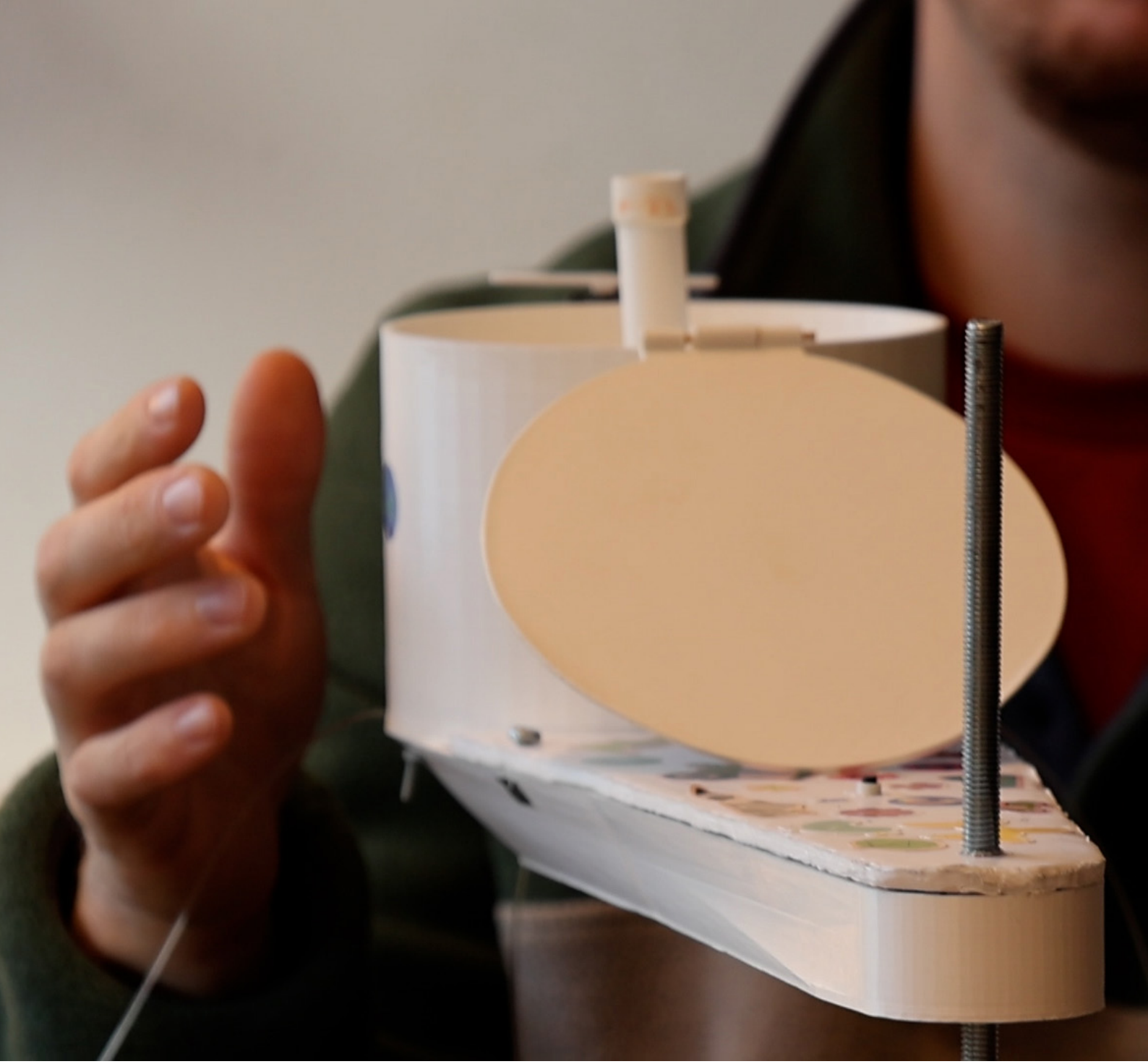


LEDEMAATJE

Sparking physical activity among older adults living with intellectual disabilities

Sophie de Blanken

Master Thesis
Integrated Product design
Delft University of Technology

November 2024

Ledemaatje: Sparking physical activity among older adults living with intellectual disabilities

Master Thesis Integrated Product Design
Faculty of Industrial Design Engineering
Delft University of Technology

Auteur
Sophie de Blanken

TU Delft supervisors
Dr. J.J Kraal (chair)
Dr.ir. M.H. Sonneveld (mentor)

External supervisors
Dr. A. Oppewal
Leerstoel Geneeskunde voor Verstandelijk Gehandicapten,
Afdeling Huisartsgeneeskunde, Erasmus MC

Drs. M. Bunskoek
Fysiotherapeut en lid Expertisecentrum Ouderen,
‘s Heeren Loo

November 2024

PREFACE

With this graduation project, I am closing a long chapter of studying in Delft. After a brief semester of Nanobiology at the other end of campus, I found my way to Industrial Design Engineering. Inspired by products like a spoon that counteracts tremors using camera stabilization technology and a glucose sensor that helps my brother navigate life with diabetes, I realized how small products can have a big impact on someone’s everyday life. However, throughout my studies, I never quite managed to work on a project in this field. So, for my final project at IDE, I set out to find a design case within the medical field focused on user experience. To my surprise, I found myself working on a project unexpectedly close to home. With an older brother (not the one mentioned above) who has a mild intellectual disability and a mother who worked as a caregiver for people with intellectual disabilities, I spent much of my childhood in and around care homes tailored to this demographic. Walking around the locations of ‘s Heeren Loo, therefore, felt oddly familiar.

Despite this personal connection, there was still so much to learn throughout this project, for which I got many people to thank:

First of all, I would like to thank my supervisory team, Jos Kraal and Marieke Sonneveld, for your guidance, constructive feedback, and encouragement. I also want to thank Marije Bunskoek and Alyt Oppewal for welcoming me into your field of expertise and providing valuable advice.

Furthermore, I want to thank everyone living and working at the residency where this project took place. Thank you for opening your home to me and supporting this project. A very special thanks to the residents who collaborated on this project, without whom it would not have been possible. Thank you for being willing to try out my prototypes, mostly consisting of cardboard and duct tape, and for sharing your crucial feedback. I’m also grateful to the caregivers who assisted during the project, especially Bodine, my contact person at the residency, for being so flexible with my planning.

I want to thank my friends Natanya and Kim, who I could always count on for advice. Your support, communication and design for interaction skills were essential for this project and my mental wellbeing. Eline, Lieneke, Teun and Merlijn, with who I was fortunate enough to share various stages of my studies and graduation with. And of course, I want to thank my family for inspiring me and being patient with me throughout my studies.

– Sophie de Blanken

SUMMARY

This project introduces “Ledemaatje,” an interactive product designed to help older adults with mild intellectual disabilities (ID) stay active in a fun, independent way. Physical activity (PA) is essential for one’s well-being, yet barriers like caregiver dependence and limited access often stand in the way for people with ID. Ledemaatje aims to change that by offering a low-barrier, engaging solution that encourages movement and social connection. Developed through participatory design, this project focused on creating an accessible and motivating experience shaped by direct user feedback at every stage.

Research into the context of living with ID and current PA interventions shaped the project’s design goals and criteria, emphasizing autonomy, accessibility, and social engagement. The development phase involved multiple interactive sessions with three older adults with mild ID, living at a residency at the organization ‘s Heeren Loo. Observations and feedback gathered during each session were leading for the design direction of this project. These sessions revealed that performing activities in a group setting were effective in prompting PA but there was still a dependency on external motivation. Further testing focused on understanding user responses to different stimuli, and levels of autonomy,

Ledemaatje’s final design enables semi-autonomous use, allowing residents to interact with the product in a group setting while requiring minimal caregiver support. Ledemaatje uses automated movements, to prompt users to push, pull, and engage with the device, promoting upper-body movements not typically used in daily activities. These interactions are further enriched by sound cues, such as applause, rewarding users and providing a positive interaction experience.

Evaluations with residents and caregiver in a typical residential setting showed that Ledemaatje effectively promotes PA and social interaction. While participants’ motivation varied depending on the task speed and complexity, feedback highlighted the product’s support for resident autonomy and engagement.

In conclusion, Ledemaatje demonstrates the value of user-centered design, providing a low-barrier, enjoyable PA option. Recommendations include refining the product’s automated features to further minimize caregiver involvement and adding adjustable settings to better suit individual capabilities. This project contributes to the development of inclusive, affordable PA interventions for individuals with ID, fostering a more active environment in care facilities.

TABLE OF CONTENTS

1

INTRODUCTION

In this chapter, the project is introduced along with its research aim and scope. Furthermore, the overarching approach and design process is elaborated on.

1.1 PROJECT INTRODUCTION

Older adults with an intellectual disability (ID) are found to have very low physical activity (PA) levels and often have sedentary lifestyles (Hilgenkamp & Oppewal, 2022). PA has been scientifically proven to be a powerful tool in preventing and treating a range of chronic diseases and medical conditions (Oppewal & Hilgenkamp, 2020). In addition, studies show that even a small increase in PA can improve the physical health of those with a sedentary lifestyle. It is especially important to promote more PA among this target group, considering there being a high prevalence of health problems among individuals with ID (Oppewal et al., 2020).

There are a multitude of reasons as to why the level of PA within this population is so low. Individuals with mild ID experience difficulty with conceptual, social and daily living skills (Boat et al., 2015), meaning that they need additional support to live a fulfilling life. As this group is highly dependent on their caregivers, lack of support and accessibility of facilities play an important role in their sedentary lifestyle. Other barriers include motivational issues, lack of awareness of options and financial limitations (Shields et al., 2022; Fjellstrom et al., 2022).

There are a number of interventions created to change the behavior of people with ID with regards to PA. However, these rely heavily on the support of caregivers, making them not accessible for people with ID. Additionally, people with ID are rarely included during the development of these interventions, causing it to not meet the needs and abilities of who it is intended for.

This project is a continuation of the master thesis "Involving older adults with an intellectual disability in the design process of the MakiMove: a modular intervention for stimulating physical activity" by Kim Adriaanse (referred to as Adriaanse (2022) throughout this report) . Her research is used throughout this graduation project, specifically her thorough research into context specific barriers and facilitators for increasing PA, and the insights she gathered while collaborating with people with ID.

The project is supervised by TU Delft and Erasmus MC and is in collaboration with the care organization 's Heeren Loo, who are providing the opportunity to work together with the target group.

's Heeren Loo
's Heeren Loo is an organization that supports individuals with ID through various services, including 24-hour residential care, supported living, day programs, and specialized therapies. They cater to people with varying levels of ID, focusing on independence, quality of life, and social engagement. 's Heeren Loo also collaborates with families and communities to provide access to education, physical activities, and job training, helping individuals with ID lead active, fulfilling lives.

1.2 AIM AND SCOPE

To aim of this project is to create an intervention to increase physical activity for older adults with mild intellectual disabilities living at a `s Heeren Loo residency, by designing a product that allows for a range of different abilities that fits within the daily routine of the residency (see Appendix A).

Individuals with ID are a very diverse group of people with many differences in cognitive and motor abilities, and a diversity of health problems. Therefore, the project will just focus on three residents of `s Heeren Loo that are able to partake in this research.

Moreover, the user should be able to exercise independently, with minimal supervision of the caregivers. As it should not become another burden for the already busy caregivers. Therefore, the product must be accessible and easy to understand for the user, while being challenging enough to keep the user engaged. However, the project does not aim to create a fully independent intervention, as social engagement between residents can be an important motivator for promoting PA.

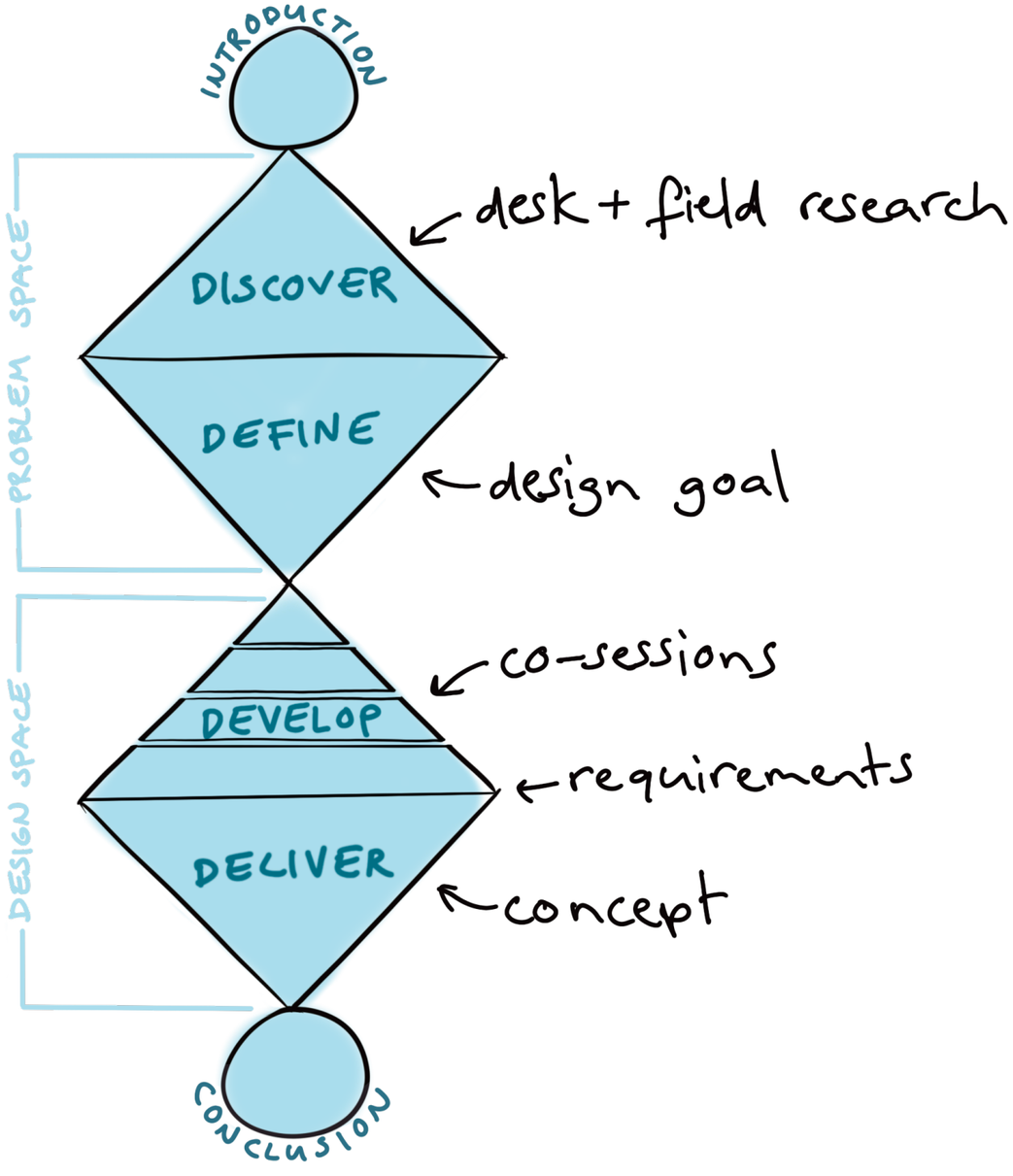
Lastly, it is important to note that it takes time to achieve behavioral change, however, testing the product over a long period of time, is not feasible within the available time frame. Hence, the project will focus more on keeping the user engaged during a session.

1.3 PROJECT APPROACH

The previous study of Adriaans was more exploratory as there is not much knowledge on co-designing with older adults with ID. This resulted in a product concept and, more importantly, tools to facilitate participatory design with this specific target group. With this acquired knowledge, this study will focus more on the creation of a physical product. This will be done through:

Human-centered design
As the target group has totally different life experiences than the designer, it is important to include the intended user to account for experiential consequences. This will be done through participatory design methods such as co-design sessions that suit the abilities of the target group.

Research through Design
The best way to gather insights from people with ID is to let them test out prototypes, as found from previous design projects (Adriaanse, 2022; Anderiesen, 2017; Benton et al., 2012; Maenhout et al., 2022). This is because abstract thinking can be challenging for this target group, whereas prototypes provide tangible aspects to reflect on. With realistic prototypes that allow for freedom in exploration and interaction it is possible to engage in some form of co-design with the intended users.



General Design Process

Phase 1: Discover
This phase consists of doing desktop and field research to get an understanding of the context, the target group and their current situation. In combination with research on ways to include the target group during the project.

RQ 1: What is a mild intellectual disability and how does it affect people's way of living?

RQ 2: What are the effects of PA and what is the situation of PA among people with ID?

RQ 3: What are current methods and products to achieve behavioral change among people with ID?

RQ 4: What are ways that Co-Creation with people with ID be facilitated?

RQ 5: Who are the people partaking in this project and what is their living situation with regards to PA?

Phase 2: Define
During this phase, the key insights of the Discover phase are redefined into this project's problem statement and design goal.

Phase 3: Develop
These phase focuses on working together with residents of 's Heeren Loo to find a solution through multiple session. During this phase both exploration and ideation activities are carried out, using a Research through Design approach to generate solutions based on the insights of the previous session. The key insights of these session are used to define the design requirements.

RQ 6: What motivates the participants to partake in PA?

RQ 7: Which exercises are suitable for all participants within this context?

Phase 4: Deliver
The insights gained during the previous phases are converted into a final design. This design is evaluated with the residents of 's Heeren Loo.

2

GENERAL CONTEXT

The goal for this chapter is to gain insights of the background context of this project by answering the next research questions:

- What is a mild intellectual disability and how does it affect people's way of living?
- What are the effects of PA and what is the situation of PA among people with ID?
- What are current methods and products to achieve behavioral change among people with ID?
- What are ways that Co-Creation with people with ID be facilitated?

These questions were answered through literary research and informal interviews with experts. The findings of these questions will be used to form the design goal for this project, which can be found in Chapter 4.

2.1 INTELLECTUAL DISABILITY

The aim of this chapter is to gain a general understanding of the target group of this project. This will be done by defining what a mild intellectual disability, its implications and exploring challenges that people with mild ID face, concerning self-image and aging.

2.1.1 What is an intellectual disability?

The American Psychiatric Association (2022) defines intellectual disability (ID) as a life-long neurodevelopmental condition, affecting cognitive and adaptive functioning.

Cognitive functioning refers to the ability to learn and problem solve. The level of cognitive functioning is indicated with an IQ-score. The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) states that an IQ-score below 70 can imply an ID (American Psychiatric Association, 2022). In the Netherlands, people with an IQ-score between 70 and 85 still have access to support, if they experience extreme difficulty with learning, behavior, and social competence (Trimbos, 2016).
Adaptive functioning refers to the skills involved in everyday life such as communication skills and social participation (American Psychiatric Association, n.d.). Adaptive functions are divided in three categories:

- Conceptual functions, such as reading, writing and memory.
- Social functions, such as social judgment, communication skills and the ability to follow rules.
- Practical functions, such as personal care, managing money and organizational tasks.

People with ID go through the same stages of life development as everyone else, but at a slower pace, and the level of development they eventually reach is lower (Trimbos, 2016). ID often manifests itself before the age of 22, during what is categorized as the developmental years. There are a variety of causes for ID, such as genetic conditions, complications during pregnancy, complications during birth, or by coming in contact with diseases or toxins at an early age (American Psychiatric Association, n.d.).

2.1.2 Mild intellectual disability

The severity of ID is classified into four different categories: ‘mild’, ‘moderate’, ‘severe’, and ‘profound’ (see Table 2.1).

Initially, there had been a focus on a person’s IQ-score when assessing the severity of ID. This one metric alone, however, is not enough to assess the complexity of how somebody is able to function within society. Therefore, the focus has shifted to the individuals adaptive skills and accessing the level of support they need to function according to their age within the cultural context (American Psychiatric Association, 2022; Kennisplein Gehandicaptensector, 2024). In light of this, mild ID is categorized as needing minimal support to live independently. Individuals with mild to moderate ID can learn practical life skills that enable them to lead a fulfilling life.

According to the (Kennisplein Gehandicaptensector, 2024), there are around 1.1 million people in the Netherlands who are diagnosed with a mild ID. Most receiving some form of long-term support that is focused on enabling personal development and providing personal assistance (Koopman, n.d.-b). Given that people with ID are a large and diverse group of people, support needs differ widely per person. Types of support can range from aid with attending school and finding work to help with understanding official letters and creating routine. The amount of support differs as well, some people with ID need the support of living in a house with full-time caregivers, while others can live on their own with minimal support.

The diversity of needs and conditions is an important aspect to take into account throughout this project. As it is not feasible to create for everyone, the project will evolve around the needs and abilities of a specific group of residents at ‘s Heeren Loo, more information on this can be found in Chapter 3.

Table 2.1: An overview of the severities of ID (American Psychiatric Association, 2022).

Severity Category	Approximate Percent Distribution of Cases by Severity	DSM-IV Criteria (severity levels were based only on IQ categories)	DSM-5 Criteria (severity classified on the basis of daily skills)
Mild	85%	Approximate IQ range 50-69	Can live independently with minimum levels of support
Moderate	10%	Approximate IQ range 36-49	Independent living may be achieved with moderate levels of support, such as those available in group homes.
Severe	3.5%	Approximate IQ range 20-35	Requires daily assistance with selfcare activities and safety supervision.
Profound	1.5%	IQ<20	Requires 24-hour care.

2.1.3 Societal impact on ID

The organization Landelijk Kenniscentrum LVB (2022) states that one of the key challenges people with ID deal with is a negative self-image cultivated by experiences of failure. This is rooted in them having difficulty adhering to the expectations of society. It is common for people to be unaware that someone has mild ID, which causes them to be held to unrealistic expectations. This leads to a lack of understanding from society when these standards are inevitably not met, and ultimately results in people with mild ID being mislabeled as lazy, spoiled, or simply unwilling to cooperate. Besides, ID interferes with people's ability to (self-)reflect, causing them to set unachievable expectations for themselves as well, which results again in feelings of failure (De Wit et al., 2011).

In the podcast 'Studio LVB' made by the health organization 'Middin', people with mild ID are able to share their own experience of living with an ID. Some of them mention the feeling of not being accepted for who they are, and not being able to fit in with others from an early age (Koopman, n.d.-a). This is one of many reasons to diagnose ID early on, allowing people to have access to a support system that can help them deal with these social challenges (Landelijk Kenniscentrum LVB, 2022). Although, even with the right support some still struggle to come to terms with their disability. It is hard to accept that you cannot do the same things as the people around you, such as having a fulltime job or starting a family (Koopman, n.d.-a). Considering the above, it is important to create a positive experience during this project that focuses on what is in people's capabilities and what they are able to achieve.

