Interview Informed Consent Form

Beste Expert,

Dit document dient om u te informeren over het verloop en de procedures van dit gesprek. Het gesprek zal ongeveer 30 minuten duren en betreft ouderen die moeite hebben zichzelf tot fysieke activiteit te krikgen. De audio van dit gesprek zal worden opgenomen en de onderzoeker zal aantekeningen maken. De informatie die door middel van dit gesprek verkregen wordt zal gebruikt worden als inspiratie voor het ontwikkelen van een prototype om ouderen te helpen actiever te worden. Dit is onderdeel van een afstudeerproject voor de studie Creative Technology en de informatie die u vertrekt in dit gesprek zal ook in het verslag van dit project komen te staan.

Uw medewerking aan dit gesprek is volledig vrijwillig. Mocht er tijdens het gesprek iets opkomen wat u zich om wat voor reden dan ook niet wil beantwoorden kan u dit laten weten en dan zal het onderwerp gepasseerd worden. U staat ook vrij om voor, tijdens of na het gesprek zonder reden uw medewerking stop te zetten. Als er op dat moment informatie is afgenomen zal die worden verwijderd.

Alle informatie die u verstrekt zal volledig anoniem gepresenteerd worden. Persoonlijk identificeerbare informatie zoals uw naam zal alleen beschikbaar zijn voor de onderzoeker en de supervisor en 66ddles66 lobserver van dit project. Dit geld ook voor de audio-opnames. Het verslag zal geen identificeerbare informatie gebruiken, alleen uw functie zal genoemd worden. Het verslag kan uw uitspraken als quotes gebruiken, maar zal deze anoniem presenteren.

De audio-opnames en de aantekeningen van dit gesprek worden veilig opgeslagen en na afloop van dit project rond juli 2022 verwijderd. Mocht u naderhand nog vragen of opmerkingen hebben over het gesprek of het onderzoek kan u de onderzoeker bereiken op a.w.kotte@student.utwente.nl en de supervisor van dit project op femke.nijboer@utwente.nl.

Als u het bovenstaande heeft gelezen kan u hieronder de drie stellingen langs gaan en uw toestemming aangeven.

- Ik geef toestemming dit gesprek opgenomen wordt en dat de onderzoeker aantekeningen zal maken.
- Ik geef toestemming dat de informatie uit dit gesprek gebruikt zal worden als inspiratie voor het ontwikkelen van een prototype en anoniem verwerkt zal worden in een afstudeerverslag.
- Ik geef toestemming dat uitspraken die ik doe in dit gesprek anoniem als quotes gebruikt kunnen worden binnen een afstudeerverslag.

Handtekening Expert Handtekening onderzoeker

---------- ----------

Appendix B: Brainwriting Template

Date: _____ **Started With**:_____

The requirements for ideas are:

- It is easy to use, also for older adults
- It offers an outside incentive for the user to motivate certain behavior, i.e. physical activity but that does not have to be mentioned explicitly.
- It offers a reminder to partake in that behavior
- It does not overwhelm the user with health data
- It does not heavily penalize not doing certain behavior

ROUND 1

Idea 1:

Idea 2:

Idea 3:

ROUND 2

Idea 4 / Expands Idea___:

Idea 5/ Expands Idea___:

Idea 6 / Expands Idea___:

ROUND 3

Idea 7 / Expands Idea___:

Idea 8 / Expands Idea___:

Idea 9 / Expands Idea___:

Appendix C: Arduino Code

```
/*
  Created by: Ard Kotte
  Title: GPArduinoCode

  RFID code based on example by Rui Santos:
https://randomnerdtutorials.com/security-access-using-mfrc522-rfid-reader-with-arduino/

  RFID Pinout: RST = 9; IRQ = UNUSED; MISO = 12; MOSI = 11; SCK = 13; SDA = 10;
*/

#include <SPI.h>
#include <MFRC522.h>
#include <FastLED.h>

//RFID Pins
#define SS_PIN 10
#define RST_PIN 9

//LED Pins and parameters
#define DATA_PIN    7
#define NUM_LEDS    49
#define BRIGHTNESS  1
#define LED_TYPE    WS2812B
#define COLOR_ORDER GRB
#define UPDATES_PER_SECOND 100
int NumLeds = 49;
int row = 3;
int CurrentBrightness;
int red = 55;
int green = 235;
int blue = 255;

int transistorPin = 2;  //Set the pin that controls the MP3 Player
bool voice = false;

int buzzerPin = 6;  //Set the pin that controls the RFID Buzzer

MFRC522 mfrc522(SS_PIN, RST_PIN);   // Create MFRC522 instance.

CRGB leds[NUM_LEDS]; //Define the LED array

void setup() {
  Serial.begin(9600);   // Initiate a serial communication
  SPI.begin();      // Initiate  SPI bus
  mfrc522.PCD_Init();   // Initiate MFRC522
  FastLED.addLeds<LED_TYPE, DATA_PIN, COLOR_ORDER>(leds, NUM_LEDS);
//Initiate the LED strip
  FastLED.setBrightness(BRIGHTNESS);  //Set LED brightness
  pinMode (transistorPin, OUTPUT);
  digitalWrite (transistorPin, LOW);
  pinMode(buzzerPin, OUTPUT);

}
void loop() {

  CurrentBrightness = FastLED.getBrightness();
  //Turn on all the appropriate LEDs
```

```
  for (int i = 0; i <= (row * 7) - 1; i++) {
    leds [i] = CRGB (red, green, blue);
    FastLED.show();
  }
  //Increase the brightness of the LEDs if its low with a quadratic
equation
  if (CurrentBrightness != 255) {
    for (int i = -225; i <= 0; i++) {
      float brightnessUp = -0.005 * pow(i, 2) + 255;
      FastLED.setBrightness((int)brightnessUp);
      FastLED.show();
      delay(6);
    }
    //Keep the voice playing
    if (voice == true) {
      delay(3500);
      digitalWrite (transistorPin, LOW);
      voice = false;
    }
  }

  // Look for new cards
  if ( ! mfrc522.PICC_IsNewCardPresent())
  {
    return;
  }
  // Select one of the cards
  if ( ! mfrc522.PICC_ReadCardSerial())
  {
    return;
  }
  String content = "";
  byte letter;
  for (byte i = 0; i < mfrc522.uid.size; i++) //Create the RFID hex string
  {
    content.concat(String(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " "));
    content.concat(String(mfrc522.uid.uidByte[i], HEX));
  }
  Serial.println();
  Serial.print("Message : ");
  content.toUpperCase();
  if (content.substring(1) == "B9 A6 57 C1") //Only if the RFID hex string
is identical to the one of the keychain, increase the LED strip count and
play the voice
  {
    //Play the card read confirmation sound
    tone(buzzerPin, 400);
    delay(100);
    tone(buzzerPin, 900);
    delay(120);
    noTone(buzzerPin);
    //Turn on the MP3 player
    digitalWrite(transistorPin, HIGH);
    delay(50);
    //Lower the brightness of the LEDs with a quadratic equation for a
nicer effect
    for (int i = 0; i <= 224; i++) {
      float brightnessDown = -0.005 * pow(i, 2) + 255;
      FastLED.setBrightness((int)brightnessDown);
      FastLED.show();
      delay(6);
```

```
    }
    row += 1; //Increase the amount of lit rows by one
    voice = true; //Keep the voice playing
    //If the color of the LEDs is still cyan, mak it more green. Green is
only reached after the keychain has been scanned twice
    if ( blue > 25) {
      blue -= 115;
    }

  }
}
```

Appendix D1: Information Brochure and Research Procedures

Thank you for your interest in this research! This brochure will inform you of the different goals and procedures that lie at the basis of this research project. Please read it carefully.

Goals

This research project concerns older adults who have trouble getting physically active. They know basic physical activity like going for a short walk everyday would be good for them, but still, for whatever reason, they struggle to actually do it. If you think you fit that description to some degree, great! Please keep reading! The goal of this research is to evaluate a prototype tool meant to help these people to consistently go for that walk. What this prototype will be exactly is yet to be determined. However, it will be a stationary device, its dimensions will fit between a coffee mug and a plant pot. The prototype will either have a touch-sensitive area or a few buttons for some simple input and will communicate with the user through audio-visual feedback. Below you can read the procedure this research will follow to perform the evaluation.