2.1.4 Aging with ID

Over the years, the expectancy and quality of life of people with ID has increased due to improved healthcare and overall living conditions. However, there are still challenges that older adults with ID face, such as a decreasing social network, keeping up with societal changes and a decline in health (Trimbos, 2016).

Some people with ID have to be taken into elderly or psychiatric care as they get older, even though they previously had been able to live independently. This is often caused by losing support from their environment, developing problems or mental disorders (Trimbos, 2016). Furthermore, the current society is changing rapidly due to technological developments. This makes it harder for people with ID to keep up, especially as banks and governmental institutes are increasingly relying on digital tools (Koopman, n.d.-a).

Research shows a faster cognitive and physical decline among people with ID compared those without. Cai and Beak (2022) state that the physical health of an individual with ID aged 60 years old is comparable with the health of someone who is 80 years old without ID. Additionally, people with down syndrome show an early decline in cognitive abilities such language skills, processing speed, attention, visuospatial and executive functions (Shields et al., 2022).

These factors highlight the increasing importance of promoting good health for older adults with intellectual disabilities. The role of physical activity in improving health is explored in the next chapter.

2.2 PHYSICAL ACTIVITY

This chapter deliberates on the current situation of physical activity (PA) among people with ID. Delving into the importance of PA and the current PA guidelines.

- Why is PA important?
- What are the causes of the low levels of PA?
- How much PA is recommended for people with ID?

2.2.1 Effects of PA for people with ID

The goal of this thesis is to create an intervention that will increase PA in older adults with ID. This section will explain why this is important by elaborating on the effects of PA for people with ID.

The WHO (2020) defines physical activity as "any bodily movement produced by skeletal muscles that requires energy expenditure". In general, PA has been shown to have a positive impact on a person's well-being and quality of life (Diz et al., 2021). Research shows that increased level of PA leads to an increased life expectancy, for the mortality rate of people who are unfit is twice as high as a fit person. For people with ID, the mortality rate of those who are unfit has increased to being even four times higher compared to those who are fit (Oppewal & Hilgenkamp, 2020).

In addition, PA has been shown to treat and prevent chronic diseases and medical conditions (Warburton, 2006). In this regard, increased PA is associated with favorable cholesterol levels, favorable glucose and insulin metabolism, increased anti-inflammatory markers, and lower blood pressure (Gaesser et al., 2011).

This makes it especially important to promote PA, considering there being a high prevalence of health problems and comorbidities among people with an ID (Hilgenkamp & Oppewal, 2022). However, research shows very low PA levels and often have sedentary lifestyles (Dairo et al., 2016).

2.2.2 Facilitators and Barriers for PA

There are a multitude of reasons as to why people with ID have taken to a sedentary lifestyle. Foremost, this group is highly dependent on their caregivers, making caregivers highly influential for the amount of PA. Therefore, a lack of support and limited accessibility of facilities are important factors contributing to the low levels of PA (Bossink et al., 2017). Additional barriers include motivational issues, past negative experiences, lacking awareness of options and financial limitations of both caregivers and people with ID (Shields et al., 2022; Fjellstrom et al., 2022).

A member of the Innovation Team at 's Heeren Loo, who was consulted during this project, also highlighted these issues. They explained that caregivers within the organization are hesitant to seek support beyond their immediate team. This is partially due to limited awareness of available resources and previous negative experiences that have discouraged them from exploring further options. Caregivers also find it difficult to leave their clients in the care of others, as they feel a great responsibility to protect them from negative experiences and potential harm. While this concern is understandable, given that not all sports centers have experience working with individuals with ID, it does limit clients to rely primarily on the expertise and motivation of their caregivers to engage in PA.

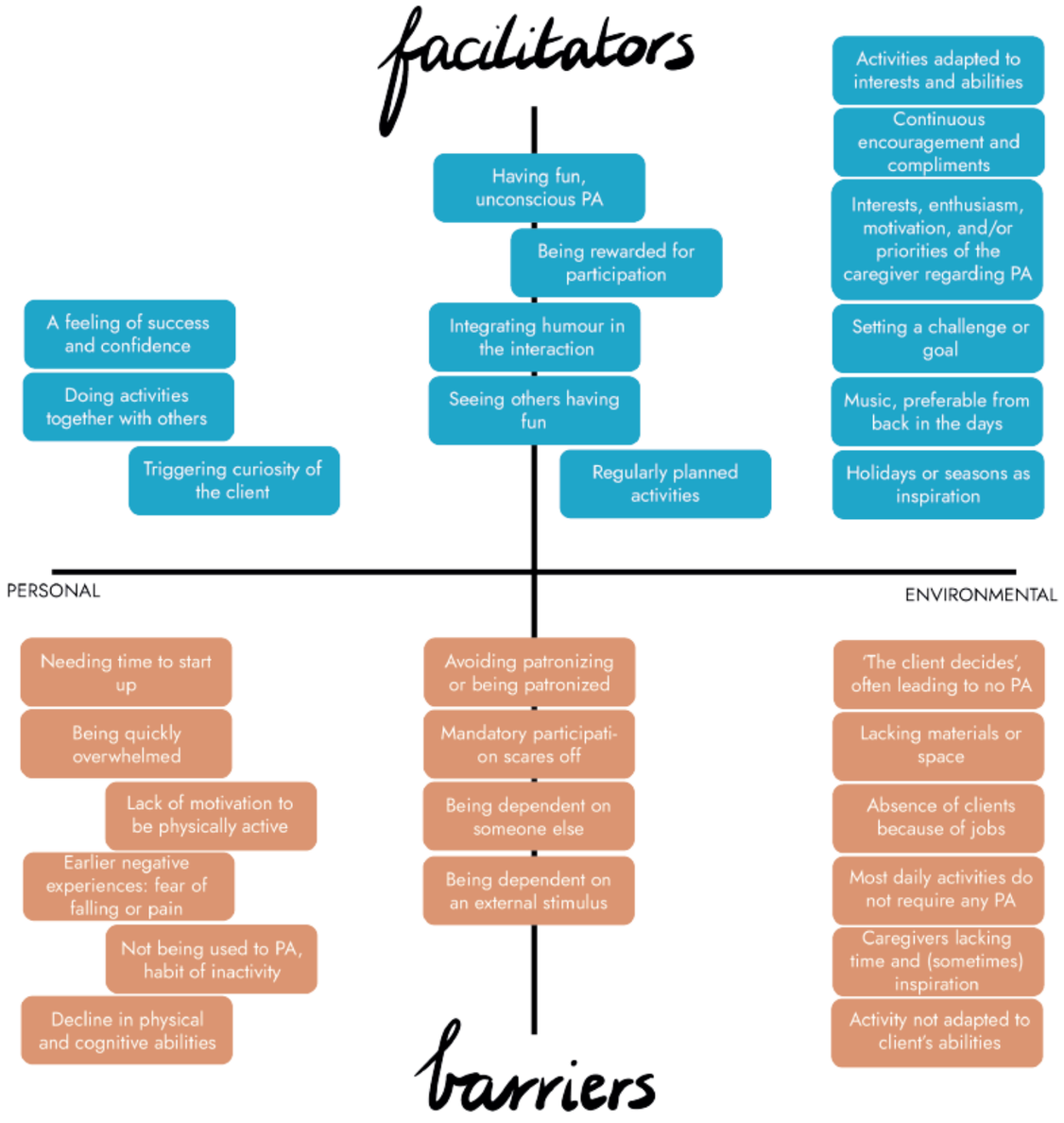


Figure 2.1: Context specific barriers and facilitators (Adriaanse 2022).

On the other hand, factors that help encourage PA behavior include being able to exercise with other people and starting with accessible exercises, such as taking a walk. These type of activities make it less daunting to start exercising and prevent failure experiences that discourages PA in the future (Haarmann et al., 2019). The topic of facilitators will be further elaborated on in Chapter 2.3.2, as part of the discussion on effective intervention implementation.

In the preceding thesis of Adriaanse (2022), she conducted multiple interviews and observations with residents, caregivers and physiotherapist of 's Heeren Loo to further understand the current PA behavior. This has resulted in an overview of context specific facilitators and barriers which can be found in Figure 2.1. Main themes that emerged from this overview include (1) promoting physical activity while respecting individual autonomy, (2) using external motivation and validation to encourage engagement, (3) designing activities that are enjoyable, accessible, and appropriately challenging, and (4) addressing resource limitations that hinder PA initiation.

Given that the research of Adriaanse was conducted in a very similar context to this project, its findings highlight key challenges and opportunities that are relevant in shaping the design goal and requirements for the final design of this project.

2.2.3 PA Guidelines for people with ID

Older adults with ID should follow the same guidelines as the general population. This means that older adults with ID need 2,5 hours per week of moderate intense exercise. Moderate intense exercise indicates activities that cause accelerated breathing and an elevated heart rate (between 50-70% of the max heart rate), while still being able to carry on a conversation (Fjellstrom et al., 2022). These 2,5 hours should be spread out over multiple sessions and in combination with balance, muscle and bone strengthening exercises at least twice per week (Kenniscentrum Sport&Bewegen, n.d.).

However, the previously mentioned guidelines are not made with people with ID in mind, as is a lack of research on the actual effects of these guidelines on this group of people. Granting that there are some indicators that PA is different for people with ID. For instance, there is a high prevalence of gait abnormalities among people with ID (Almuhtaseb et al., 2014). Gait abnormalities causes stress on muscles and joints and forces people to expend more energy while walking, leading to an increase in energy exerted during daily activities (Chambers & Sutherland, 2002). Furthermore, PA has been shown to be even more effective for people with ID, as the minimum amount of PA needed for reduced health risks is much lower than that of the general public (Oppewal et al., 2020).

Considering the problems, the official guidelines have been adapted (Kenniscentrum Sport&Bewegen, n.d.):

1. PA is good, more PA is better.
2. Stand up more often or change position.
3. Add an extra moment of exercise to your day!

These guidelines are formulated so accessible for the target group. As well as being more motivating and stimulating, as it focusses more on what is possible within the context. Taking into account that small changes can lead to noticeable results.

Nevertheless, with these revised guidelines there is still an extra push needed to change the PA levels. The next chapter will explore the subject of interventions and what makes it effective for people with ID.

2.3 INTERVENTION

With the information gathered in the previous chapter, it is now clear that the current level of PA among people with ID needs to change in order to improve their wellbeing. This chapter focuses on understanding how these behavioral changes can be achieved in order to promote a more active lifestyle and evaluating current interventions.

This chapter starts off with a review of current interventions intended to change the PA behavior of people with ID, identifying potential opportunities for this project. Thereafter, the Fogg Behavioral Model is discussed to gain a general understanding of what is needed to achieve a change in behavior. Lastly, the CMOC model is used to establish guidelines for creating an effective intervention for people with ID.

Figure 2.2: Fitbit as individual intervention (Hardy, 2023).

Figure 2.3: Badminton as group intervention (In Beweging, n.d.).

Figure 2.4: Exercise park as communal intervention (Ellemeet Aan Zee, 2021).

2.3.1 Current PA interventions

There are a number of interventions developed to initiate and maintain healthy levels of activity, ranging from individual to community based (LaCaille & Appleseth, 2020).

- Commonly, **individual** interventions focus on tools for setting goals and behavioral self-monitoring, often using devices such as smartwatches (see Figure 2.2) and pedometers to track progress.
- **Group**-based interventions utilize the social context as a motivator, using group exercise programs where people can set common goals and be supported by other (more experienced) members (see Figure 2.3).
- At the **community** level, interventions focus on raising awareness and creating opportunities, targeting a larger audience. Examples of these are information campaigns or the installation of outdoor exercise equipment in communal spaces as shown in Figure 2.4.

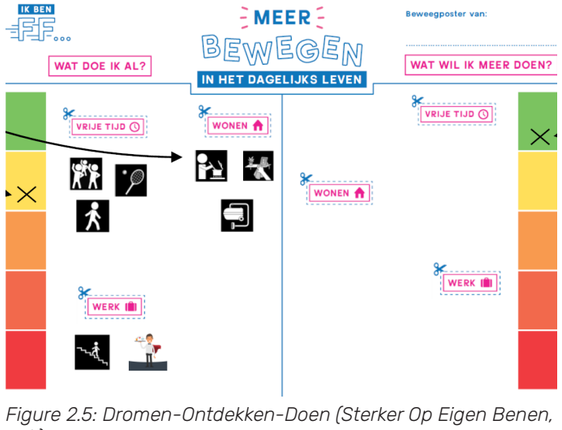


Figure 2.5: Dromen-Ontdekken-Doen (Sterker Op Eigen Benen, n.d.).

Interventions for people with ID
There is a range of PA behavior interventions that are developed specifically for people with ID. In the context of this project, the discussion in this section will focus on intervention products.

There are affordable and accessible products that help to initiate PA, such as 'Dromen-Ontdekken-Doen' (Sterker Op Eigen Benen, n.d.; see Figure 2.5). They provide tools for caregivers to aid it the discussing of PA behavior and to create personal goals with people with ID. Products such as the 'Beweegtas' (Team Sportservice, n.d.-a; see Figure 2.6) aim to make PA more accessible by providing an arrangement of items that caregivers can use to do playful exercises together with their client. Although these interventions are targeting people with ID, most of them rely heavily on the support from caregivers.

'Steffie' (n.d.) is an online platform developed to explain a diversity of difficult topics (e.g. making

Figure 2.6: Beweegtas (Team Sportservice, n.d.-b).

Figure 2.7: Fit met Steffie (Fit met Steffie, n.d.).

Figure 2.8: SilverFit (SilverFit, n.d.-a).

friends, using public transport, online banking) in a way that is accessible for people with ID, among these topics is PA. 'Fit met Steffie' (n.d.) provides a database of exercises and helps in finding the activities that fit someone's interests and context (see Figure 2.7). This product enables people with ID to access information on PA, however, it relies on their personal motivation, which has been identified as a potential barrier (see Chapter 2.2.2).

Finally, there are technological products that aim to make PA more stimulating and fun. The Moofie stick (Moofie, n.d.) is designed to make exercise more interesting and interactive by incorporating light and music (see Figure 2.9). This product can be used autonomously as it uses simple product interactions and voice cues. There is still a learning curve for this product as these cues are not always intuitive. Similarly, products from SilverFit (n.d.-b) use digital interactive technology to create activities in the form of games (see Figure 2.8). However, the latter is not specifically designed for people with ID and must be used under the guidance of a healthcare professional. The downside of these technological products is that they are very expensive and therefore once again inaccessible. 's Heeren Loo does have some of these products, but they are only lent out to residencies for a limited amount of time, after which they have to purchase them themselves.

In conclusion, this review of interventions reveals several opportunities for this project. There is a need for an intervention that is tailored to enable more independent use by people with ID and reduce reliance on caregiver support. Such a product should proactively initiate PA, helping overcome motivational barriers. In addition, the solution would remain affordable for healthcare organizations, increasing its accessibility and practicality in real-world settings.

Figure 2.9: Moofie stick (Moofie, n.d.).

2.3.2 Achieving behavioral change

Changing from a sedentary lifestyle to a more active lifestyle requires a change of behavior. There are a multitude of models and theories that help with understanding and facilitating behavioral change. One of these behavior models is the Fogg Behavior Model (FBM) (Fogg, 2009). This model (see Figure 2.10) defines behavior (B) as a result of motivation (M), ability (A) and prompt (P). Meaning that for any behavior to occur, there must be sufficient motivation, enough ability to perform the behavior, and an effective prompt to trigger it. This is represented in the formula B = MAP.

Motivation is defined as the desire to perform the behavior, consisting of three core motivators: pleasure/pain, hope/fear, and social acceptance/rejection.

Ability refers to the ease or difficulty of performing the behavior. Even if motivation is high, if the task is too difficult, the intended behavior will not happen. There are six factors that affect ability: time, money, physical effort, mental effort, social deviance and non-routine.

Prompt, also known as a trigger, is the cue or call to action that initiates the behavior. There are three different kinds of prompts:

- Facilitators: When ability is low, a prompt can increase ability.
- Sparks: When motivation is low, a prompt can increase motivation.
- Signals: When both motivation and ability are high, a simple reminder or signal can trigger the behavior.

As can be seen in Figure 2.10, the FBM is typically represented as a curve on a two-axis graph: motivation (y-axis) and ability (x-axis). Prompts must occur above this curve (the action line) for behavior to happen. Below the curve, either motivation or ability (or both) is insufficient for the behavior to occur, even if a prompt is present. The inclusion of prompts is what makes the FBM stand out from other models as it highlights one of the barriers discussed in the previous chapter. Specifically, the dependence on external stimuli among people with mild ID, as noted by Adriaanse (2022) in her research on this topic.

By addressing all three components of the FBM model, it is possible to design interventions that encourage behavior change. For this to be effective, however, it is important to understand how these components can be addressed specifically for people with ID.

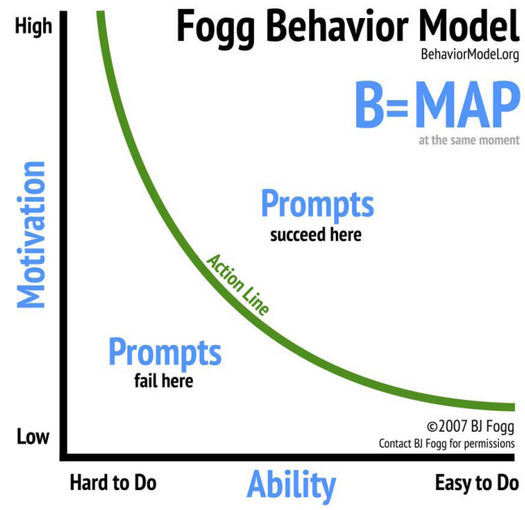


Figure 2.10: Fogg Behavior Model (Fogg, n.d.).

2.3.3 Intervention guidelines for people with ID

The CMOC (context, mechanism and outcomes configurations) model by Westrop et al. (2024) is developed to guide interventions to be effective for people with ID. Represented in this model (see Figure 2.11) are the wider context outside of the intervention (yellow segments), the context specific to the intervention (blue segments) and mechanisms (such as behavioral and emotional response) of people with ID and their caregivers (green segments).

For this chapter, it is most relevant to look at the five intervention specific contexts, as they provide clear guidelines that can be used throughout this project:

1. **Support involvement**
   Knowledge, skills, and attitudes on the topic of healthy lifestyles of caregivers is key for supporting lifestyle modifications. These can be improved by providing training for caregivers. Additionally, the priority of lifestyle interventions is dependent on the workload and life pressures of caregivers. For formal caregivers, this priority can be increased by having wider organizational support and clear communication between all caregivers involved.

2. **Autonomy and choice**
   Adults with ID often have limited control over their own life. Having choices made for them makes people passive and reluctant to engage in lifestyle changes. This means that even though supporting a healthy lifestyle is important, there should also be space for people to make their own decisions to partake in lifestyle changes. Information should be accessible and comprehensible for adults with ID to allow them to give informed consent.

3. **Accessibility and suitability**
   Interventions should be tailored to the cognitive and adaptive skills of the participant. Providing easy to read materials, visual aids and concrete examples while avoiding abstract concepts. Furthermore, granting rewards and incentives can motivate people and give them a sense of accomplishment and pride. Lasty, actively involving people in interventions and creating concrete goals together.

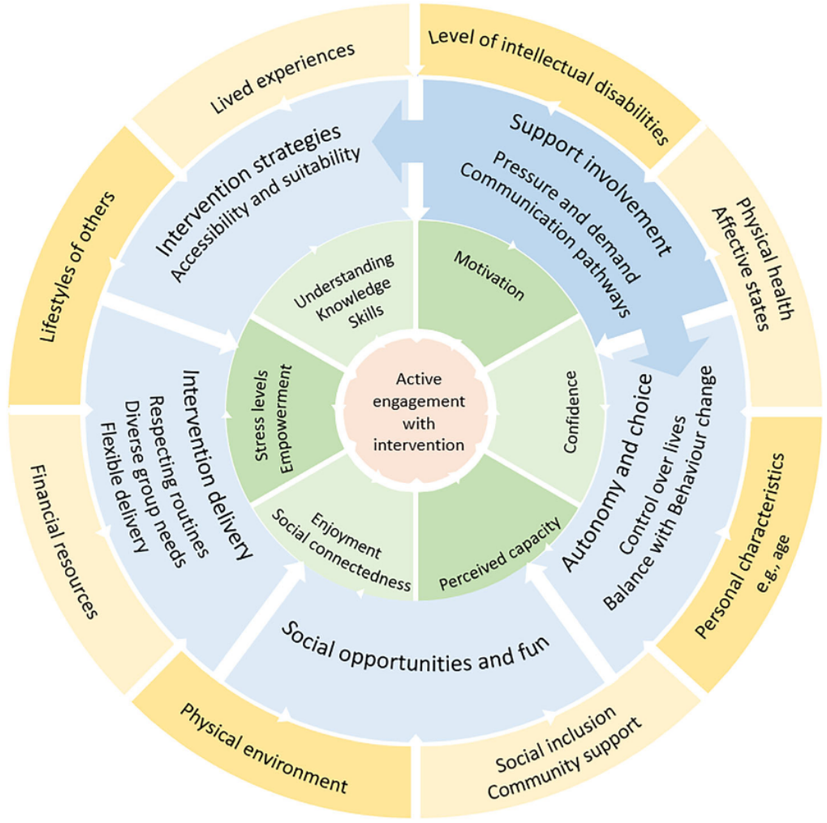


Figure 2.11: Visual overview of the lifestyle modification intervention model (Westrop et al., 2024).

4. **Intervention delivery**
   Interventions have to fit within the current daily routine, this can otherwise cause distress and reduce motivation. It is important to be flexible and respect individual needs, in particular when interventions are group-based and include people with diverse support needs. If not, some people may feel unstimulated while others may feel overwhelmed, creating a negative experience for everyone. Including people with ID during the development of interventions will negate these problems and lead to a result that reflects the needs, wants and abilities of people with ID.

5. **Social opportunities and fun**
   Peer involvement and group-based interventions can lead to social connectedness, enjoyment, and motivation, which is important for people to actively engage with an intervention and adhere to it over a longer period of time. Adding music and humor can also help in this regard.

To conclude, the CMOC model provides a comprehensive framework for designing interventions to meet the specific needs of people with ID. It also takes into account the barriers and facilitators previously discussed in Chapter 2.2.2. The final design should follow the guidelines derived from this model to ensure that the outcome is effective and meaningful for both individuals with ID and their caregivers. This is done by incorporating the guidelines into the design goal and product requirements. Only the topic of “support involvement” will not be fully addressed, as it requires changes at an organizational level, which is beyond the scope of this project.

2.4 CO-DESIGN

As discussed in the previous chapter, one of the requirements for creating an effective intervention is to include the intended target group throughout the development process. In this chapter, we will discuss how to include the residents of 's Heeren Loo throughout the design process of this project.

Co-design refers to the collective creativity of designers and people not trained in design working together throughout the design process (Sanders & Stappers, 2012). As the target group has totally different life experiences than the designer, it is important to include the intended user to account for the resulting experience of a design. However, co-designing methods evolve around cognitive skills such as imagination, abstract thinking and reflecting, which are skills people with ID struggle with. Therefore, co-designing has to be adapted to the abilities of the participants. Researching previous projects (see Appendix B) of which the design process was in collaboration with people with ID (including the thesis of Adriaanse) has led to the following guidelines.

Method guidelines

- Structure the creative sessions in such a way that participants can anticipate what is expected of them. Staring each session with the overall goal of the project, a recap of previous sessions and the schedule for the current session. (Benton et al., 2012; Maenhout et al., 2022)
- Be sure to simplify, dose, and organize the session and exercise material. As well as being aware of using concrete instructions that fit the experience of the participant. Avoid abstract methods such as storytelling exercises. (Adriaanse, 2022; Benton et al., 2012; Fjellstrom et al., 2022)
- Incorporate visual materials to aid understanding and engagement. Refrain from asking participants to write things down. If necessary, have the researcher document the necessary details. (Benton et al., 2012; Maenhout et al., 2022)
- Using realistic prototypes (with the help of 'Wizard of Oz' method) to provide tangible aspects of the design for participants to reflect on (Adriaanse, 2022; Anderiesen, 2017; Benton et al., 2012).
- Encourage participants to think out loud during testing to provide insight into their thought processes. (Maenhout et al., 2022; Sanders & Stappers, 2012)
- Allow for freedom in exploration and interaction while providing guidance through examples. Balancing the number of examples to inspire creativity without limiting it. (Benton et al., 2012; Maenhout et al., 2022)

Social guidelines

- For successful co-design, it is key to build trust and report between the researcher and the participants throughout the project. This enables people to express themselves more freely, creating more input that can be used to improve the design (Adriaanse, 2022; Maenhout et al., 2022).
- Similarly, it is important to be aware of the group dynamics. There has to be an atmosphere of thrust among the participants for successful co-creation (Maenhout et al., 2022; Westrop et al., 2024).
- Having a caregiver or another familiar figure present during co-design sessions, to create a more trustworthy and open environment. Additionally, they can act as moderators between participant and researcher, e.g. providing explanation when a question or instruction is unclear for the participant, and also to give the researcher more context to a comment of participant (Anderiesen, 2017; Maenhout et al., 2022).

Researcher guidelines

- Being enthusiastic sparks engagement of the participants, while being patient facilitates the discovery of input generation methods (Adriaanse, 2022; Maenhout et al., 2022).
- Being able to give away co-decision power to participants to fosters project autonomy, but it's crucial to strike a balance between empowerment and overwhelming participants (Benton et al., 2012; Westrop et al., 2024).
- Be flexible and plan for adaptability by always preparing a back-up plan, to allow for changes in time frame, mood and to provide space for input of the participants (Adriaanse, 2022; Maenhout et al., 2022).

Together, these guidelines have provided a base for preparing and conducting the participatory design sessions of this project (see Chapter 5), especially during the initial sessions. As stated in these guidelines, however, the actual methods and material used for these session is highly dependent on the people involved in the design process. Learning how to collaborate effectively with the residents of 's Heeren Loo has been an ongoing process throughout this project, achieved by carrying out the sessions together and reflecting on each experience.

2.5 Conclusion and project implications

In this chapter, relevant background information on intellectual disability, physical activity, interventions and co-design have been explored and outlined.

People with mild ID embody a wide and diverse range of people with their own specific support needs and abilities. Therefore, it is important to focus on a specific group of people, such as the residents of a location of 's Heeren Loo, in order to create an appropriate intervention. Because of the impact of ID on cognitive and adaptive functioning, people with ID experience difficulties in fitting into society, which can lead to a negative self-image. It is therefore particularly important for this project to promote positive experiences that focus on the individual's abilities rather than limitations.

Physical activity has been shown to be good for people's overall well-being and quality of life. It is especially important for adults with ID, who often face more health complication. Even small increases in PA can lead to noticeable improvements in their health. Despite this, PA levels in this group are low, mainly due to lack of support, accessibility issues, motivation issues and negative past experiences. However, social, fun, and well-adapted activities have been shown to increase PA, providing a direction for this project.

In general, to achieve behavioral change there must be sufficient motivation, sufficient ability to perform the behavior, and an effective prompt to trigger it. For people with ID the effectiveness of an intervention depends on support involvement, autonomy and choice, accessibility and suitability, intervention delivery and social opportunities and fun. Many current interventions are often inaccessible, both in terms of cognitive demands and financial cost, and they tend to limit autonomy by relying heavily on caregiver support, so these are important issues to tackle in this project.

Finally, to develop an effective intervention, it's important to involve end users throughout the design process. For collaborations with people with ID, during this project, it's critical to consider their cognitive and adaptive abilities by ensuring that exercises are well-structured, concise and straightforward, using visual cues and tangible representations. In addition, fostering a positive and trusting environment is key. It is important to give participants autonomy and freedom to explore, emphasizing the need for flexibility in approach.

3

DESIGN SETTING

The goal of this chapter is to introduce the residents who contributed to this project and to elaborate on their living situation, including their current behavior with regards to PA. This chapter is based on field research that involved spending a day with caregivers and residents, as well as conversations and observations during multiple visits over the course of this project.

3.1 LIVING ENVIRONMENT

Location

This graduation project is in collaboration with one of the locations of ‘s Heeren Loo, based in a small village outside residential care park ‘Het Westerhonk’ of ‘Heeren Loo. This residency is located on the upper floor of an elderly nursing home of a different organization. The residency is divided into three homes with each a separate living room (see Figure 3.3) and kitchen. Each resident has their own bedroom with bathroom and necessary amenities. An abstract floor plan of the residency is shown in Figure 3.1.

Together, they share a central space used for daily activities and social events called the SOOS (see Figure 3.2). These daily activities are varied, meaning that residents can find a wide range of products in the SOOS , from art supplies to wellness items to musical instruments.

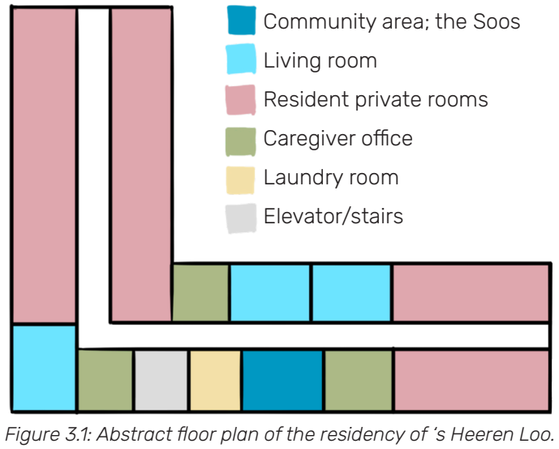


Figure 3.1: Abstract floor plan of the residency of ‘s Heeren Loo.

Caregivers

Each home has one caretaker per part of the day. Working on the same floor, however, allows the caretakers to work closely together and organize group activities. The staff mostly consist of full-time caretakers, with the addition of a few temporary workers. In front of each living room hangs a picture of the caretakers working that day. Whoever is coming to work is communicated only the day before, so as to avoid confusion and false expectations if the schedule changes.

Each home is staffed with one caretaker per shift, but since they all work on the same floor, they collaborate closely and organize group activities. The team is primarily made up of full-time caretakers, supplemented by a few temporary workers. A picture of the caretakers on duty that day is displayed outside each living room. To prevent confusion or unmet expectations due to potential schedule changes, the staff’s schedule is communicated only the day before. During the night, the staff of the other nursing home takes care of the residents of ‘s Heeren Loo. This is done as it is cheaper compared to their own caretakers working night shifts.

Figure 3.2: The SOOS.

Figure 3.3: One of the living rooms at the residency.

3.2 RESIDENTS

The residents at this location are generally around 70 years old and have been diagnosed with mild to moderate ID. The residents come from varied backgrounds. Some have previously lived independently or with minimal support, but they had to move to a 24h care home due to age-related issues. Others have spent most of their lives in professional care homes. Six people live at each home, resulting in a total of 18 residents at this location. Whilst residents are free to move around the residency, they generally prefer to stay within their own home. Mobility levels vary widely among the residents, though most require the aid of a walker to move around.

Participating Residents

Three residents are involved in this project, all in their mid-70s. One of the participating residents uses an electric wheelchair and has limited movement in their limbs. Yet, they remain eager to participate in physical group activities. The other two residents struggle with balance and walking, having to use a walker even indoors. There is also a noticeable difference in apathy between these residents. While one is very curious and open, the other likes to wait-and-see before reacting and needs more time to adjust to a situation. To the right, each resident is described briefly. This overview is not intended to fully capture who they are but rather to provide a snapshot of traits and abilities relevant to the project.

Participating Resident 1

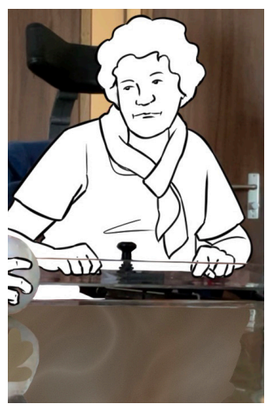
Physical traits:
Uses a walker and can walk very short distances independently.

Personality traits:
Positive, cooperative, and a bit timid.

Participating Resident 2

Physical traits:
Relies on a walker at all times

Personality traits:
Initially hesitant due to motivational barriers but fully commits once engaged.



Participating Resident 3

Physical traits:
Uses an electric wheelchair and has limited arm mobility.

Personality traits:
Welcoming and determined to complete tasks.

3.3 DAILY ROUTINE

Since most of the residents are in their 70's, meaning that they can enjoy their retirement and do not have to go to work to a daytime activity center. To still keep everyone active and provide meaning to the day, daily activities are organized in the SOOS by an additional caretaker. These activities last around an hour ranging from cooking to bingo and crafting to water balloon battles (see Figure 3.4). These are not mandatory to join, but everyone is encouraged to give it a try. The other nursing home also organizes activities that the residents of 's Heeren Loo are free to join if they have permission from their caregivers. An general overview of the daily routine of the residency can be found in Table 3.1.

Between group activities, the residents keep mostly to themselves and retreat back to their rooms. Most common activities during this time are drawing, making puzzles, crafting, watching tv, listening to music or taking a nap. Some are given small chores such as wiping the floor or taking care of helping with preparing dinner. During this time, caretakers are mainly found in their office to take care of their administrative workload.

Table 3.1: General daily schedual.

Time	Activity
7:00-9:30	getting up (washing, dressing, breakfast) & extra medical care
10:00-10:15	morning walk
11:00-12:00	joint day activity
12:30-13:30	lunch
14:00-14:15	afternoon walk
15:00	change in shift of caregivers
17:30-18:30	dinner
20:30-22:00	to bed (washing, changing, medication)

Figure 3.4: A week schedule of the daily activities at SOOS.

3.4 CURRENT PA BEHAVIOR

Twice a day, the residents are invited to go on a walk together, in the morning and afternoon. While these are not mandatory to join, it is highly encouraged by both caregivers and fellow residents. The route and time for these walks differ depending on who joins the walk, but they generally walk around the neighborhood for about 15 minutes. Outside these couple of walks, the residents generally remain indoors, except for pre-approved appointments and under supervision for safety reasons.

Each of the three living rooms is equipped with a home-trainer (see Figure 3.5). These are used daily by most residents, as encouraged by the caregivers and fellow residents. As was observed during a couple of the visits to the residency. The residents are able to use this home trainer independently, because they are fairly straight forward to use and need minimal preparation work. Although, some need a caregiver to be present to motivate them to actually use the home-trainer and not just sit on it. To keep track of time on the home-trainer, the caregivers set a kitchen timer for 10-15 minutes. Additionally, a few residents are still able to use a traditional or duo-bike outdoors. Other physical activities depend on the day's group activities, which may include various games, most of which are sedentary.

Figure 3.5: Home-trainer

Besides craft supplies, there are plenty of active games in the SOOS like air hockey and darts, these can be seen in Figures 3.6-3.9. However, these are not used outside of group activities organized by the caregivers. One of the reason for this being that most games are hard to use independently by residents, due to their size or number of elements that can fall onto the ground when being played. This once again highlights the importance of accessibility and autonomy for products to be effectively used. Another barrier is that most of these games are being stowed away in closets where they are out of sight and therefore forgotten.

Designing something that can hold a prominent place in a room and that people want to keep on display can therefore be vital for the success of the design. Even if it is temporarily stowed away to make room for other activities, people should feel motivated to bring it back on display, ensuring that there is a visual reminder to use the design.

Figure 3.6: Closet full of products for daily activities.

Figure 3.7: A variation on darts

Figure 3.8: Games stored on a table in the SOOS.

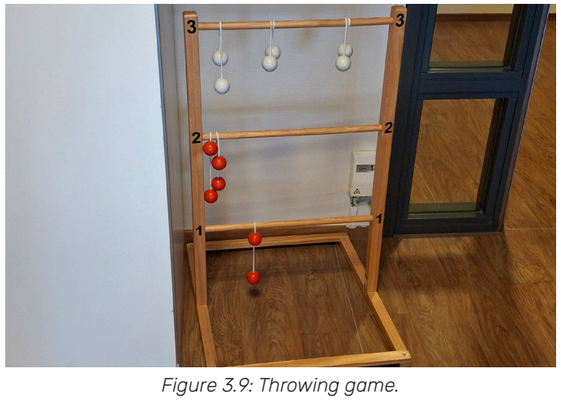


Figure 3.9: Throwing game.

3.5 Conclusion and project implications

In this chapter, the living situation and PA behavior of the residents of one of the ‘s Heeren Loo locations have been explored and outlined.

To conclude, the residents of this care facility are primarily older adults with mild to moderate ID who live under 24-hour care. Their daily routine includes group activities and physical exercise, such as twice-daily walks and the occasional use of a home-trainer. Despite efforts to promote PA, many active games remain unused due to their complexity or because these are stored out of sight. This highlights the need for a design that is not only easy to use, but also readily accessible and visible. In order to increase PA among the residents, it is important to find a solution that fits into daily routines, promotes autonomy, and accommodates the varying physical and cognitive abilities of the participating residents.

4

DESIGN BRIEF

Based on the findings presented in the previous chapters, the initial design goal for this project was adjusted. The project's direction and goal for the continuation of the project is elaborated on in this chapter.

4.1 PROJECT DIRECTION

Physical activity is crucial for the well-being of adults with ID, as even small increases in PA can significantly improve their health. However, current PA levels are low due to limited support, accessibility challenges, and lack of motivation. Research shows that fun, socially engaging, and well-adapted activities can improve participation, offering direction for this project. Effective interventions should provide adequate support, autonomy, accessibility, and a motivating structure that balances cognitive simplicity with engaging prompts.

People with mild ID represent a diverse group with unique support needs, requiring interventions tailored to their specific abilities. For this project, focusing on a group of older adults with mild to moderate ID in a ‘s Heeren Loo care facility helped ensure a relevant design approach. These residents, under 24-hour care, engage in group activities and physical exercise. Yet available active games often go unused due to complexity or inaccessibility. This highlights the need for a product that is easy to use, visible, and seamlessly fits into daily routines.

Finally, involving end users throughout the design process is essential. By tailoring exercises to participants’ cognitive and adaptive abilities, incorporating visual cues, and fostering a positive environment, the project can enhance autonomy and support a flexible approach that respects each individual’s unique needs and preferences.

A Research through Design approach will be used for the continuation of this project. Several design features will be explored in collaboration with the participating residents to gradually develop a final design. This will be done over several sessions through an iterative approach, with each session building on the insights of the previous one. This is done over several sessions through an iterative approach (see Figure 4.1), with each session building on the insights of the previous one.

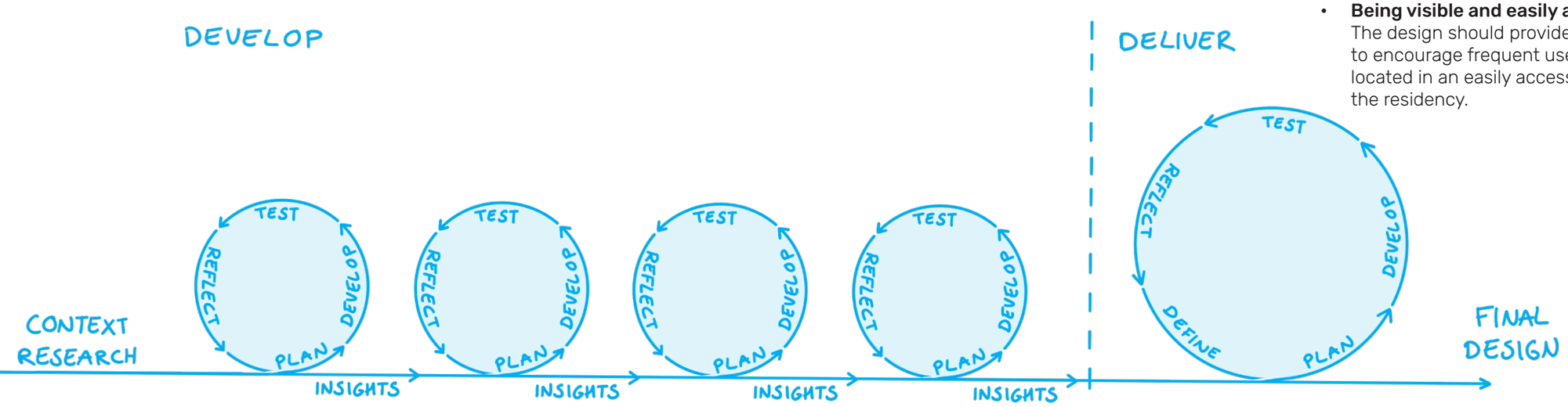


Figure 4.1: Overview of the iterative design process during the develop and deliver phases.

4.2 DESIGN GOAL

Increase the physical activity of older adults, with mild intellectual disabilities living at a `s Heeren Loo residency, by designing a playful product that encourages social interaction and can be used autonomously.

Subgoals:

- **Stimulating small changes while creating a positive association with PA**
  The design should initiate low-impact exercises, fostering enjoyable and engaging experiences that focus on the residents’ current abilities.
- **Being accessible by both residents and residency**
  The design should accommodate a range of cognitive and physical abilities of the residents, while being financially feasible and fitting within the daily routine of the residency.
- **Being visible and easily available**
  The design should provide a clear reminder to encourage frequent use and should be located in an easily accessible place within the residency.

5

PARTICIPATORY DESIGN

This chapter outlines the participatory design process with three residents of ‘s Heeren Loo that led to the development of the final concept. While not a co-design process in the strict sense, as the participants were not directly involved in generating solutions, the residents played a crucial role by providing feedback on potential solutions. This feedback shaped and determined the direction of the project, resulting in a solution that was closely aligned with their needs and preferences.

The approach followed the Research through Design methodology, ensuring an iterative process in which insights from each session informed the next steps, ultimately leading to the final design presented in Chapter 6. The design process spanned four sessions, focusing on engaging participants with physical prototypes, as discussed in Chapter 2.4. Feedback was gathered through a combination of direct observation and interview questions, with observation being the primary tool for capturing meaningful insights. Video recordings further supported the analysis, allowing subtle interactions and body language cues to be reviewed in detail.

5.1 EXPLORING CURRENT PA EXERCISES

The aim of the first session was to inquire about the opinion and experience of the participants on PA. As well as getting an impression of the physical abilities of the participants. This was achieved by doing a few exercises together with the participating residents that tested the participants' range of motion and incorporated common group-based game elements like collaboration and competition. Furthermore, this first session was important to gain experience with setting up and carrying out collaborative activities with the participants.

Goal

- What are the experiences of the participating residents during PA?
- What are the physical capabilities of the participating residents?

Description

Three playful PA exercises were chosen for this session: moving with music, passing over balloons and throwing bean bags. These were selected as they test range of motion, collaboration and competition. Following these exercises, the participants, with guidance from the researcher, assessed the activities using a visual feedback form used during the preceding thesis by Adriaanse (2020), see Appendix C.

For the first exercise the participants were asked to mirror the movements of the researcher, while playing music chosen by the participants. These movements were kept simple and mainly focused on moving the arms and feet to make sure the exercises were accessible for all participants.

During the following activity the participants and researcher passed around a balloon to each other, trying to keep it in the air (see Figure 5.1). This game started off with one balloon, but after a few minutes a second balloon was added. In addition to using their hands and feet, participants were provided with a foam stick to move the balloon away.

Each participant was given a few bean bags at the start of the last activity. The goal of this exercise was to throw their bean bag towards a cone, as close as possible (see Figure 5.2). Later on, the cone was replaced by small bowling pins as was suggested by one of the participants to make it more fun (see Figure 5.3).

Due to the physical abilities of the participants all exercises were performed while sitting down.

Figure 5.1: Passing around a balloon with foam stick.

Figure 5.2: Throwing bean bags towards a cone.

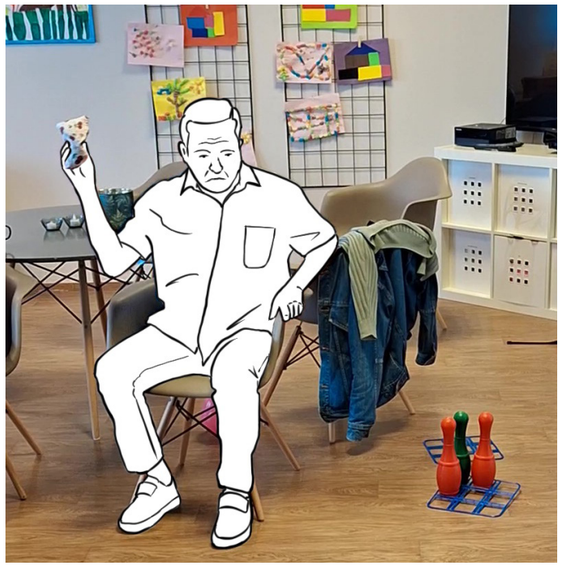


Figure 5.3: Throwing bean bags to knock over pins.

Findings

Overall, the participants enjoyed the activities, except for the mirroring of movements. This activity was disliked by one of the participants, because some of the exercises felt uncomfortable to do, e.g. swinging the arms above the head and stretching the hands as far as possible towards the feet. This was not a problem during the other exercises as the focus was set on a different goal than the movement itself. Resulting in the participant initiating similar movements that were earlier deemed as uncomfortable. Another factor could be that the participant was not familiar with the first exercise and needed more time to adjust.