Procedures

The preferred location of the research will be at your place of living, although if you do not want this or prefer another location this can be arranged. Participation is voluntary, so it will not be rewarded. The research will be conducted in three phases. Phase one is meant to evaluate the usability of the prototype. First, you will be given an explanation of the workings of the prototype. Then, you will be asked to interact with the prototype through the input means it has, which will either be a touch sensitive area or buttons. Upon this interaction the prototype will give a response through audio and visual feedback. Throughout this interaction you will be asked to articulate any thoughts surrounding the prototype and what it is trying to communicate to you, i.e. thinking out loud. The researcher will note this down.

Phase two is a short interview to ask you what you think of the prototype. Anything you think should be there and is missing or should not be there, if you think this is a direction that could help you be more physically active. The interview will also touch more broadly on your views on the topic of physical activity.

Phase three will ask you to fill in a short survey. This will ask you questions about the prototype and its functions. The questions will be in the form of Likert scale questions where you will be given a question or statement and asked to answer it on a scale of five levels. As an example, one question could be to rate the following statement: "*I see myself using this tool in the future.*", with answers being: "*Strongly disagree – Agree – Neither agree nor disagree – Agree – Strongly agree*" The questionnaire will also contain a couple of open questions.

Below is a table depicting the entire research procedure, including a short introduction and debriefing. The total research time will be between 45 and 60 minutes.

Activity	Time
Introduction, see and introduce the prototype	5 minutes
Phase 1: Interact with the prototype while thinking out loud	10 minutes
Phase 2: Interview about the prototype and physical activity	15 minutes
Break	10 minutes
Phase 3: Filling in the questionnaire	10 minutes
Closing information and debriefing	5 minutes

Contact Info

Does this sound like something you would like to help with? Please contact the researcher at a.w.kotte@student.utwente.nl and we'll get in touch to finalise recruitment, including an informed consent procedure, and planning to conduct the research.

Appendix D2: Informed Consent Form

Dear participant,

The goal of this research is to evaluate the usability and effectiveness of a prototype tool which aims to address demotivation to be physically active for older adults. To perform this evaluation, the prototype will be subject to user-testing, performed in three phases. Phase one will assess the usability. The prototype will perform a function and you will be asked to shortly interact with it while saying out loud what you think the prototype is trying to communicate to you. This will take around 10 minutes. Phase two will be a semi-structured interview about the prototype and physical activity. This will take around 15 minutes. Part three is a short questionnaire with both Likert scale and open questions concerning the prototype. Filling this in will take around 10 minutes. The research will also introduce the research beforehand, offer a break after part 2 and a debriefing bringing the total research time to 45-60 minutes.

Participation is voluntary and will not be rewarded. You will not face any risks to you physical or psychological well-being. The research will refrain from discussing potentially distressing or emotionally charged topics, however if you feel uncomfortable discussing certain parts of this research or do not want to answer certain questions, you can indicate this and it will not be discussed. Furthermore, if you feel you would like to be excluded or withdraw from the research before, during or after you have provided your input, this can be indicated without explanation and all data collected up until that point will be removed from the research and erased. This will not impact you negatively. The preferred location of the research is at your place of living, however if this is in any way not your preference please indicate this and the researcher will look at alternative locations.

This research will collect your name, age, responses to the three phases of the research and researchers notes. This information will be kept confidential and will only be shared within the research team, namely the main researcher, the supervisor and the critical observer. All data used in the report will be anonymised, including quotes and nothing will be traceable to you or your participation. After the research has concluded around July of 2022 the data will be erased.

If any unclear points or points of critique come up surrounding the data collection before, during or after the research, participants can contact the researcher at a.w.kotte@student.utwente.nl, the research supervisor Femke Nijboer at femke.nijboer@utwente.nl or the Ethics Committee Information and Computer Science at ethicscommittee-cis@utwente.nl.