Playing with the balloons sparked the most energetic response, as both participants sprang into action when the balloon came into reach without needing any further instructions. The reactive factor of the game helped keep their attention longer than the other activities. The introduction of a second balloon did not appear to have any further influence, as attention still remained on one balloon.
The energy stayed high during the balloon game as there was no clear end to the game. Contrary to the bean bag throwing for which the bean bags had to be picked up by the researcher after each round, leading to frequent inactive moments during the game.

Concerning the set-up of the session, the main lesson from this session was to inquire feedback through conversation instead of the visual feedback form. The reason being that it was harder to get in depth feedback from the participants and gathering quantitative data did not match the exploratory design phase. Another insight was offering the participants more time to transition between settings by getting comfortable with a cup of coffee before starting the session.

Design insights

- Participants become more active when reacting to external stimuli.
- The focus should be on an aspect other than the physical activity itself.
- Interaction with the product should be based on concepts or activities the participants are already familiar with.
- The primary focus should be on seated activities that can be extended to standing activities when developing the intervention to a broader audience.

5.2 EXPLORING SPARKS & TRIGGERS

Building on the findings of the previous session, particularly the participant's response to external stimuli, the goal of this session is to explore different triggers for initiating PA. This was via color changing lights (see Figure 5.4) and a remote-controlled toy car (see Figure 5.5).

Goal

- Does an active product cause more activity among its users?
- What is the reaction of the participating residents to technological sparks?
- Does it create a similar reaction as to the balloons in the previous session?

Description

First the interaction with light was initiated by placing a remote-controlled light in the middle of the table where the participants were seated. A second light was placed on the tray of the wheelchair of one of the participants as they were not able to reach the table. The participants were instructed to touch the light as fast as possible when it switched color (see Figure 5.6). Participants were later asked to touch the light only for a specific color.

Next, to vary the arm movements of the participants and create a more socially interactive game, a rope was attached to the light. One participant was asked to pull the light away when it changed color, while the other was still tasked with touching the light (see Figure 5.7). For the participant in the wheelchair, the researcher moved the light.

In order to get the interaction with a moving product, one of the lights was attached to a remote-controlled toy car that moved around across the table in front of the participants. The participants were instructed to touch the light once it got within reach regardless of light changing color (see Figure 5.8).

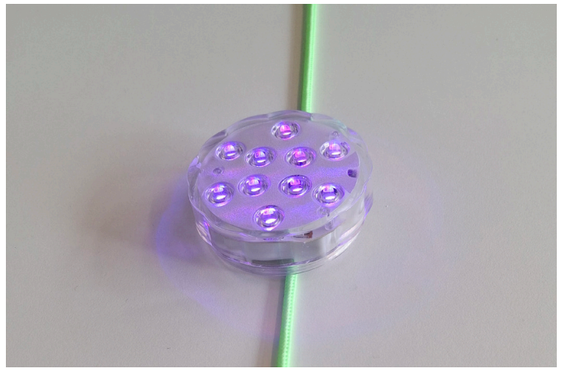


Figure 5.4: Remote-controlled light that changes color.

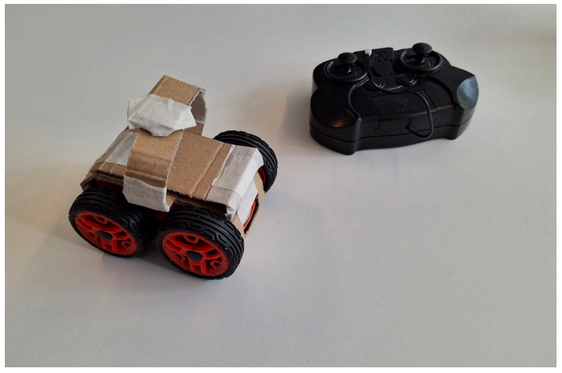


Figure 5.5: Remote-controlled toy car.

Figure 5.6: Touching the light once it changes color.

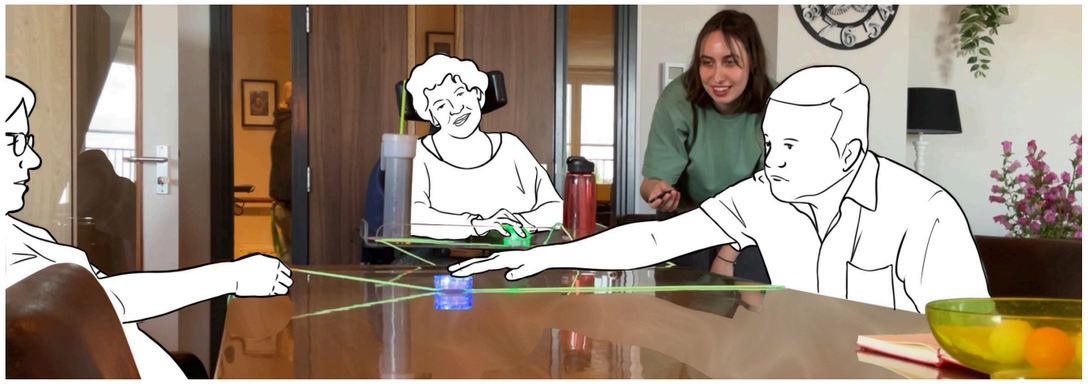


Figure 5.7: Touching the light once it changes color while the other to pulls it away from them.

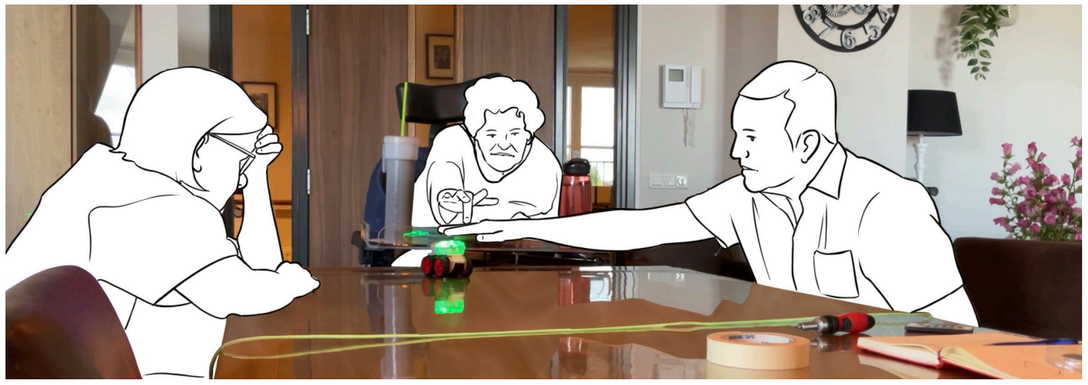


Figure 5.8: Touching the light once it changes color while it moves around on a toy car.

Figure 5.9: Placing a ball in a basket on top of a toy car while it moves around the table.

Lastly, a basket was attached to the toy car and the participants were then tasked with throwing a ball into the basket while the car moved around the table (see Figure 5.9). This was done to introduce a more challenging interaction that involved more PA.

Findings

Overall, the participants needed less support compared to the previous session, as the activities were straight forward and confined to the table. Furthermore, the participants took on a more active role during this session than the previous one. It did still highlight the need for a variety of external stimuli, as relying on just one type quickly became monotonous after a few minutes, lowering engagement.

This session also reinforced insight from the previous session to provide one action to focus on at the time. For example, pulling the rope to move the light away from the other participants worked when it was their sole objective. Asking the participants to combine this action with touching the light got too confusing. Which resulted in the amount movements being reduced during the game as the participants were not sure what to do.

Moving the toy car between participants made the activities more inclusive by allowing the light to be moved closer to the person in the wheelchair. This enabled them to reach the same interaction point as others, creating a shared objective and reducing confusion.

Finaly, even though the participants were actively involved, there was no variety in the kind movements of the participants as the actions required were one dimensional. The next step would be to explore more motions and gestures the participants can do.

Design insights

- The interaction needs to provoke a variety of movements, engaging the upper body and feet.
- Different interactions should be provided (not simultaneously) to maintain interest and encourage continuous activity for close to 10 minutes.
- Technological triggers can be used to capture and sustain user engagement.

5.3 EXPLORING DIGITAL INTERACTION

Following up on the insights gained in the previous session, this session aims to explore a solution to diversify the movements for the participants using a digital environment. A digital solution was sought out as it is less dependent on the user's physical environment and tools, allowing more freedom in exploring different movements. Moreover, a digital product has the potential to create personalized movements and interactions to the specific abilities and interests of the user.

Looking at current products (see Chapter 2.3.3) it was concluded that digital products that make use of motion-sensing devices are effective in stimulating PA. That is, if the user is able to connect what is happening on screen to what is happening in real life. For people with ID this can be too abstract to understand. To be able to consider a motion-sensing input device as viable tool for this project, it is crucial to test how it is received by the residents of 's Heeren Loo. This assessment is carried out during this session by having the participating residents interact with a Microsoft Kinect.

Goal

- What level of abstraction can the interaction take while still being clear to the residents?
- Does the Microsoft Kinect enable more variety in PA motions?

Description

A digital prototype was made in which real time camera footage captured by the Microsoft Kinect was filtered to only show the outline of the people and items in frame. Resulting in an abstract image of the residents and their surroundings (see Figure 5.10). This image was put on the TV screen in front of the participating residents. First, each participant was asked to move their hands to show how their movements appeared on the screen in front of them.

Next, a green circle was placed on top of (filtered) camera footage on screen, indicating a certain point the residents would have to move their hands or feet to. Once this was achieved, the green circle was moved to another area. This was repeated until the participants became uninterested.
exercises were performed while sitting down.

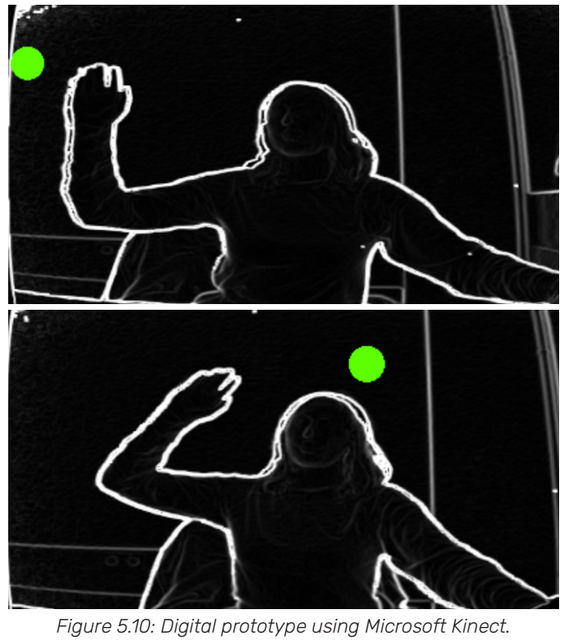


Figure 5.10: Digital prototype using Microsoft Kinect.

Findings

The interaction with the digital interface was too abstract, when the participants did not see a clear representation of themselves on screen. Once switching over to real-time camera footage of the participants (see Figure 5.11), they were able to recognize themselves, enabling them to make this connection. This way they could be directed to move their arms and feet to a certain point indicated by the green circle on the screen. As a result, the Kinect was successful in diversifying PA motions. It was also successful in creating an inclusive experience as all residents were able to participate equally and no special adjustments needed to be made.

Although, there were still some challenges that became clear during this session. The participants had previously indicated the joy they experienced when doing activities together. Using a TV, however, took away from these social interactions since the focus was on the screen in front of them and not on each other (see Figure 5.12). One of the caregiver explained that the residents only use the TV to sit and watch. They do not join in PA themed TV shows such as 'Nederland in Beweging' (which occasionally happens at other 's Heeren Loo residencies). This results in the TV area being associated with passive activities and not being an environment suitable for igniting collaborative PA.

Following this session, the decision was made to move to a physical product for several key reasons:

- A physical product allows for easier social engagement among its users. This can also be achieved by adapting a digital environment to a table, such as Anderiesen's (2017) Tovertafel. However, this limits the range of motion that users can engage in and increases costs due to the use of more advanced technology.
- The residents are unfamiliar with digital interventions which may hinder independent use and effectiveness.
- A physical product also serves as a tangible visual reminder, whereas digital interventions can be easily overlooked when not in use, increasing the likelihood of being forgotten.

Figure 5.11: The interaction of the residents with the digital prototype, which uses real time camera footage.

Figure 5.12: Residents focus on interacting with the digital prototype displayed on the TV.

Design insights

- The interactions have to be tangible in order to be understood by the user.
- The attention point should be positioned in the middle of the users to facilitate social interaction.
- Environments associated with passive activities should be avoided.
- The final design should be a physical product.

5.4 EXPLORING CONTINUED INTERACTION

From the previous session it became clear that the final design should be a physical product. Still, the question remained as to how to encourage participating residents to remain active for several minutes in order to achieve the elevated heart rate necessary to reap the health benefits of PA. A target of 10 minutes was set because this is approximately the amount of time residents typically spend on the home-trainer. This is also consistent with the amount of time they had been able to focus on an activity in previous sessions.

The aim of this session was to design a product that responds to movement and motivates the user to maintain the activity through continued interaction with the object. Hence a new prototype was created, as is shown in Figure 5.13, which is a ball with a light inside that automatically reacts to movement (see Appendix D). Additionally, a speaker was used to play music that changed based on the movements of the prototype.

Goal

- What is the reaction of the residents to the outputs (light and music) of the product?
- Is the connection between the change in outputs and movement clear to the residents? And does it encourage continues movement?
- Does the prototype support social interaction between the users? Is the prototype inclusive for all users?

Description

For the prototype, a gyroscope was used that could track the angular speed of the ball.
This way the light inside the ball could automatically change color and brightness the more rapidly the ball moved around. Another insensitive was tested by adding music, changing the tempo of the song in relation to the motion, which was done manually via an external speaker and laptop.

The participating residents were asked to simply roll the prototype to each other across a table (see Figure 5.14). First testing the reaction, the light, and later the reaction to the music.

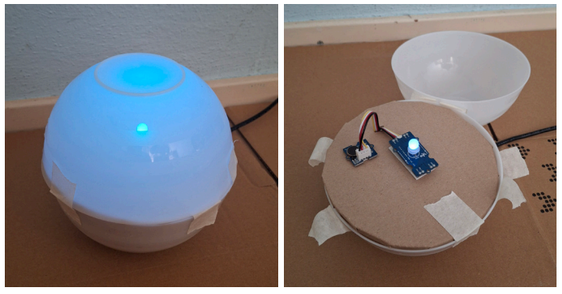


Figure 5.13: The prototype with a light inside that provides different outputs depending on whether it is in motion.

Findings

The residents took enjoyment in passing the prototype around to each other, reigniting the social spark that had been missing during the previous session (see Figure 5.15). Reaffirming that the project should continue with a physical prototype located between the users.

Nonetheless, the connection between their movements and the reaction of the prototype proved to be too complicated. At some point during the session, the light within the prototype switched off, which had no impact on the interaction with the product. There was a positive reaction to the music, however, the change in the tempo in relation to the speed of the ball was not noticed.

Additionally, the design was not inclusive for the participant in a wheelchair. They had to lean forward to reach the prototype which was an uncomfortable position for them to be in for a longer period of time. This was tried to adjust for during the session by positioning the wheelchair sideways (see Figure 5.16), however, this position quickly tired out their arm.
Based on these findings, the prototype was revised. As it was believed that simplifying the outputs of the prototype to make them more noticeable and clearer to understand.

Figure 5.14: The residents rolling the prototype to each other across the table.

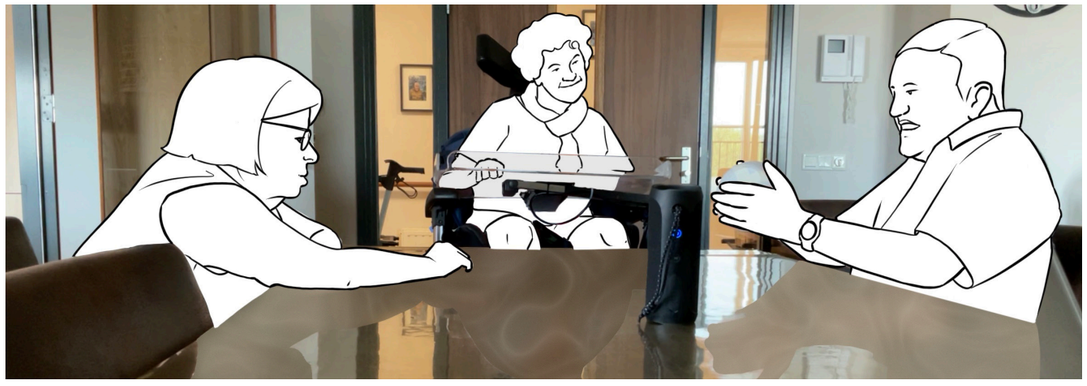


Figure 5.15: Residents are socially engaged while interacting with the prototype.

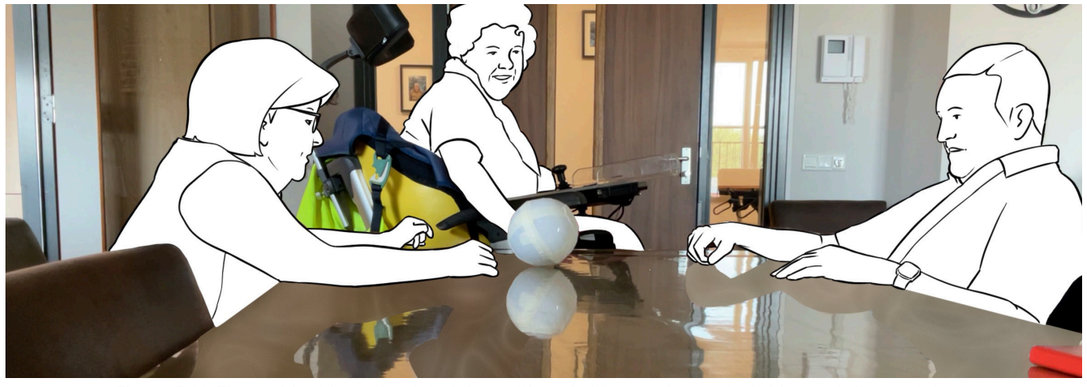


Figure 5.16: The resident in a wheelchair is positioned sideways to comfortably reach the prototype.

Description | Revised version

The prompt of the outputs was adjusted to reward when continuously moving the prototype, instead of giving different outputs depending on the intensity of the movement (see Table 5.1). Hopefully this would allow the residents to make the connection between movements they make and the outputs of the product.

Lastly, a rope was attached to the prototype, as is shown in Figure 5.18. This way they did not need to reach the prototype in order to move it around, to make the interaction more inclusive for the person in the wheelchair.

With these changes, a new session was carried out continuing on the same research questions as before (see Figure 5.17).

Figure 5.17: Participants passing the interactive prototype to eachother.

Figure 5.18: Resident pulling on the string attached to the prototype, allowing them to move it comfortably.

Table 5.1: Comparison between initial and revised product interactions.

Initial product interaction	Revised product interaction
The light changes intensity and color based on the speed at which the prototype is moved.	The light shines softly when in continuous motion. The light pulses brightly on and off when the prototype is not in motion.
The tempo of the music changes based on the speed at which the prototype is moved.	The music is playing when the prototype is in continuous motion. The music stops when it is not in motion.

Findings | Revised version

The revised prototype did not result in significant changes compared to the previous version. There was still no connection made between moving the prototype and the outputs of the prototype. In addition, stopping the music when the ball was not moving was perceived as suggesting that the activity had ended rather than motivating them to continue. This relates back to the previous sessions where it was found that there needs to be a trigger or spark before an activity is initiated by the participating residents. Therefore, the focus of this project should be on using these initial sparks throughout the interaction to motivate users.

Furthermore, the rope was relatively effective for including the person in the wheelchair, as it enabled them to comfortably move the prototype around. Although, this did not come to fruition during the session, as it was challenging to pull the prototype while the others were pushing the prototype around. This means that to create an effective collaborative experience, the participants should be given the same goals that are achievable through similar (inter)actions.
The implication of these findings for the final design is that it the interaction point should be elevated above the table so that none of the participants have to be in an uncomfortable position throughout the use of the product. In addition, the design should incorporate simple physical interactions, such as pushing, pulling, and lifting, that are accessible to all participants, despite their varying abilities.

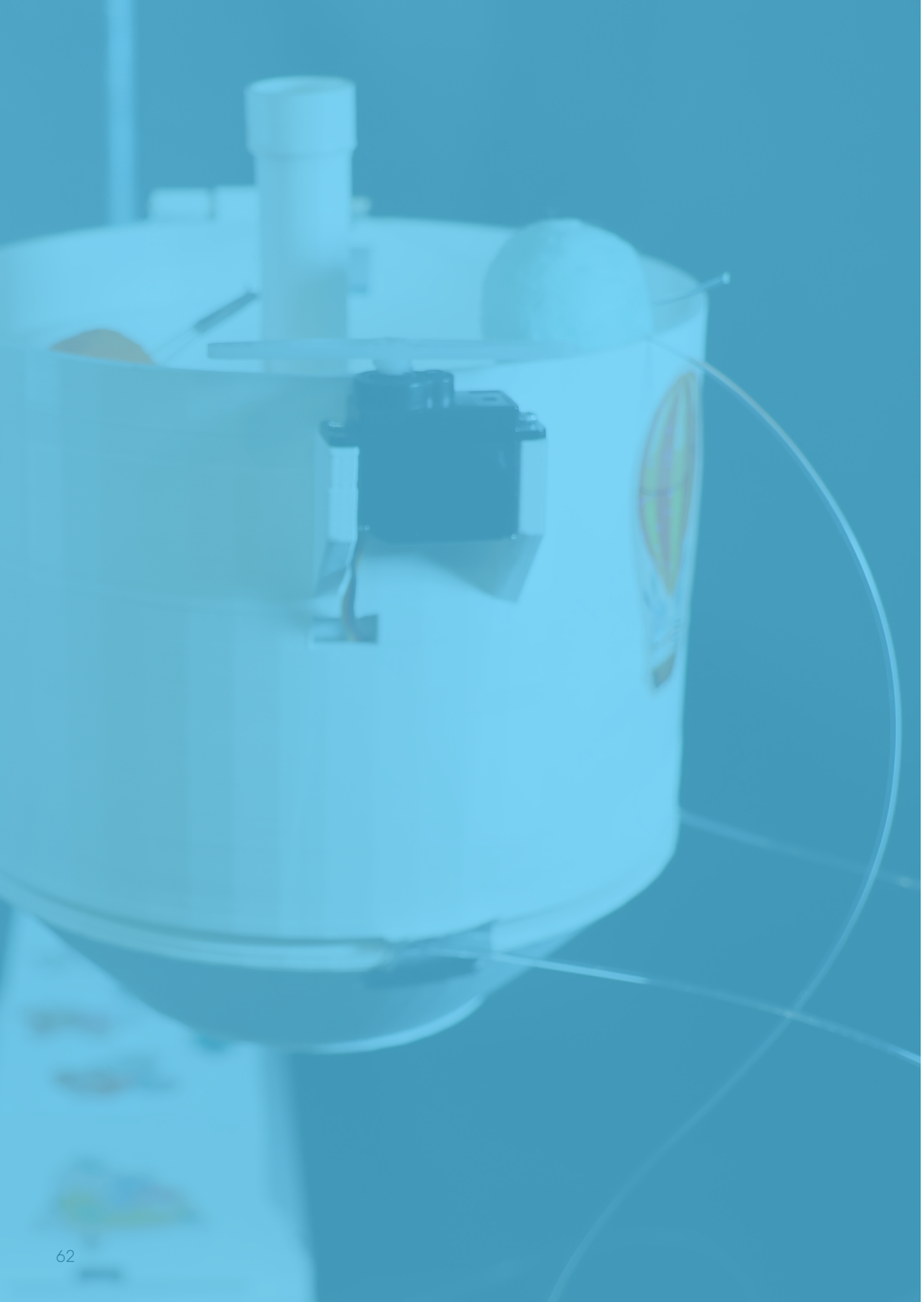
Design insights

- Product reactions, such as light and music, can enhance the product experience but it will not independently encourage PA.
- Interactions with the product should be simple and clear (less is more).
- All users should be given the same goals, achievable through similar interactions, to create an effective collaborative experience.
- The primary interaction point should be elevated above the table, allowing all participating residents to engage with it.

5.5 DESIGN REQUIREMENTS

To conclude the develop phase, key insights of the co-designing process are combined with insights of the discover phase to create the following list of requirements:

1. The product should promote positive experiences that highlight individual strengths and abilities, avoiding a focus on limitations.
   Chapters 2.1 & 2.2 & 2.3 | Exploration 5.1
2. The product should promote autonomy and choice by minimizing reliance on caregiver support.
   Chapters 2.2 & 2.3
3. The main focus should be on something other than the physical activity itself.
   Exploration 5.1
4. The design should stimulate a range of different movements.
   Exploration 5.2
5. The product should offer a range of external stimuli to promote ongoing PA for close to 10 minutes.
   Chapter 3.4 | Explorations 5.2 & 5.3
6. Interactions should be straightforward, easy to understand, and physically engaging for users.
   Chapters 2.2 & 2.3 & 2.4 | Explorations 5.3 & 5.4
7. The design should be elevated above the table for easy access by all users.
   Explorations 5.2 & 5.4
8. The product should be designed for seated use, ensuring accessibility for those with limited mobility.
   Exploration 5.1
9. The product should be financially accessible.
   Chapters 2.2 & 2.3
10. The design should fit within the daily routine of the residency, encouraging low barrier PA.
    Chapter 2.2 | Chapter 3.3
11. Interactions with the product should feel familiar to the user.
    Chapter 2.3 | Explorations 5.1 & 5.3
12. The focal point should be centrally placed to encourage social interaction among users.
    Exploration 5.3
13. The product should provide shared objectives that are achievable through similar interactions, in order to create an effective collaborative experience.
    Explorations 5.3 & 5.4
14. The final design should be a physical object that serves as a constant visual reminder.
    Chapter 3.4 | Exploration 5.3
15. The product must be adaptable for both seated and standing use, supporting PA that aligns with each user's capabilities.
    Chapter 2.1 | Exploration 5.1



6

FINAL DESIGN

In this chapter, the final design of Ledemaatje is presented, focusing on its key features and how it functions to support the physical activity of older adults with intellectual disabilities. A use scenario is provided to illustrate how the product can be integrated into daily routines, highlighting its interactive elements and accessibility.
Lastly, it describes the concept evaluation which includes feedback from the participating residents and one of their caregivers, offering insights into the effectiveness of the design in meeting the needs of the users.

6.1 GENERAL FINAL CONCEPT

Following the insights and the derived requirements of the previous chapters, the final concept ‘Ledemaatje’ was developed, shown in Figure 6.1.

Ledemaatje is a playful and collaborative product that provides certain reaction cues that prompt older adults with mild ID to perform a range of movements. Making use of prompts ensures that the focus is not on PA itself but should intuitively derive from the interaction with the product. The product consists of three key components: the bucket and launching balls, the rod and arm, the base:

The bucket embodies the main interaction point of the product. Attached to the bowl by string are small balls that can automatically be launched out to the bucket (see Figure 6.3) via a spring mechanism. This mechanism will be futher elaborated on in Chapter 6.3, when explaining the technical working of the final design. The goal of the user is to throw or simply place the balls back inside the bucket before they are launched again (see Figure 6.5). The bucket is automatically moved towards and away from the user, provoking them to either push the bucket away (see Figure 6.2) or pull the bucket towards them (see Figure 6.4). The latter can be done with the strings attached to the balls. This way users can pull the bucket in to a better position in order to throw the ball back into it.

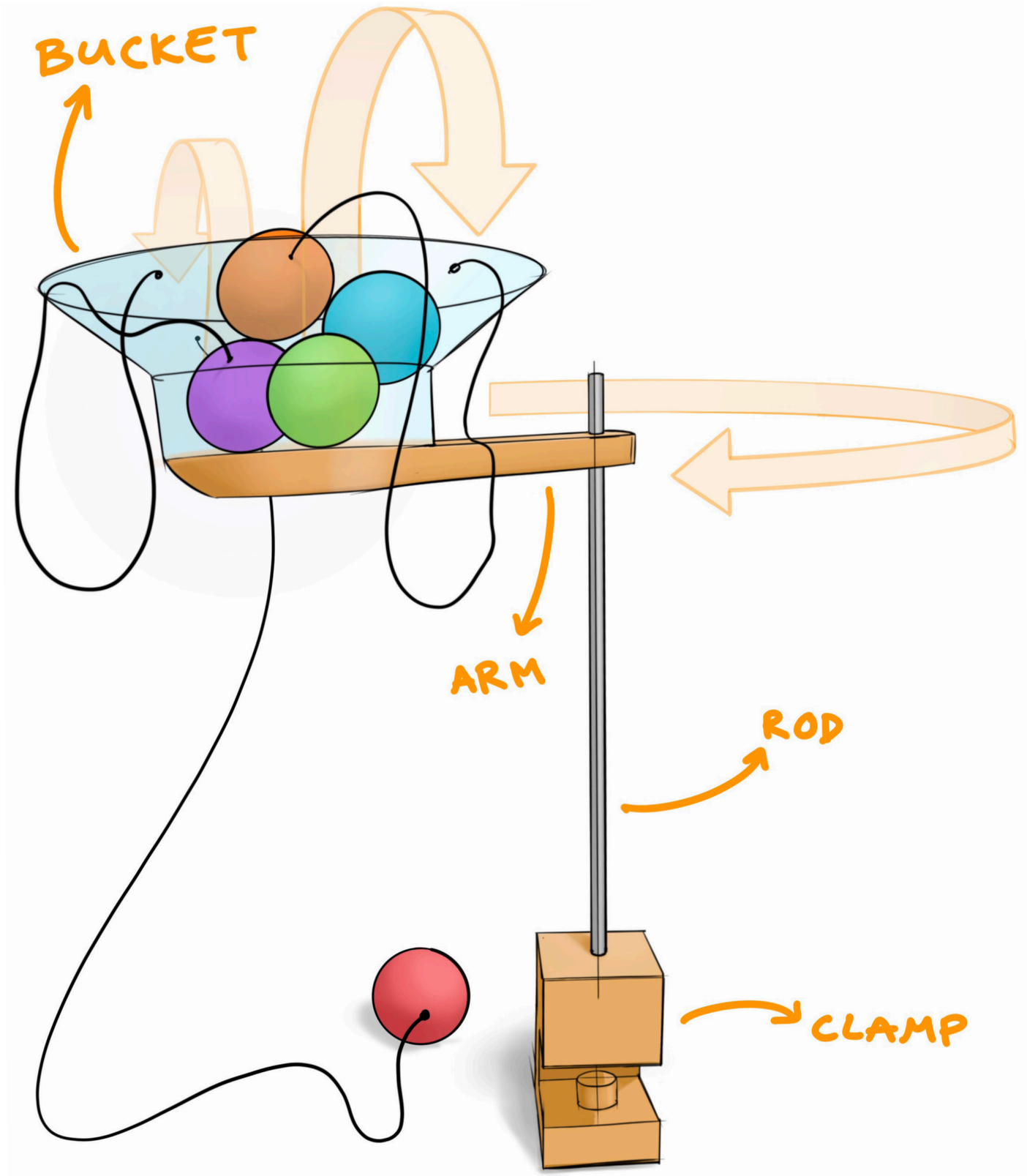


Figure 6.1: Final concept.

Figure 6.2: Pushing Ledemaatje towards other user.

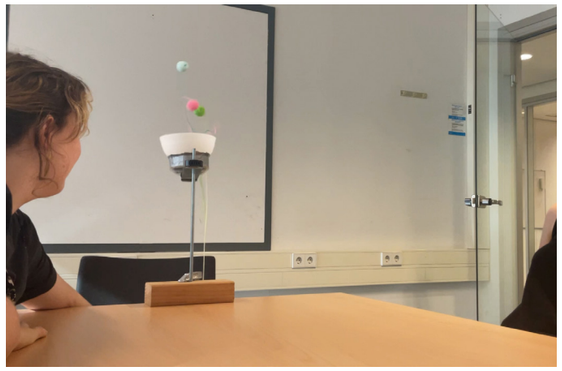


Figure 6.3: Launching little balls from the bucket.

Figure 6.4: Pulling Ledemaatje by the strings attachted.

Figure 6.5: Throwing the balls back into the bucket.

By being attached to a stepper motor, the rod turns around its axis, which in turn moves the arm and bowl attached to it. This presents the main external stimuli used for pushing and pulling. The arm being moved this way also allows the bucket to get closer to users enabling them to place a ball inside of it if they are unable to throw it. This ensures a positive experience as people with different abilities can complete the same task. The rod also ensures that the bowl is elevated above the table at a height that can be comfortably reached by somebody in a wheelchair.

The base ensures that Ledemaatje can be attached to the side of a table, providing a solid foundation that guarantees it remains firmly in place when being pushed and pulled.

The external stimuli and interactions are kept simple and straightforward, to trigger intuitive reactions which in necessary for encouraging PA. Moreover, Ledemaatje is easy to set up as it only action required is clamping it to a table. All elements are attached to each other, so everything stays within reach of the user, and does not fall onto the ground, ensuring easy packing up as well. Ledemaatje being attached to a table provides a visual reminder for the product to be used, under the condition that it can stay they outside of being used.

6.2 TESTING FINAL CONCEPT

The general concept was tested with the participating residents to get their input on the overall concept and to test how the product is used within the context. This was done using a low fidelity prototype (see Figure 6.6), meaning that all motorized features were performed by the researcher.

Goal

- Does the product effectively prompt and sustain PA?
- Is the product intuitive and easy to use with minimal instruction?
- Is the product inclusive and adaptable to different user needs?

Figure 6.6: Low fidelity prototype of the final concept

Description

First the participants were asked to push the bucket away from them whenever it was close to them (see Figure 6.7). This was first done without moving, to allow the users to get a feeling for the product while gauging the accessibility of the product. Later on, the arm was manually moved towards the participants to engage them in the interaction.

Next, the participants were instructed to pull the bucket with the rope attached to the prototype (see Figure 6.8). Once again, the activity started off without moving the arm before manually adding movement.

To conclude, the reaction to launching the balls out of the bucket was tested by using a catapult mechanism from underneath the bucket. After the balls were launched, the participants were asked to put the balls back into the bucket while the arm was moved around by the researcher (see Figure 6.9.

Figure 6.7: Resident pushing the bucket to eachother.

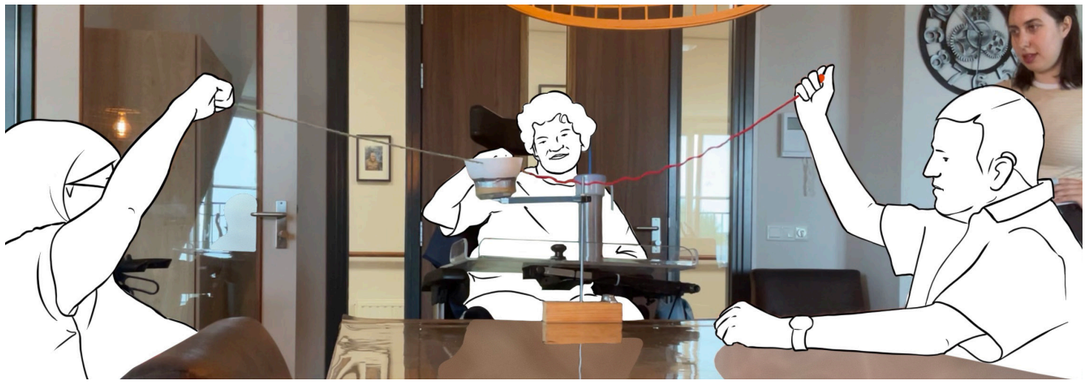


Figure 6.8: Residents pulling the bucket towards themselves.

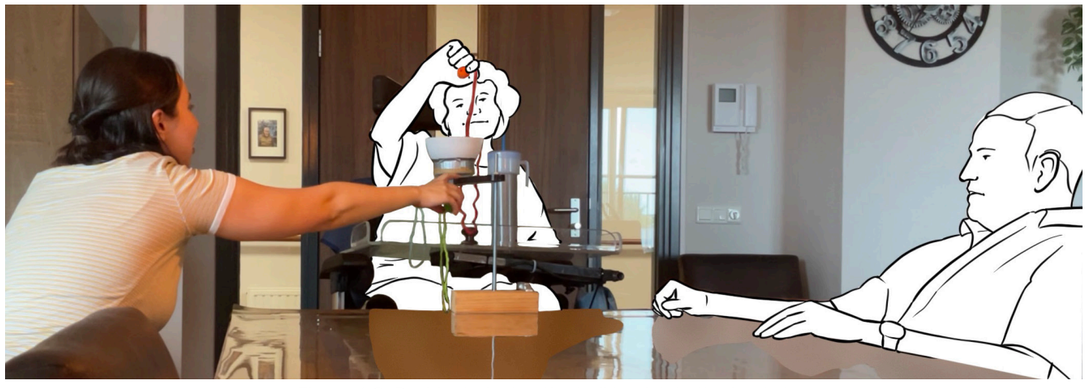


Figure 6.9: Resident placing the ball back into the bucket.

Findings

Overall, the prototype successfully encouraged a variety of physical activities, including arm movements above the head to prevent the string from catching on the pole (see Figure 6.8), and was inclusive of all participating residents.

The experience while using the product was positive, but there was a clear need for more encouragement from the product itself, as well as a clearer goal or purpose for pushing or pulling it. As the participants became quickly bored without the encouragement of the researcher. One of the participants expressed an interest in adding music to make the product more entertaining and engaging. This was also something they enjoyed from the previous sessions.

The need for automatic movement was also highlighted, as the prototype required frequent manual adjustments to keep the game engaging and fun for up a couple of minutes (see Figure 6.9). While residents were interested in the idea of launching the balls out of the bucket, the feature was not fully functional in the prototype, making it difficult to evaluate. However, participants did attempt to launch the ball themselves, indicating potential interest in this functionality.

Design insights

- Additional stimuli, such as music, should be incorporated to make the experience more engaging.
- The product must present clear objectives for the interaction to maintain user motivation.
- The product should signal when the interaction is complete after a few minutes, providing positive reinforcement for the participants' engagement.

6.3 FINAL DESIGN

The concept of Ledemaatje has been refined based on the residents' interaction with the product and their feedback, particularly regarding the need for additional stimuli and clear objectives during use. This, along with defining the technical functionality, has resulted in the final design, which is shown in Figure 6.10.

Product interaction

To use Ledemaatje, it must be securely clamped to the side of a table, with users seated around it and within reach of the product. When powered on, lights on the bucket illuminate to signal that the product is ready and to highlight the primary interaction point. After a few seconds, music begins to play, and the product automatically rotates in increments, encouraging user engagement. When the bucket comes within reach, participants are prompted to push it away towards a fellow user. After roughly a dozen pushes, the bucket will open, launching a ball accompanied by cheering sounds to motivate the users. The goal is then for all users to return the balls to the bucket before it closes, while it continues to move. These automated movements keep the user engaged and sparks PA. An overview of the interaction steps is visualized in the storyboard in Figure 6.11.

The difficulty level can be adjusted by turning a dial on the base, which controls the product's movement speed. After a few minutes, the music will stop, and applause will signal the end of the activity. The product then powers down to prevent unexpected movements that could cause accidents when the product is left unattended. A new session can be started by pressing the button, which can also be used at any time to turn off the product if any issues arise during use.

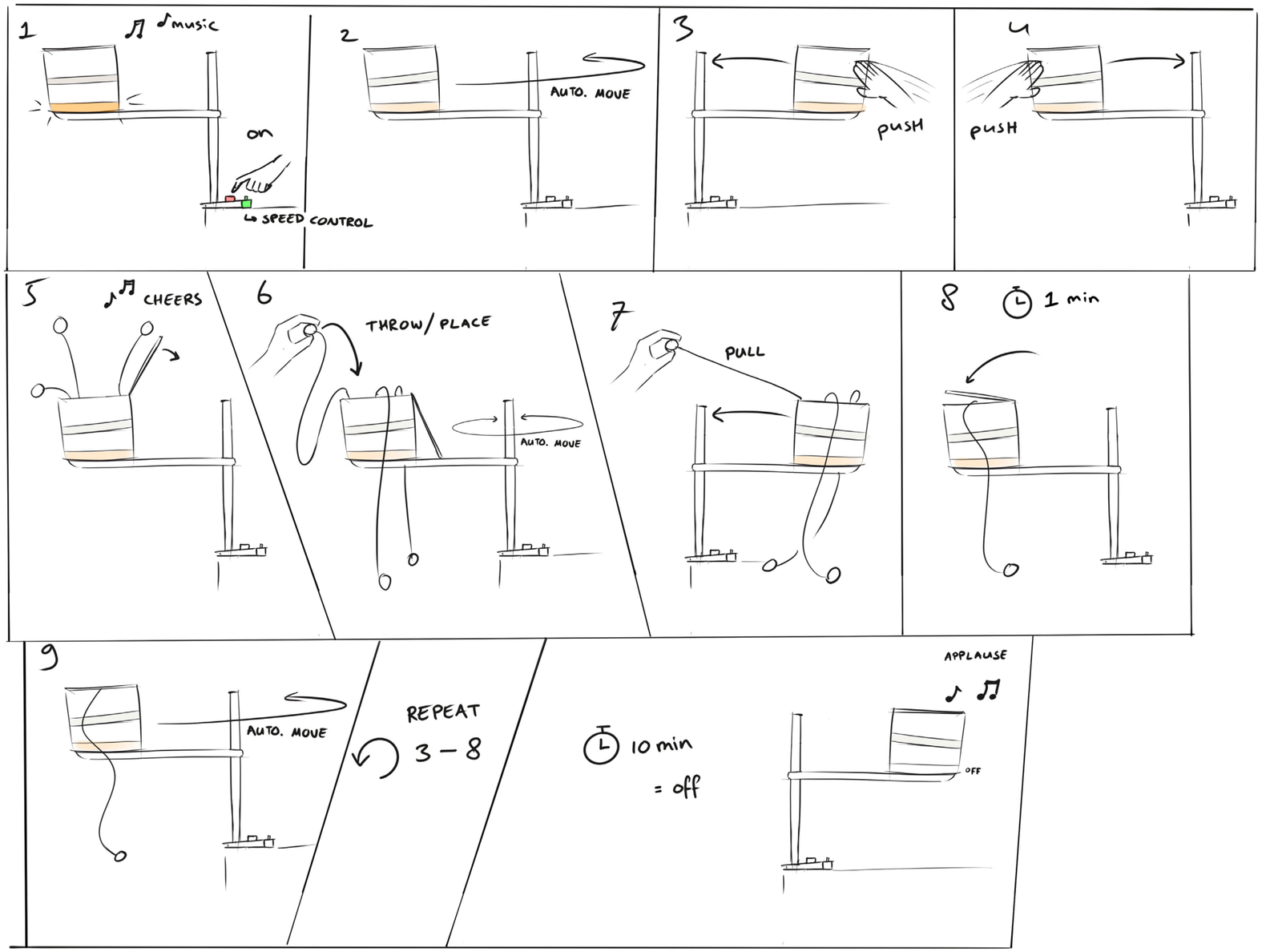


Figure 6.11: Storyboard of the interaction with Ledemaatje.

Figure 6.12: Adjusting the movement speed.

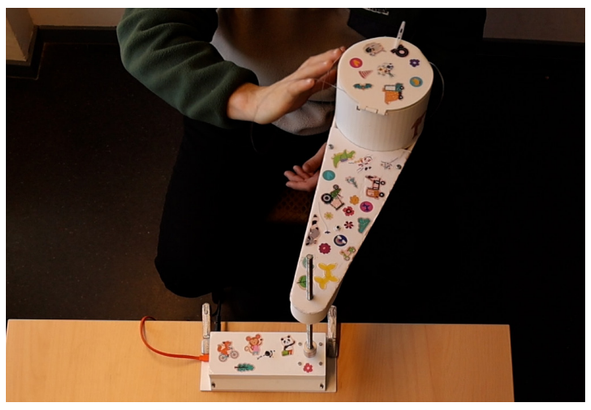


Figure 6.13: Pushing Ledemaatje.

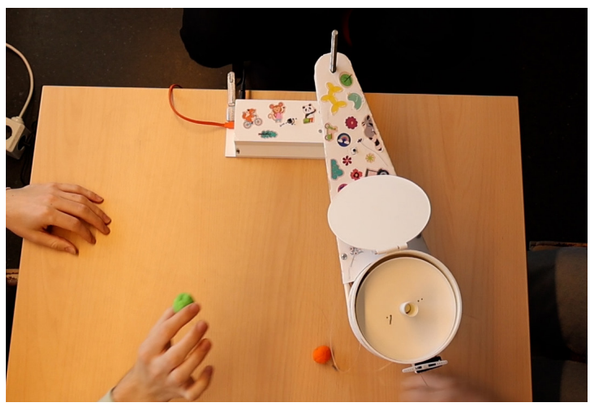


Figure 6.14: Throwing balls back into the bucket of Ledemaatje.