If the above is clear, please go through the questions below and tick the “yes” box only if you fully understand and agree with what the questions states.

Consent Form for Motivating the Unmotivated: Older adults and physical activity

YOU WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
I have read and understood the study information dated [DD/MM/YYYY], or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	○	○
I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	○	○
I understand that taking part in the study involves interacting with a prototype, answering interview questions about said prototype and physical activity and filling in a questionnaire.	○	○
Use of the information in the study		
I understand that information I provide will be used for a graduation project report.	○	○
I understand that personal information collected about me that can identify me, such as [e.g. my name or where I live], will not be shared beyond the study team.	○	○
I agree that my information can be quoted in research outputs	○	○

Signatures

_____ _____ _____

Name of participant [printed]

I have accurately read out the information sheet to the potential participant and, to the best of my ability, ensured that the participant understands to what they are freely consenting.	○	○

_____ _____ _____

Researcher name [printed] Signature Date

Study contact details for further information:

Researcher: Ard Kotte

Contact: a.w.kotte@student.utwente.nl

Supervisor: Femke Nijboer

Contact: femke.nijboer@utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee Information & Computer Science: ethicscommittee-CIS@utwente.nl

Appendix E: User Testing questionnaire in Dutch

Hieronder staan een aantal vragen over het prototype wat u net heeft gebruikt en wat over heeft gehoord om door u beantwoord te worden. Probeer alle vragen te beantwoorden, maar als u een vraag niet wil beantwoorden mag u die overslaan. Bij veel vragen zult u gevraagd worden te kiezen uit een aantal antwoorden, hier zal een sterretje bij staan. Kies hier het antwoord wat u het beste vindt passen. Bij vragen zonder sterretje mag u zoveel opschrijven als u wil. Vul om te beginnen eerst uw naam en leeftijd hieronder in.

Naam:_____ Leeftijd:_____

Deel 1: Gebruiksvriendelijkheid

***Vraag 1: Hoe makkelijk was het bedienen van het prototype?** (Omcirkel het antwoord wat u het beste vindt passen)

Erg moeilijk	Moeilijk	Makkelijk nog moeilijk	Makkelijk	Erg Makkelijk

***Vraag 2: Hoe duidelijk was het dat het prototype uw sleutelhanger had gelezen?** (Omcirkel het antwoord wat u het beste vindt passen)

Erg onduidelijk	Onduidelijk	Duidelijk nog onduidelijk	Duidelijk	Erg duidelijk

Vraag 3: Wat dacht u dat het prototype duidelijk wilde maken met de extra lampjes en de stem die wat zei? (Vul hieronder in)

***Vraag 4: Het prototype probeerde te laten zien dat u met uw activiteit een meter bijvulde en dat de stem daar blij van werd. Hoe duidelijk was dat voor u?**

(Omcirkel het antwoord wat u het beste vindt passen)

Erg onduidelijk	Onduidelijk	Duidelijk nog onduidelijk	Duidelijk	Erg duidelijk

***Vraag 5: Hoe klonk de stem?** (Omcirkel het antwoord wat u het beste vindt passen)

Erg onvriendelijk	Onvriendelijk	vriendelijk nog onvriendelijk	Vriendelijk	Erg vriendelijk

Vraag 6: Heeft u nog andere opmerkingen, plus- of minpunten over het prototype en het gebruik van het prototype? (Vul hieronder in)

Deel 2: Scenario

Voor de vragen in dit deel krijgt u een kort scenario te lezen over gebruik van een verder ontwikkelde versie van het prototype. Deze versie van het prototype kan alles wat ook eerder besproken is, zoals dingen zeggen als u langs de bol loopt en veel verschillende dingen zeggen als u uw activiteit inscanned. Ook is het glas van de bol voor deze versie minder doorzichtig zodat de elektronica niet te zien is.

Scenario: U heeft sinds kort de glazen bol in gebruik genomen. De glazen bol staat in de hoek van uw kamer, alleen de onderste twee strookjes met lampjes staan aan. Dit betekent dat u de afgelopen paar dagen relatief weinig actief bent geweest.