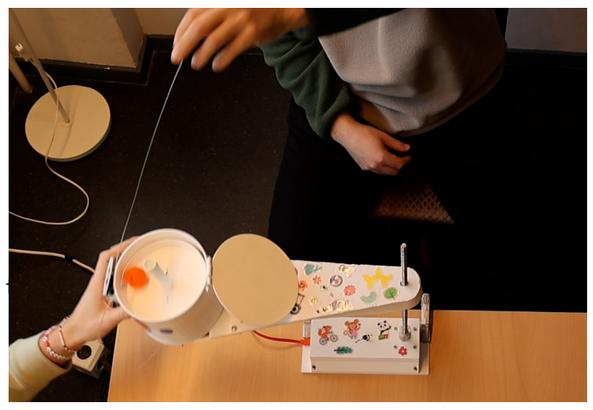


Figure 6.15: Pulling Ledemaatje by the string attached to the ball.

Figure 6.16: Ledemaatje attached to a table in a living room setting.

Product use in context

Ledemaatje is designed to be used independently by older adults with mild intellectual disabilities, thanks to its compact form and intuitive interactions. However, some caregiver assistance is still required for setup and initial introduction of the product. Once set up, users can start and stop interactions simply by pressing a button.

Additionally, the focus of this project has been on seated activities, as standing exercises were not feasible for the people involved in this project, due to their physical limitations and safety concerns. However, to accommodate a broader audience and maximize health benefits, the final design can be adjusted for standing use (see Figure 6.18). Caregivers can replace the rod with a longer, more stable version to support this adjustment. For standing use, it is crucial that there is ample space around the table, and that users have extra support, such as a walker with the brakes engaged, when needed.

The product can remain attached the one of the tables in the communal area of the residency to serve as a visual reminder (see Figure 6.16), similar to the hometrainer discussed in Chapter 3. However, in order to encourage users to keep

Figure 6.17: Ledemaatje decorated with stickers.

it on display, it is essential to add a personal touch. The residents like to be creative and enjoy showing off their work, this can be noted by the drawings displayed in the common area and through interactions while visiting the residency in which some residents proudly shared their artistic creations. This was also observed when visiting other location of 's Heeren Loo at the start of the project as well as in the preceding thesis of Adriaanse (2022). Therefore, an important step before using the Ledemaatje is to allow users to decorate its exterior, allowing them to personalize the design and make it something they are proud to display. Decorations depend on what is avaiable at the residency, ranging between painting on the product or adding stickers, as can be seen in Figure 6.17. Although, an extra layer protective coating or glue may be added to make the decorations stay on the product during use.

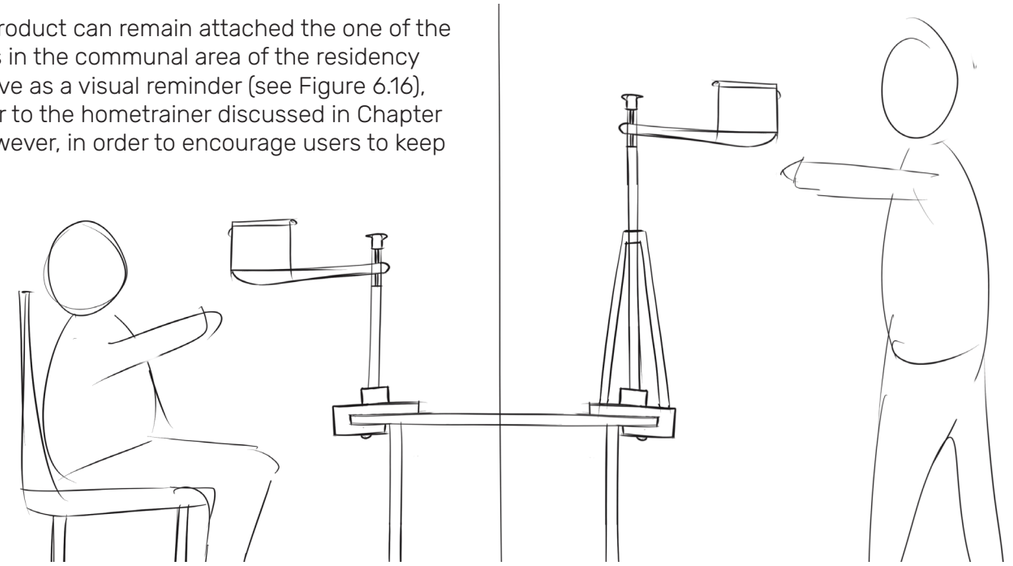


Figure 6.18: Extending Ledemaatje for standing use.

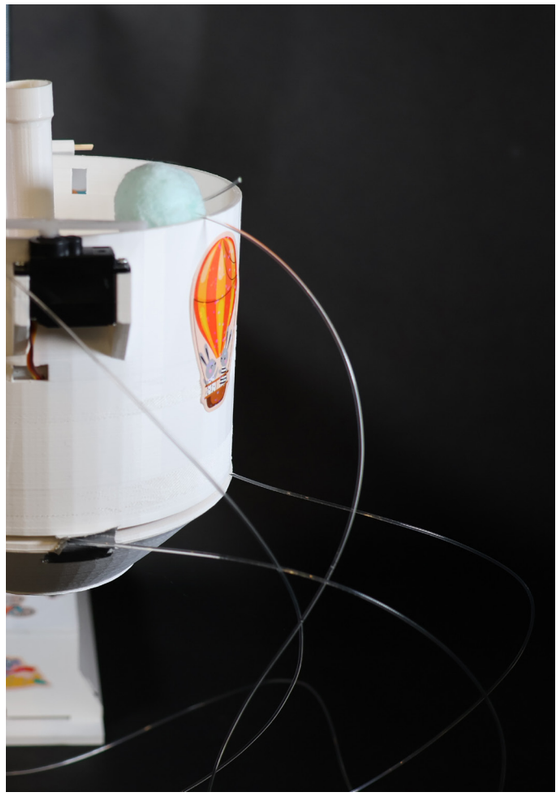


Figure 6.19: Nylon cords attachted to the launching balls.

Technical workings

As briefly mentioned at the start of this chapter, Ledemaatje makes use of a stepper motor to automatically move the arm and bucket in a circular motion. The arm is attached to the rod by using a threaded hole with the same diameter as the rod. This ensures a snug fit that is secure enough so that the arm moves in accordance with the rod, while simultaneously being loose enough so it can freely move around when being pushed or pulled (see Figure 6.20), even as the stepper motor is moving in the opposite direction. The stepper motor is programmed to move around 90 degrees every few seconds. The tempo between spins can be adjusted by using a dial (see Figure 6.21), making it possible to create a more challenging interaction by decreasing the pause between spins and vice versa. The direction in which the motor, and therefore the arm, spins is randomized to keep the user engaged (see Appendix G).

The launching balls are attached to the bucket with thin nylon cords (see Figure 6.19). This type of cord is specifically used because the smooth texture of the cord makes it less likely to tangle compared to other materials, and if it tangles the cords can be easily pulled apart. During product testing the cords did get stuck by wrapping themselves around the rod after longer periods of use. This can be fixed by spinning the bucket in the opposite direction, but this is annoying when having to do this multiple times when playing around with the product. Therefore, to minimize this effect the motion of the arm has been programmed to regularly switch between spinning clockwise and counterclockwise. This way, the cord is less likely to fully wrap around the rod.

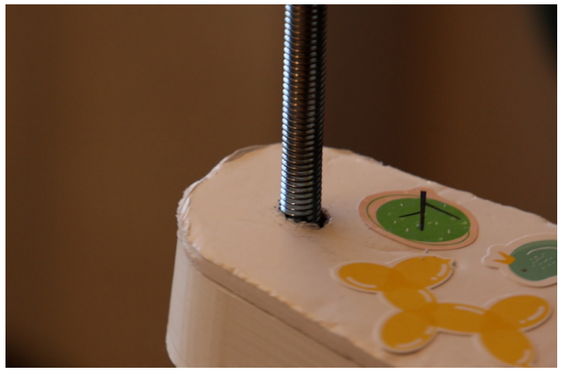


Figure 6.20: Arm attachment to rod.

Figure 6.21: Dial to adjust the time between spins.

Figure 6.22: Visual representation of aluminum strip.

The exterior of the bucket is fitted with an aluminum strip as presented in Figure 6.22. When the strip is connected to an electric circuit, it is able detect the electrical conductivity of the human body when touched, similar to the workings of a touchscreen. Being able to register human touch, allows the system to keep track of how many times the bucket has been pushed and initiates the launching mechanism.

There are multiple steps and mechanisms involved in launches the balls out of the bucket, as is presented in the storyboard in Figure 6.24.

When the balls are thrown in the bucket, they lend on a platform inside the bucket that is positioned on top of a spring (See Appendix F). To initiate the launching mechanism, the platform is pulled down by two servo motors inside the bucket. This compresses the spring and creates tension. Next, the lid is moved on top of the bucket and held in place by two other servo motors. Once the lid is secure, the two servo motors inside the bucket release the platform, but due to the protrusion on top of the platform it is still trapped underneath the lid. Finally, once it is time to launch the balls, the latch keeping the lid in place is released, that in turn releases the spring. This motion pushes the platform upward which launches the balls out of the bucket (see Figure 6.23).

The code used to program this system can be found in Appendix G.

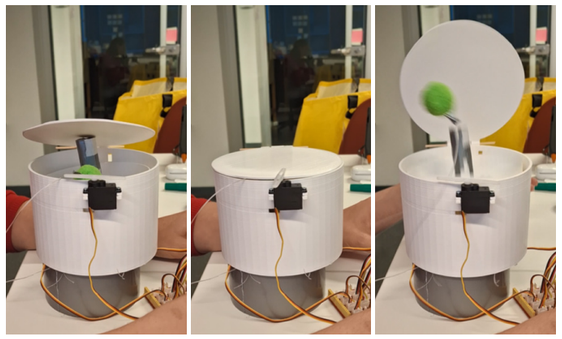
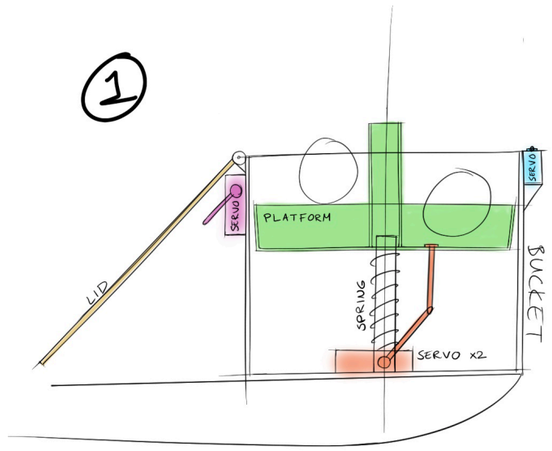
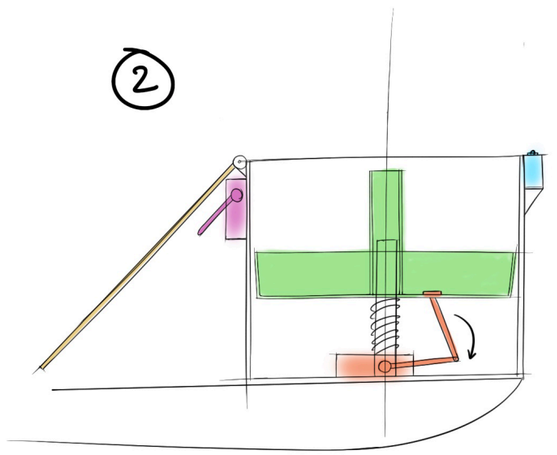


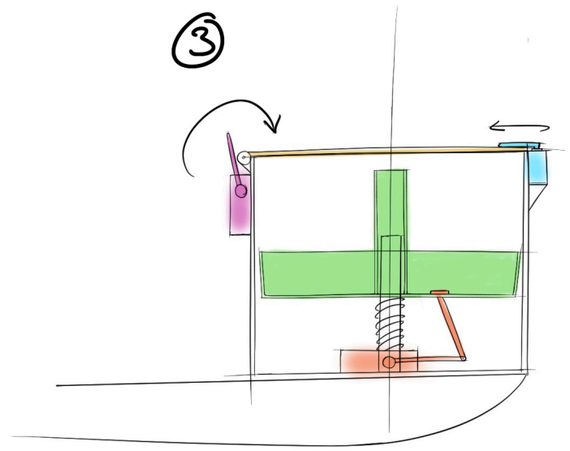
Figure 6.23: Prototype of launching mechanism.



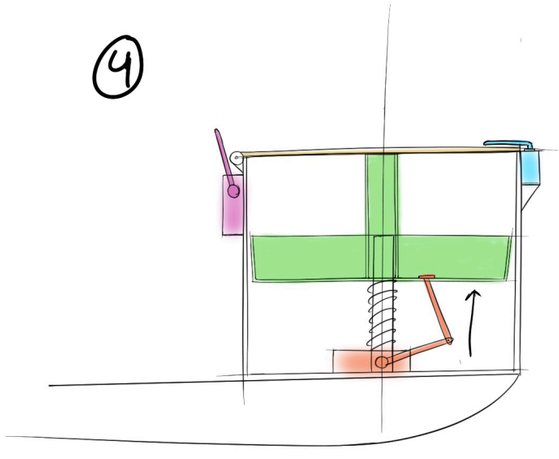
The little ball are placed back in the bucket.



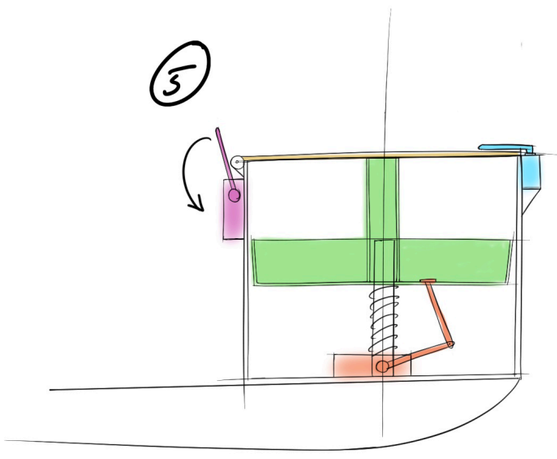
The platform (green) is pulled down by the servo motors (orange), putting tension on the spring.



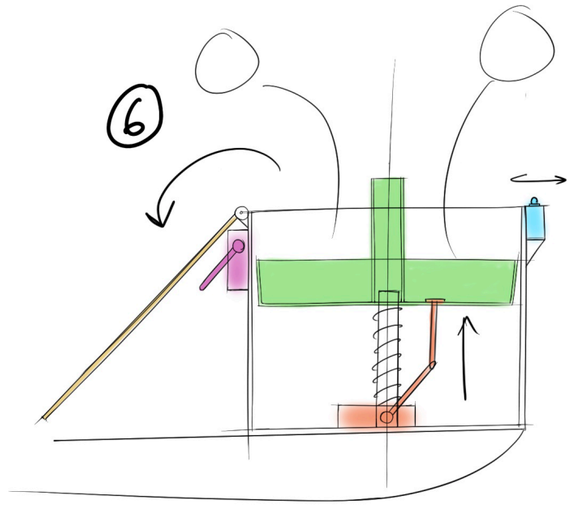
The lid is closed one servo motor (purple), while another servo motor (blue) locks the lid in place.



The platform is released by the orange servo motors, but still held in place by the lid. This way, there is still tension on the spring.



The arm of the purple servo is moved back, to allow space for the lid to pop open once it is released.



Finally, the blue servo releases the lid, allowing the spring to expand. This causes the platform to jump up, lauching the little ball out of the bucket.

Figure 6.24: Storyboard of the launching mechanism of Ledemaatje.

6.4 EVALUATION FINAL DESIGN

The final design was evaluated with the participating residents and one of the caregivers of the residency. The evaluation session with the residents aimed to access the intended interaction scenario in terms of usability and engagement. This involved guiding residents through the intended use scenario, gathering feedback through observations during the session, and asking questions after the session. The caregiver evaluation focused on understanding the product's usability within the broader residency context. For this, the product was demonstrated, followed by an interview to gather the caregiver's insights.

6.4.1 Evaluation with residents

The evaluation with the three participating residents focused on the product interaction experience, specifically assessing ease of use, user engagement and the level of PA provoked by the interaction. This was done using the final prototype, which featured automated movement of the arm in combination with the ball-launching system that could be activated by pressing a button. This setup allowed participants to interact with the product semi-independently, although assistance was still needed to close the lid and reset the ball launching system. In addition, sound cues that were part of the product interaction scenario, such as music, cheering, and applause, were played through a Bluetooth speaker. Feedback was collected through observations during the session and by asking follow-up questions after participants interacted with the prototype.

Research questions:

1. Is the intended product interaction clear for users to understand and follow?
2. Does the product accommodate users of varying physical abilities?
3. To what extent does interaction with the product elicit PA?
4. To what extent does the product maintain user engagement during use?
5. Do participants enjoy interacting with the product and does it create a fun experience?

Plan

The three participating residents first received a brief introduction to the product. The researcher turned on the prototype and guided them through the steps together (see Figure 6.25). Once the music started, the participants were encouraged to engage with the product as practiced. Since the prototype was not fully automated, the researcher had to manually release and close the lid of the bucket throughout the session, in addition to playing the accompanying cheering sounds. This made the interaction only partially autonomous. The activity continued for the intended 10 minutes, after which the music was turned off and the sound of applause was played as a cue that the session had been successfully completed. Finally, the participants were asked a few questions about their experience with the product.

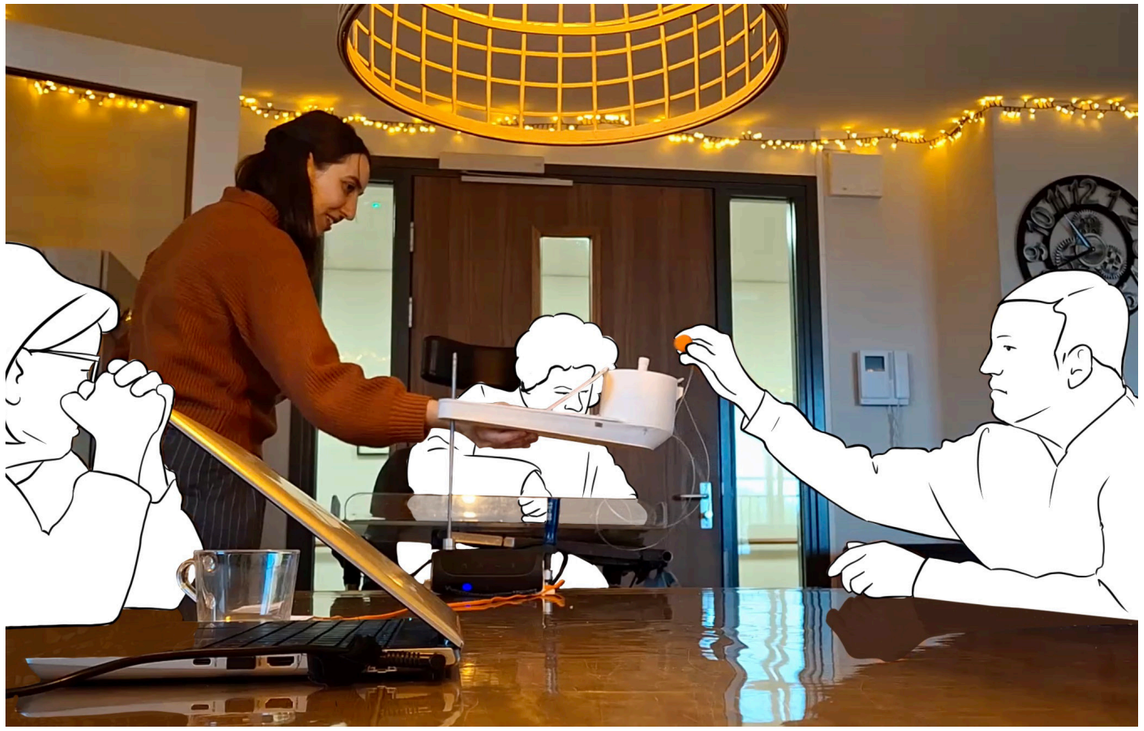


Figure 6.25: Practise round before evaluation session.

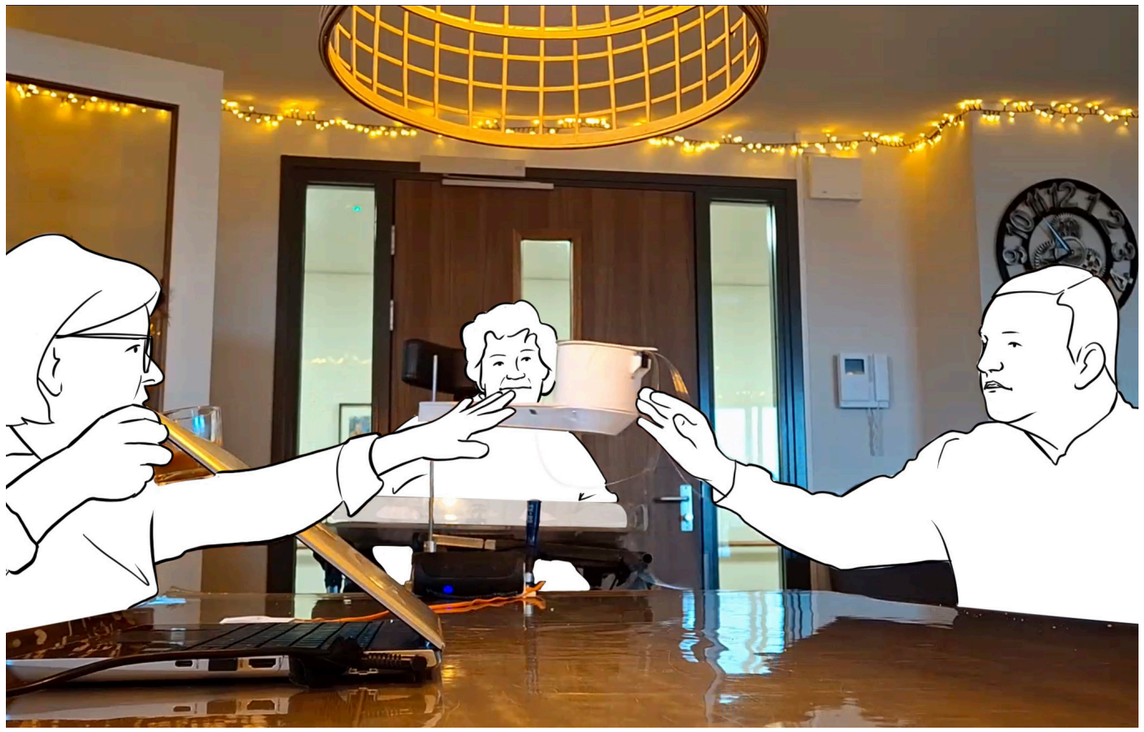


Figure 6.26: Residents interacting with Ledemaatje during evaluation session.

Figure 6.27: Ledemaatje decorated with stickers, with the help of one of the residents.

Findings

After a brief explanation and a practice round, participants quickly understood how to interact with the product. The main task was to push the bucket back and forth to reach each other. Although, due to the randomized movement of the arm, it sometimes required a few attempts to get a ball in the bucket. This did not discourage the participants, in fact, they supported each other, which motivated everyone to stay engaged.

The design of the product allowed participants of varying physical abilities to interact comfortably. All participants were able to push and pull the bucket regardless of the speed of the arm movement (see Figure 6.26). However, when it came to throwing balls into the moving bucket, some participants found the task challenging if the arm moved too quickly, which could lead to frustration. Slower movements allowed more participants to successfully throw balls into the bucket, but prolonged waiting could lead to a loss of focus as others took their turn. Adjusting the speed based on the task, slower for throwing and faster for pushing, would likely optimize both engagement and accessibility.

The products automated movements did elicit PA through various arm movements as seen in the previous session. In addition, residents kept changing their posture, depending on the position of the bucket. When it was moving towards them, they straightened up to either push it away or throw a ball in to it. Once this task was complete, they would slough back into their seat. This behavior was, once again, dependent on the movement speed of Ledemaatje. When this increased, they started to be more actively engaged changing their posture to being straight for a longer period of time.

The primary activity of pushing the bucket provided consistent physical movement. Even after the main interaction period of approximately 10 minutes, one participant continued to playfully push the bucket as a pastime, demonstrating continued interest in the activity.

During practice with the prototype, one resident needed time to adjust to the mechanical noises. Overall, however, the activity seemed enjoyable, with participants having fun despite occasional moments of frustration when the arm moved the bucket out of reach during ball tosses.

Additional Decoration

Although not part of the formal evaluation plan, residents were invited to help decorate the prototype after the session. The purpose was to observe their reactions to personalizing the product and to gain insights into what this decoration process could involve. Additionally, this activity was intended to provide a sense of closure to the project. However, the session had mixed results: one resident had to leave earlier than expected due to a prior commitment, while another was tired after the activities and chose to rest in their room instead.

This left one resident to assist with the decoration, who was fortunately enthusiastic about participating in this activity. Given this resident's physical abilities, stickers were chosen as the decoration medium, as other available art supplies were not accessible for them to use. Decorating with stickers turned out to be an enjoyable activity for the resident and added a playful element to the product's appearance (see Figure 6.27). Although this small trial does not offer sufficient information to make definitive recommendations on the decoration process, it suggests that decoration activities would have been more successful if planned as a separate session.

6.4.2 Evaluation with caregiver

As a final evaluation a caregiver of the residency was interviewed on whether the final design would be the right fit for the people at the residency as intended. This was done just after the evaluation session with the residents, so the caregiver was able to see the product in use.

Research questions:

- Does the product fit within the residency and the other residents?
- When would they envision using the product within the home?
- To what extent would residents be able to use the product independently?

Findings

According to the caregiver, the product appears to be a good fit for the participating residents. This is largely due to its automated features, which make it easy and enjoyable to use. However, the constant motion might be tense or overstimulating for some other residents.

The caregiver stated that Ledemaatje would likely be well-suited as part of the daily activities held at the SOOS, where it could be initiated a few times a week. There is a possibility of even daily use, but that is highly dependent on how well it is received by residents, which can sometimes be difficult to predict. Ledemaatje can stay in a visible area in the SOOS, if it is easily switched between different tables, and not permanently attached to any single table.

While the caregiver does think that the product can be largely used independently. They would still suggest caregiver supervision. This is less of an issue at the SOOS, as there are often caregivers in the vicinity. Moreover, as an innovative product, Ledemaatje requires some extra assistance when first introduced, helping residents adjust to the experience. However, once seen in use, the caregiver found product's operation is intuitive to use for residents, providing a simple, creative solution for encouraging physical activity.

7

CONCLUSION

Bringing this project to a close, this chapter reviews the project and its outcomes. The discussion examines the results in light of the previously established design goals. From this, recommendations for further development are proposed. The chapter concludes with a reflection on the participatory design process involving ‘s Heeren Loo residents, as well as a personal reflection.

7.1 DISCUSSION

In this chapter, the results of this project will be reviewed to see if the goals set out during this project were met, while also looking at the strengths and limitations of this project. In addition, the chapter shows how this project contributes to the existing literature.

Design Goal

The aim of this project is to *increase PA of older adults, with mild ID living at a 's Heeren Loo residency, by designing a playful product which encourages social interaction and can be used autonomously.*

Subgoals:

- Stimulating small changes while creating a positive association with PA
- Being accessible by both residents and residency
- Being available and visible

In order to discuss and assess whether these goals have been achieved by the final design, it has been broken down into five parts:

Increasing physical activity

This project aimed to introduce small, positive changes in PA for residents. The focus was on creating an enjoyable experience rather than high-intensity exercise. A key challenge was to balance motivation, accessibility, and increased PA. Many residents were hesitant to try larger movements if they anticipated discomfort or difficulty, which created a need for external motivation that conflicted with the goal of fostering independent use. Similar to this, the intervention was designed to be used being in a seated position, considering the physical abilities of the residents involved.

During the design sessions, it became clear that activities performed needed to be similar for all users, in order to avoid confusion and foster a collaborative environment. However, varying physical abilities made it difficult to fully meet the needs of each resident. To create an enjoyable social experience, activities were chosen that were accessible to all participants. As a result, not all residents achieved elevated levels of PA. Still, due to its interactive feature being positioned above the table, Ledemaatje encouraged arm and shoulder movements that are not typically used in everyday activities.

A goal of 10 minutes of use was set, which corresponded to the duration residents typically engage in other PA activities at the residency. Which was also consistent with their attention span during participatory design sessions. Although sound cues helped maintain engagement, Ledemaatje could not fully replace the motivation provided by caregivers. However, its automated movements proved effective in keeping residents active.

In conclusion, this project successfully promoted light, seated activities that engaged residents. Although Ledemaatje could not fully replace caregiver encouragement, its automated movements were effective in stimulating physical activity and offered residents an alternative way to stay active.

Fostering a positive experience

One of the main facilitators found in previous research was to create a positive and social experience. Therefore, creating an activity that residents could perform together was important. Moreover, as found in literature and noticed throughout the participatory sessions, it was important to shift the focus from PA to creating a fun experience that would 'unintentionally' spark PA. Shifting the attention towards engagement with others, reduces potential feelings of inadequacy and encourages sustained participation. Sound cues like applause and cheering contributed to this positive experience, helping users feel motivated and accomplished. Observations during testing highlighted that this playful approach improved users' mood and willingness to engage in repeated interactions.

Autonomous use

Ledemaatje's simple interactions, combined with the lack of separate parts, make it an accessible product that many users can use autonomously. Findings from user testing confirmed that Ledemaatje's automated movements effectively help users stay engaged and encourage them to perform various movements while interacting with the product. However, the initial setup still requires the involvement of a caregiver, which is a barrier for users to use the product on their own. As the research on previous interventions has shown (see Chapter 2.3), it is important to provide users with this autonomy and choice. However, there is also something to be said about whether fully

independent use is desirable, because residents enjoy being able to spend time with caregivers. This was not fully explored during the project but became clear during the evaluation sessions of the final design. This can also be seen in the use of the home-trainer by the residents. While some enjoy using it independently, others need guidance from caregivers to make it an enjoyable experience.

Accessibility

The intended interactions with Ledemaatje are kept simple to ensure cognitive inclusivity. While there is a brief learning curve due to its novelty, a short introduction is enough for residents to feel comfortable using it, as observed during evaluation sessions.

When attached to a table, Ledemaatje allows residents to easily initiate use, and the adjustable arm speed provides flexibility in difficulty, adapting to individual abilities. Ledemaatje was designed to be accessible for residents in electric wheelchairs, addressing the needs of one particular resident. However, a caregiver noted that the movements may feel overwhelming for some residents. During the first demonstration, one resident found the motor sound unpleasant.

To maintain affordability, Ledemaatje was developed without costly electronics, such as sensors. Instead, it relies on commonly available motors to keep production costs low, making it financially accessible for care facilities. Ledemaatje provides an accessible, adaptable way for residents to engage in light PA, though minimizing sensory discomfort could further improve the experience.

Visibility

For Ledemaatje as a regular PA prompt, it was important to make it both visible and readily available. Much like the home trainer in the residency, Ledemaatje can be left out in communal areas, acting as a visual reminder and encouraging spontaneous use. Moreover, involving residents in decorating Ledemaatje's exterior allows for a sense of personal ownership, increasing the likelihood that they will engage with it more frequently. However, this last part is highly dependent on the user, as the caregiver interviewed remarked that some may find this too childish of an activity to engage with.

To conclude, Ledemaatje is able to stimulate small changes in PA by sparking physical interactions through automated movements. The product is designed to be accessible and visible, while its interactive features helped engage residents. Overall, it provides an enjoyable and social way for residents to participate in PA. Although, the level of autonomous use is somewhat limited by the need for caregiver assistance.

Project strenghts

This project's primary strength lies in its participatory design approach, where user input guided the development process from start to finish. By involving residents directly and consistently incorporating their feedback, the design evolved in a way that aligns with the unique needs, preferences, and abilities of the target audience. Even though it is essential for the implementation of interventions, this user-centered approach is not commonly used when developing interventions for people with intellectual disabilities. Therefore, this project contributes to the knowledge on actively people with intellectual disability in the design process.

Another key strength is Ledemaatje's ability to create engaging interactions autonomously, requiring minimal setup and assistance from caregivers. Once activated, the product independently prompts users with interactive movements, sound cues, and other sensory elements that motivate users to stay active. This feature empowers residents to use the product independently, reducing the need for constant caregiver involvement while fostering a sense of agency. By balancing independence and accessibility, Ledemaatje becomes a practical, self-directed activity that caregivers can integrate easily into residential settings.

Project limitations

A primarily limitation to this project is the small sample size, as only three residents participated in the development of the final design. This limits the generalizability of the findings to a broader population. Additionally, the project focused exclusively on seated activities, which may not reflect the needs of users who are capable of more varied forms of physical activity. Further evaluation with a broader participant base would have validated and refined the product's effectiveness across a wider range of abilities and preferences.

Likewise, the final design was not evaluated with a more diverse group of stakeholders and experts, which might have provided additional insights into its usability and impact across different care settings.

Lastly, no research was conducted on the product's effectiveness over an extended period, so it remains unclear whether the product can effectively be used and helps increase physical activity in the long term.

7.2 RECOMMENDATIONS

The next recommendations are proposed in order for the further development of Ledemaatje:

1. Further Research with a Broader Audience
Future research should include a larger and more diverse group of participants to assess the product's usability and effectiveness across various settings. Testing with a wider audience will help to ensure the product's adaptability and inclusivity.

2. Creating Adjustable Features
To better accommodate users with diverse capabilities, the product should include adjustable settings, such as the number of pushes required to open the bucket, the overall duration of interaction, and the speed and intensity of movement. This flexibility would allow caregivers to tailor the product's use for each resident's physical and cognitive abilities, enhancing inclusivity and engagement. Additionally, testing standing use could help determine further adaptations for users with varied mobility levels.

3. Increasing Built-In Encouragement
Adding more forms of encouragement directly within the product could improve user motivation and engagement. Researching new auditory, visual, or tactile prompts may enhance the overall user experience and sustain interest over time.

4. Enhancing Product Safety
The safety considerations of the final design need to be developed for autonomous use. This includes features such as padded surfaces and ensuring that the product remains below head height during use. These adjustments could prevent potential injuries and increase comfort for users.

5. Optimizing Mechanical Components
Improvements to mechanical features, such as strengthening the spring system that launches the balls, are necessary for consistent performance. In the current prototype, weak springs and lower-cost motors have limited reliability, so upgrading these components will be essential. Additionally, while the prototype is optimized for 3D printing, design adjustments are recommended to make it suitable for scalable production methods, such as injection molding.

6. Refining the Product Form
Although the current design follows a form-follows-function approach, further research is recommended to refine the product's aesthetic appeal. Design enhancements can ensure that Ledemaatje aligns better with users' preferences for a more inviting appearance.

7. Exploring Personalization Options
More research is recommended into the personalization/decoration process during the initial stages of product use. Finding ways to make customization enjoyable for a wider range of users could enhance feelings of ownership and encourage regular interaction with the product.

Together, these recommendations aim to refine the final design, making it better suited for implementation.

7.3 CONCLUSION

This project developed Ledemaatje, an interactive product aimed at promoting physical activity among older adults with mild intellectual disabilities.

Through a participatory design approach, the project aligned closely with the needs and preferences of its users, emphasizing accessibility, enjoyment, and independence. Ledemaatje enables users to engage in physical activity with minimal caregiver intervention by autonomously guiding interactions through movement and sensory cues, fostering a sense of agency and social connection.

Although the current prototype has limitations, such as a small participant group and a focus on seated activities, Ledemaatje demonstrates the potential for creating inclusive, user-centered solutions that encourage physical activity and independence in residential care settings.

7.4 REFLECTION

Participatory design process

Reflecting on the participatory design process with the three residents at ‘s Heeren Loo, much of what has been highlighted in previous projects was also experienced here. These were found most important throughout this project:

Actions speak louder than words:
Recording sessions proved essential for later review, as it was challenging to observe everything in real time, especially when managing interactive elements of the product. Video footage allowed for closer analysis of missed interactions and product engagement. In addition, it was helpful to keep questions short and to the point after each session; participants quickly lost interest if too many questions were asked or became frustrated with repeated questions on the same topic.

Use realistic prototypes:
This approach, supported by previous research, was highly effective. A tangible prototype allowed participants to engage directly with the product, making it easier to test specific actions and gain nuanced insights. Physical prototypes also provided a concrete reference during follow-up discussions, helping to guide conversations and increase clarity. Participants were open and honest in their reactions, resulting in straightforward and valuable feedback. This did mean, however, that sessions needed more preparation, as each time some sort of prototype had to be developed.

One task at a time:
Allowing sufficient time for each activity without overlapping was critical. While some sources suggested encouraging participants to think aloud to gain insight into their thinking, this would unnecessary complexity when participants were asked to do so. Instead, asking questions immediately after each activity provided clearer feedback and made the experience smoother.

Planning flexibility:
The residency involved in this project was very supportive and flexible with scheduling sessions. Still some planning adjustments were necessary. At times, overlapping schedules or changing moods of participants required adjustments to planned activities. In these instances, it was helpful to shorten sessions or modify activities to better meet participants’ needs and energy levels.

Acting as motivator:
As noted in previous literature, maintaining an active and engaging presence was essential for eliciting feedback. Participants were more likely to share their thoughts when prompted in a positive, energetic manner. However, it was also important to balance enthusiasm to avoid overwhelming participants and to create a comfortable environment for feedback.

Personal reflection

As anticipated, it took some time to adjust the sessions to fit both the daily routines of the residency and the residents themselves. Finding the best approach for gathering feedback involved a good amount of trial and error, eventually leading me to focus heavily on observations as the primary feedback method. Over time, observing residents’ interactions became the most effective way to gather valuable insights, as described in this report. Despite the initial challenges, I genuinely enjoyed the participatory design sessions. It was fulfilling to get to know not only the project participants but also other residents and caregivers, building a connection within the community.

I’m especially grateful to have worked closely with a target group that is not usually included in the design process. This project gave me a new perspective on inclusive design and strengthened my skills in facilitating a participatory design process—an area I hadn’t had much experience with before, but one I wanted to develop further before graduating. Working with this group required me to adjust my expectations, especially as some ideas that seemed promising initially didn’t engage participants as I’d hoped. Through repeated trial and error, I learned that simplicity was key for creating engaging interactions. Even when certain sessions didn’t go as planned, I was able to gain valuable insights and pivot the project’s direction based on these learnings.

One of the main challenges I encountered was balancing the involvement of multiple stakeholders throughout the project. Coordinating input and guidance was incredibly valuable and helped elevate the project, but I found it difficult at times to incorporate reflective feedback while maintaining forward momentum. I often felt a step or two behind, as if each new insight required substantial adjustments, which sometimes disrupted progress. This balance between continuous reflection and steady progress is an area I still need to work on.

Additionally, I found myself spending a significant amount of time in the conceptual design phase, trying to identify a direction that would be practical and engaging for the residents. This part of the project required patience, as it took several sessions to land on an approach that fit the residency’s needs. However, I was able to transition to embodiment design toward the project’s end, which allowed me to leverage my strengths and create a tangible outcome that I could proudly showcase. This shift was a rewarding experience and gave me a strong sense of accomplishment as I brought the project to completion.

REFERENCES

Adriaanse, K. (2022). Involving older adults with an intellectual disability in the design process of the MakiMove: A modular intervention for stimulating physical activity [Technical University of Delft]. http://resolver.tudelft.nl/uuid:681c8107-d527-48a6-a62e-83cef97c24c5

Almuhtaseb, S., Oppewal, A., & Hilgenkamp, T. I. M. (2014). Gait characteristics in individuals with intellectual disabilities: A literature review. Research in Developmental Disabilities, 35(11), 2858–2883. https://doi.org/10.1016/j.ridd.2014.07.017

American Psychiatric Association. (n.d.). What is Intellectual Disability? Retrieved April 30, 2024, from https://www.psychiatry.org:443/patients-families/intellectual-disability/what-is-intellectual-disability

American Psychiatric Association. (2022). Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR). American Psychiatric Association Publishing. https://doi.org/10.1176/appi.books.9780890425787

Anderiesen, H. (2017). Playful Design for Activation: Co-designing serious games for people with moderate to severe dementia to reduce apathy [Delft University of Technology]. https://doi.org/10.4233/UUID:EBEEF0FA-46FE-4947-86C1-C765A583770A

Benton, L., Johnson, H., Ashwin, E., Brosnan, M., & Grawemeyer, B. (2012). Developing IDEAS: Supporting children with autism within a participatory design team. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, 2599–2608. https://doi.org/10.1145/2207676.2208650

Bossink, L. W. M., Van Der Putten, A. A., & Vlaskamp, C. (2017). Understanding low levels of physical activity in people with intellectual disabilities: A systematic review to identify barriers and facilitators. Research in Developmental Disabilities, 68, 95–110. https://doi.org/10.1016/j.ridd.2017.06.008

Chambers, H. G., & Sutherland, D. H. (2002). A Practical Guide to Gait Analysis. JAAOS - Journal of the American Academy of Orthopaedic Surgeons, 10(3). https://journals.lww.com/jaaos/fulltext/2002/05000/a_practical_guide_to_gait_analysis.9.aspx

Dairo, Y. M., Collett, J., Dawes, H., & Oskrochi, G. R. (2016). Physical activity levels in adults with intellectual disabilities: A systematic review. Preventive Medicine Reports, 4, 209–219. https://doi.org/10.1016/j.pmedr.2016.06.008

De Wit, M., Moonen, X., & Douma, J. (2011). Richtlijn Effectieve Interventies LVB (p. 58). Landelijk Kennis Centrum LVG. https://www.kenniscentrumlvb.nl/product/richtlijn-effectieve-interventies-lvb-2/

Ellemeet aan Zee. (2021, May 31). Beweegpark—Ellemeet aan Zee. https://ellemeet.top/beweegpark-ellemeet-schouwen-duiveland/

Fit met Steffie. (n.d.). Hoe werkt Fit met Steffie? Fit met Steffie. Retrieved September 5, 2024, from https://www.fitmetsteffie.nl/nl/hoe-werkt-het-/

Fjellstrom, S., Hansen, E., Hölttä, J., Zingmark, M., Nordström, A., & Lund Ohlsson, M. (2022). Web-based training intervention to increase physical activity level and improve health for adults with intellectual disability. Journal of Intellectual Disability Research, 66(12), 967–977. https://doi.org/10.1111/jir.12984

Fogg, B. (n.d.). Behavior Model. Behaviormodel. Retrieved September 6, 2024, from https://behaviormodel.org/

Fogg, B. (2009). A behavior model for persuasive design. Proceedings of the 4th International Conference on Persuasive Technology, 1–7. https://doi.org/10.1145/1541948.1541999

Gaesser, G. A., Angadi, S. S., & Sawyer, B. J. (2011). Exercise and Diet, Independent of Weight Loss, Improve Cardiometabolic Risk Profile in Overweight and Obese Individuals. The Physician and Sportsmedicine, 39(2), 87–97. https://doi.org/10.3810/psm.2011.05.1898

Haarmann, A., Voss, H., & Boeije, H. (2019). Sporten en bewegen door mensen met een lichte verstandelijke beperking. NIVEL. https://www.nivel.nl/sites/default/files/bestanden/Sporten_en_bewegen_mensen_lichte_verstandelijke_beperking.pdf

Hardy, I. (2023, May 10). Select Fitbit Fitness Trackers and Smartwatches are up to 25 percent off. MobileSyrup. https://mobilesyrup.com/2023/05/10/fitbit-smartwatch-google-amazon-canada/

Hilgenkamp, T., & Oppewal, A. (2022). Physical activity, exercise and fitness: The new medicine. Journal of Intellectual Disability Research, 66(12), 901–902. https://doi.org/10.1111/jir.12985

In Beweging. (n.d.). Senioren sport met In Beweging – In Beweging. Retrieved September 7, 2024, from https://www.inbewegingsport.nl/bewegen/senioren-sport-met-in-beweging/

Kenniscentrum Sport&Bewegen. (n.d.). Beweegrichtlijnen voor mensen met een verstandelijke beperking. Retrieved February 14, 2024, from https://www.kenniscentrumsportenbewegen.nl/beweegrichtlijnen/bewegen-voor-mensen-met-een-verstandelijke-beperking/

Kennisplein Gehandicaptensector. (2024, March 18). Licht verstandelijke beperking. kennispleingehandicaptensector_nl. https://www.kennispleingehandicaptensector.nl/clientgroepen/licht-verstandelijke-beperking

Koopman, N. (n.d.-a). Cliënten over het leven met een lvb (11) [Broadcast]. https://www.middin.nl/podcasts/podcastserie-studio-licht-verstandelijke-

beperking/wat-is-een-lvb

Koopman, N. (n.d.-b). Wat is een lvb? (1) [Broadcast]. https://www.middin.nl/podcasts/podcastserie-studio-licht-verstandelijke-beperking/wat-is-een-lvb

LaCaille, R., & Appleseth, H. (2020). Interventions and Strategies to Promote Physical Activity. In M. D. Gellman (Ed.), Encyclopedia of Behavioral Medicine (pp. 1234–1241). Springer International Publishing. https://doi.org/10.1007/978-3-030-39903-0_1618

Landelijk Kenniscentrum LVB. (2022). Je ziet het niet, dus leer het zien! Landelijk Kenniscentrum LVB. https://www.kenniscentrumlvb.nl/product/je-ziet-het-niet-dus-leer-het-zien/

Maenhout, L., Verloigne, M., Cairns, D., Cardon, G., Crombez, G., Melville, C., Hove, G. V., & Compernolle, S. (2022). Co-creating an intervention to promote physical activity in adolescents with intellectual disabilities: Lessons learned within the Move it, Move ID!-project [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-2312695/v1

Moofie. (n.d.). “Hallo, ik ben moofie”. Zo stelt dit nieuwe, interactieve beweegproduct zichzelf aan je voor. Moofie. Retrieved September 5, 2024, from https://www.moofie.nl/

Oppewal, A., & Hilgenkamp, T. I. M. (2020). Is fatness or fitness key for survival in older adults with intellectual disabilities? Journal of Applied Research in Intellectual Disabilities, 33(5), 1016–1025. https://doi.org/10.1111/jar.12724

Oppewal, A., Maes-Festen, D., & Hilgenkamp, T. I. M. (2020). Small Steps in Fitness, Major Leaps in Health for Adults With Intellectual Disabilities. Exercise and Sport Sciences Reviews, 48(2), 92–97. https://doi.org/10.1249/JES.0000000000000216

Sanders, E. B.-N., & Stappers, P. J. (2012). Convivial design toolbox: Generative research for the front end of design. BIS.