***Vraag 7: Stel, u kijkt naar de bol en u ziet dat er maar twee strookjes met lampjes aan staan. Zou u dan sneller besluiten om iets actiefs te gaan doen?**
(Omcirkel het antwoord wat u het beste vindt passen)

Absoluut niet	Nee	Neutraal	Ja	Zeker

***Vraag 8: Stel, het zien van de twee lichtstrookjes haalt u nog niet over om naar buiten te gaan. Even later loopt u langs de bol en daarop zegt hij het volgende:" *Hey, ik begin echt leeg te raken dus zou je alsjeblieft even naar buiten kunnen gaan?*". Zou u na zo'n uitspraak van de bol sneller besluiten iets actiefs te gaan doen?** (Omcirkel het antwoord wat u het beste vindt passen)

Absoluut niet	Nee	Neutraal	Ja	Zeker

***Vraag 9: Stel, wat de bol zei haalde u wel over om naar buiten te gaan. U loopt een rondje van een minuut of 20, en als u weer thuis komt laat u uw stappenteller scannen door de bol. Zodra u uw stappenteller scant gaan de lichtjes even uit, gaan ze weer aan in een groenere kleur en is er een strookje bij gekomen. Daarop zegt de bol:"*Zooo, dat voelt een stuk beter zeg, dankjewel!*". Hoe zou u zich hierna voelen over het rondje wat u net heeft gelopen?** (Omcirkel het antwoord wat u het beste vindt passen)

Erg onvoldaan	Onvoldaan	Neutraal	Voldaan	Erg voldaan

***Vraag 10: Stel, u wordt de volgende dag wakker en ziet dat het derde streepje wat gister aan is gegaan door het rondje wat u heeft gelopen al weer bijna uit staat. Zou u daarop sneller besluiten om iets actiefs te gaan doen?** (Omcirkel het antwoord wat u het beste vindt passen)

Absoluut niet	Nee	Neutraal	Ja	Zeker

Deel 3: Concept

U heeft vandaag een hoop gehoord over het concept van de glazen bol. Deze vragen gaan over een wat bredere kijk op het concept.

***Vraag 11: Zou u de glazen bol graag in uw kamer hebben staan, oftewel zou u hem mooi vinden in uw kamer?** (Omcirkel het antwoord wat u het beste vindt passen)

Absoluut niet	Nee	Neutraal	Ja	Zeker

Vraag 12: Wat zou u veranderen aan het uiterlijk van de bol? (Vul hieronder in)

***Vraag 13: Zou u de bol gebruiken als het een bestaand product was?** (Omcirkel het antwoord wat u het beste vindt passen)

Absoluut niet	Nee	Neutraal	Ja	Zeker

Vraag 14: Waarom wel of niet? (Vul hieronder in)

***Vraag 15: Zou u de bol fijn vinden om te gebruiken?** (Omcirkel het antwoord wat u het beste vindt passen)

Absoluut niet	Nee	Neutraal	Ja	Zeker

Vraag 16: Waarom wel of niet? (Vul hieronder in)

***Vraag 17: Zou de bol u motiveren om iets vaker actief te zijn?** (Omcirkel het antwoord wat u het beste vindt passen)

Absoluut niet	Nee	Neutraal	Ja	Zeker

Vraag 18: Waarom wel of niet? (Vul hieronder in)

***Vraag 19: Zou u het fijn vinden om de stem van de bol een aantal keer per dag te horen?** (Omcirkel het antwoord wat u het beste vindt passen)

Absoluut niet	Nee	Neutraal	Ja	Zeker

Vraag 20: De stem zou aangepast kunnen worden op uw voorkeuren. Bijvoorbeeld door hem meer of minder serieus te laten klinken of door bepaalde accenten te geven. Denk aan een Vlaams, Amsterdams of Gronings accent. Wat zou u aanpassen aan de stem denkend aan dit soort voorbeelden? (Vul hieronder in)

Vraag 21: Heeft u nog andere opmerkingen, gedachtes, punten van kritiek of dingen die u denkt dat het concept goed doet? Laat hier alles achter wat u nog graag zou zeggen over het concept en het prototype. (Vul hieronder in)