Shields, N., Mizzi, N., Buhlert-Smith, K., Strydom, A., Prendergast, L., & Hocking, D. R. (2022). A 12-week exercise programme has a positive effect on everyday executive function in young people with Down syndrome: A pilot non-randomised controlled trial. Journal of Intellectual Disability Research, 66(12), 924–938. https://doi.org/10.1111/jir.12979

SilverFit. (n.d.-a). Inzet SilverFit 3D bij arm- en handrevalidatie van CVA-patiënten. https://silverfit.com/nl/ervaringen/klantervaringen/inzet-silverfit-bij-ergotherapeutische-arm-handrevalidatie-van-cva-patienten

SilverFit. (n.d.-b). Know more. Retrieved September 5, 2024, from https://www.silverfit.com/en/research

Steffie. (n.d.). Steffie helpt je verder! Steffie.nl. Retrieved September 5, 2024, from https://www.steffie.nl/

Sterker Op Eigen Benen. (n.d.). Dromen, ontdekken en doen! Meer bewegen in het dagelijks leven. Retrieved September 5, 2024, from https://www.sterkeropeigenbenen.nl/kennisproducten/gezond-leven/

Team Sportservice. (n.d.-a). Aan de slag met de beweegtas. Team Sportservice West Friesland. Retrieved September 7, 2024, from https://jouw.teamsportservice.nl/west-friesland/voor-jou/beweegtassen/

Team Sportservice. (n.d.-b). Slimmer Sterk. Team Sportservice West Friesland. Retrieved September 7, 2024, from https://jouw.teamsportservice.nl/west-friesland/project/welke-beweegtassen-zijn-er/attachment/slimmer-sterk-2/

Trimbos. (2016). Verstandelijke beperking en psychische klachten bij ouderen. Trimbos-instituut. https://www.trimbos.nl/kennis/ouderenpsychiatrie-nkop/verstandelijke-beperkte-ouderen/

Westrop, S. C., Rana, D., Jaiswal, N., Wu, O., McGarty, A. M., Melville, C., Ells, L., Lally, P., McEwan, M., Harris, L., & Germeni, E. (2024). Supporting active engagement of adults with intellectual disabilities in lifestyle modification interventions: A realist evidence synthesis of what works, for whom, in what context and why. Journal of Intellectual Disability Research, 68(4), 293–316. https://doi.org/10.1111/jir.13120

WHO. (2020). Guidelines on physical activity and sedentary behaviour. World Health Organization. https://books.google.nl/books?id=QI5FEAAAQBAJ

APPENDICES

APPENDIX A: PROJECT BRIEF

Personal Project Brief – IDE Master Graduation Project

Name student Sophie de Blanken **Student number** 4,569,911

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title Creating an intervention to increase physical activity among older adults with mild intellectual disability

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

The target group of this project is older adults with mild intellectual disability (ID). Individuals with mild ID have an IQ that ranges from 50 to 70 and experience difficulty with conceptual, social and daily living skills (Boat et al., 2015)

Adults with ID are found to have very low physical activity (PA) levels and often have sedentary lifestyles (Hilgenkamp & Oppewal, 2022). PA has been scientifically proven to be a powerful tool in preventing and treating a range of chronic diseases and medical conditions (Oppewal & Hilgenkamp, 2020). In addition, studies show that even a small increase in PA can improve the physical health of those with a sedentary lifestyle. Considering that there is a high prevalence of health problems among individuals with ID, it is especially important to promote more PA (Oppewal et al., 2020).

There are a multitude of reasons as to why the level of PA within this population is so low. As this group is highly dependent on their caregivers, lack of support and accessibility of facilities play an important role in their sedentary lifestyle (Oppewal et al., 2020). Other barriers include motivational issues, lack of awareness of options and financial limitations (Shields et al., 2022; Fjellstrom et al., 2022).

This project is a continuation of the master thesis *"Involving older adults with an intellectual disability in the design process of the MakiMove: a modular intervention for stimulating physical activity"* by Kim Adriaanse. Her final concept will be used as the starting point. In addition, the tools she developed during her thesis on how to design for individuals with mild ID will be used throughout this graduation project.

The project is supervised by TU Delft and Erasmus MC and is in collaboration with the care organization `s Heeren Loo, who are providing the opportunity to work together with the target group.

➔ *space available for images / figures on next page*

introduction (continued): space for images

Boat, T. F., Wu, J. T., Disorders, C. to E. the S. S. I. D. P. for C. with M., Populations, B. on the H. of S., Board on Children, Y., Medicine, I. of, Education, D. of B. and S. S. and, & The National Academies of Sciences, E. (2015). Clinical Characteristics of Intellectual Disabilities. In *Mental Disorders and Disabilities Among Low-Income Children*. National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK332877/

Fjellstrom, S., Hansen, E., Hölttä, J., Zingmark, M., Nordström, A., & Lund Ohlsson, M. (2022). Web-based training intervention to increase physical activity level and improve health for adults with intellectual disability. *Journal of Intellectual Disability Research*, *66*(12), 967–977. https://doi.org/10.1111/jir.12984

Hilgenkamp, T., & Oppewal, A. (2022). Physical activity, exercise and fitness: The new medicine. *Journal of Intellectual Disability Research*, *66*(12), 901–902. https://doi.org/10.1111/jir.12985

Oppewal, A., & Hilgenkamp, T. I. M. (2020). Is fatness or fitness key for survival in older adults with intellectual disabilities? *Journal of Applied Research in Intellectual Disabilities*, *33*(5), 1016–1025. https://doi.org/10.1111/jar.12724

Oppewal, A., Maes-Festen, D., & Hilgenkamp, T. I. M. (2020). Small Steps in Fitness, Major Leaps in Health for Adults With Intellectual Disabilities. *Exercise and Sport Sciences Reviews*, *48*(2), 92–97. https://doi.org/10.1249/JES.0000000000000216

Shields, N., Mizzi, N., Buhlert-Smith, K., Strydom, A., Prendergast, L., & Hocking, D. R. (2022). A 12-week exercise programme has a positive effect on everyday executive function in young people with Down syndrome: A pilot non-randomised controlled trial. *Journal of Intellectual Disability Research*, *66*(12), 924–938. https://doi.org/10.1111/jir.12979

image / figure 1 Sources

image / figure 2

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

The aim of the project is to **INCREASE** the amount of PA among individuals with mild ID living at one of the residencies of `s Heeren Loo.

Individuals with ID are a very **DIVERSE** group of people with many differences in cognitive and motor abilities, and a diversity of health problems. Therefore, the project will just focus on the residents of `s Heeren Loo that are able to partake in this research.

Additionally, the user should be able to exercise **INDEPENDENTLY**, with minimal supervision of the caregivers. As it should not become another burden for the already busy caregivers. Therefore, the product must be **ACCESSIBLE** and easy to understand by the user, while being **CHALLENGING** enough to keep the user engaged.

Lastly, it would be of interest to look into the **SOCIAL** aspect of exercising as motivation for the user. It is important to keep the user motivated to achieve behavioural change. Testing the product over a long period of time, however, is not feasible within the available time frame. Hence, the project will focus more on keeping the user **ENGAGED** over multiple sessions.

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Create an intervention to increase physical activity for older adults with mild intellectual disabilities living at a `s Heeren Loo residency, by designing a product that allows for a range of different abilities and interests and that fits within the daily routine of the residency.

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

The previous study of Adriaans was more exploratory as there is not much knowledge on co-designing with older adults with ID. This resulted in a product concept and, more importantly, tools to facilitate participatory design with this specific target group. With this acquired knowledge, this study will focus more on the creation of a physical product. This will be done through:

Human-centred design: As the target group has totally different life **EXPERIENCES** than the designer, it is important to include the intended user to account for experiential consequences. This will be done through **PARTICIPATORY DESIGN** methods such as **INTERVIEWS** with stakeholders and **CO-DESIGN** sessions that suit the abilities of the target group.

Research through Design: The best way to gather insights from people with ID is to let them test out **PROTOTYPES**, as found from previous design projects. This is because abstract thinking can be challenging for this target group, whereas prototypes provide tangible aspects to reflect on. With realistic prototypes that allow for **FREEDOM IN EXPLORATION AND INTERACTION** it is possible to engage in some form of co-design with the intended users.

Project planning and key moments

*To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting**, **mid-term evaluation meeting**, **green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	6 Mar 2024
Mid-term evaluation	8 May 2024
Green light meeting	7 Aug 2024
Graduation ceremony	11 Sep 2024

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	✓
For how many project weeks	25
Number of project days per week	4,0

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

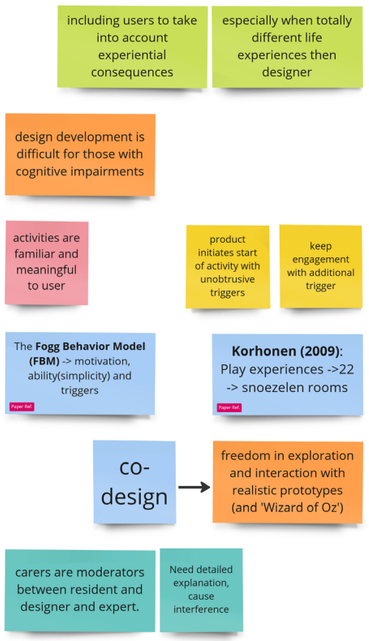
I have always been interested in the impact that design can have on everyday life. Specifically, how it can empower individuals who struggle with heath complications to still live a relatively normal life.

Throughout this project I want to increase my knowledge of social design by designing for and with vulnerable groups such as individuals with mild ID, which I have never done before. To learn how to include them (and their caregivers) in the design process through the `Research through Design' method. This, by using tangible prototypes to facilitate co-designing sessions. Resulting in a design that is driven and refined by the feedback of the target group.

Last but not least, I want to prove my technical design knowledge as an integrated product designer by creating a high-fidelity prototype that shows the product embodiment skills that have gathered throughout my studies.

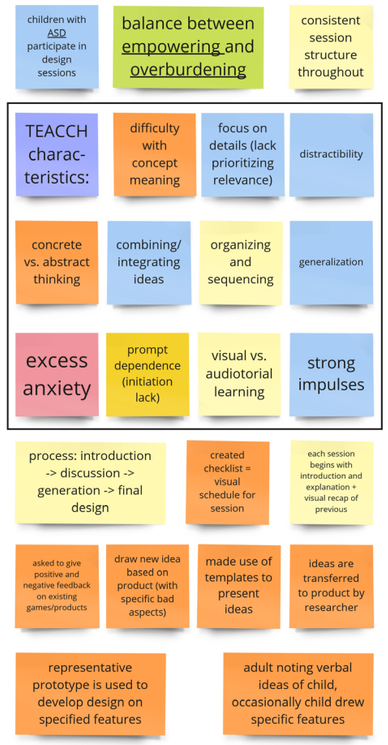
APPENDIX B : CO-DESIGN LITERATURE FINDINGS

Playful Design for Activation: Co-designing serious games for people with moderate to severe dementia to reduce apathy.
Anderiesen (2017)



Wat Beweegt Jou?
Afdeling Buitengewone Zaken (?)

Developing IDEAS: supporting children with autism within a participatory design team.
Benton et al. (2012)



Co-creating an intervention to promote physical activity in adolescents with intellectual disabilities: lessons learned within the Move it, Move ID!-project.
Maenhout et al. (2022)

APPENDIX C: SESSION 1 PLANNING AND RESULTS

CREATIVE SESSION I – PREP

GOAL

1: **Exploring the current experience of PA among the target group.**
- What does the target group experience while doing PA?
- What are their physical capabilities?
- What is their level of interest for PA?

2: **Gaining first experience setting up and executing a collaborative session with the target group within the specific context**, using the co-design guidelines as a starting off point.

Tips Anne

Spellen makkelijk houden, kort en krachtig uitleggen, coachen en complimenteren

Gebruik muziek. dansen vinden de meeste erg leuk

Zorg dat het gestructureerd en rustig blijft (niet overprikkelen)

Gebruik een grote bal zodat mensen in een rolstoel, of op een stoel mee kunnen rollen

In een groep, laat iedereen op een stoel zitten, dan is iedereen op gelijke hoogte

Beweeg sessies duren ongeveer 40 min. warming up + oefeningen

1. MUSIC

Goal: testing range of motion

Time: approx. 5 minutes

Tools: music box
Music: Frans Bouwer, Andre Rieu,..

Set-up: sitting in a circle

Activity:

1. Swinging arms on the beat of the music

2. Lifting feet one by one on the beat of the music

3. Clapping on the beat of the music

4. Moving hands from head to shoulders to knees and if possible to toes.

*Try all activities as best your abilities.

2. BALLOON

Goal: testing the effect of a social activity

Time: approx. 8 minutes

Tools: 2 balloons & 3 foam sticks

Set-up: sitting in a circle

Activity:

1. *Researcher throws a balloon to each person (one by one) in the group.*
Using the foam stick, lightly hit the balloon away once it gets close.

2. Passing the balloon to each other by hitting it lightly with a foam stick. Only hit the balloon once it get close.

3. Doing the same as before, but adding a second balloon.

*Use feet to kick the balloon, if you cannot reach with the stick or are not able to hold the stick. Use hands is not able to use feet.

3. BEAN BAGS

Goal: testing the effect of a competitive game

Time: approx. 8 minutes

Tools: 8 bean bags (pittenzakjes) & cone

Set-up: sitting in a circle placing the cone in the middle of the group. Each person gets one bean bag.

Activity:

Going clockwise, each person throws a bean bag to the cone as close as possible. The person that throws their bean bag the closest wins.

At first, each person gets one try per game. Later, everyone gets two bean bags and therefore two tries per game.

*Use feet to kick the bean bag towards the cone, if throwing is too hard.

QUESTIONS

	
Ik vond het leuk om te doen	Ik ben er moe van geworden
	
Ik snapte wat ik moest doen	Ik vond het leuk om samen te doen
	
Ik wil het graag nog een keer doen	Ik ben trots op wat ik heb gedaan

SCHEDULE

Setting up [10:00-10:05]
- chairs in a circle
- blowing up balloons
- selecting music

Introduction [10:05 - 10:10]
- greetings
- introduce session:
  - **goal project** = "samen een manier te bedenken om meer te gaan bewegen"
  - **goal session** = "wat jullie vinden van bewegen. Hiervoor gaan we een paar oefeningen te doen. Daarna ga ik vragen wat jullie van de oefeningen vonden."
  - **consent** "Mag ik van jullie tijdens de oefening een aantal foto's en video's maken? Dan kan ik laten zien wat we hebben gedaan. En kunnen we daar later naar terugkijken."

1. Moving to the music [10:10 - 10:15]
- starting music
- waving arms
- lifting feet (one by one)
- clapping hands (on the beat)
- head, shoulders, knees (and toes)

BREAK [10:15 - 10:17]

2. Batting Balloons [10:17 - 10:25]
- giving out foam sticks
- passing the balloon to each person
- trying to pass the balloon around
- second balloon

BREAK [10:25 - 10:27]

3. Throwing Bean Bags [10:27 - 10:35]
- giving out bean bags
- one by one through the bean bag to come closest to the cone
- adding multiple bags per round

BREAK [10:35 - 10:37]

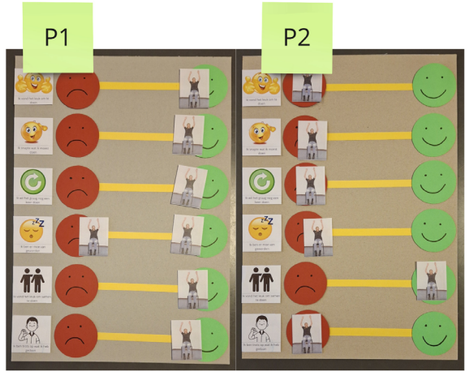
Feedback [10:37 - 10:45]
- setting up questionnaire (x2)
- verbally go through the questions for each activity
- ask for extra clarification if necessary

R1. MUSIC

Goal: testing range of motion

P1:
- Vond het heel leuk -> deed enthusiast met alles mee
- Had zelf een nummer voorgesteld (andre rieu)
- Had zoiets al eerder gedaan
- Deed alle beweging oplettend na (dirigent)

P2:
- Bewegen op muziek niet leuk -> pijn last van lichaam
- Deed niet mee, wel met voeten bewegen en in het begin heen en weer deinen op de muziek



R2. BALLOON

Goal: testing the effect of a social activity

P1:
- Ook enthousiast -> moedigde ook P2 aan om mee te doen
- Focus op 1 ballon ter gelijkertijd
- Tijdje 1-op-1 doorgespeeld
- Vond later 2-vs-1 het leukst
- Graag meedoen met het uitkiezen met voorwerpen

P2:
- Vond ballonnen overslaan heel leuk
- Alleen geen behoefte aan het gebruiken van een 'baton'
- Gebruikte zowel handen en voeten
- Was er op een gegeven moment klaar mee, maar deed wel weer mee na een paar minuutjes
- Aan het eind van de sessie nog een keer ballonnen overgespeeld -> 2 tegen 1

P1 P2

R3. BEAN BAGS

Goal: testing the effect of a competitive game

P1:
- Was iets voorzichtiger
- Gooide meer in de buurt van de pion dan er tegenaan
- Bij het pakken van meer pionnen stelde diegene voor om daarvoor in de plaats kegels te pakken -> bowlen
- Nieuwsgierig naar voorwerpen "wat zit er in de zakjes", "zijn die van de hema"?

P2:
- Begon heel enthousiast met het gooien van de pittenzakjes -> kegel omver
- Had er alleen geen zin meer in toen er meer pionnen bijkwamen
- Zei later dat diegene het wel nog een keer wil doen, maar nu te moe was geworden
- Over het algemeen erg resoluut in diens mening, duidelijke JA of NEE
- Heeft een korte aandachtsboog voor dingen die diegene niet interessant vind

P1 P2

CONCLUSION

Hoe actiever het spel hoe actiever de deelnemers
- actie -> reactie

Zittend aan tafel in de woonkamer
- toegankelijker om op te zetten
- beter bezochte locatie

SESSION

What went well:
- having different options worked well
- most of the questions were clear
- two participants session worked well

Improvements:

<u>Schedule</u>
- Taking more time before the start of the session, e.g. to drink coffee and catch up.
- Create a visual tool to keep track of the timeline's schedule.
- Ask the caretakers what the participants can do after the session.
- Take more time for the questions

<u>Questions</u>
- it was unclear that the smileys were supposed to be an a scale -> add a neutral smiley in the middle to create 3 options
- the tired question was confusing, as it was the opposite to the other questions: yes = red instead of yes = green
- asking more in depth questions was harder balance do with two people at the same time -> take more time

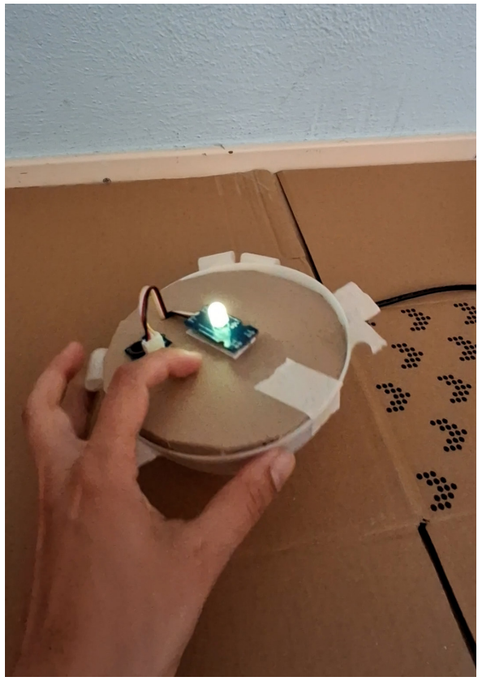
APPENDIX D: INTERACTIVE BALL PROTOTYPE

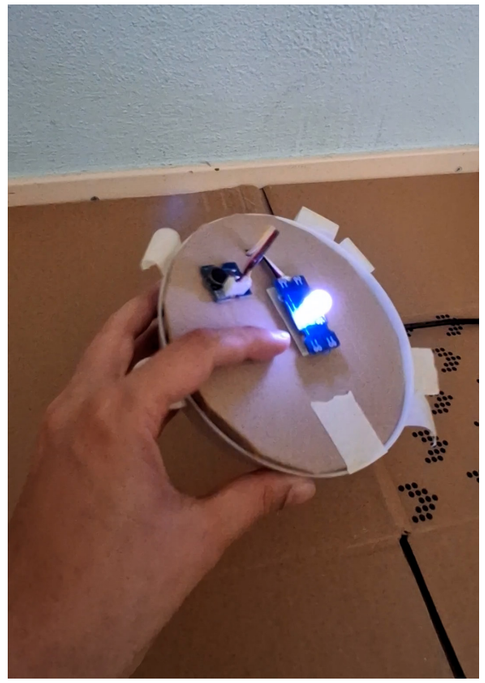
Arduino code:

Color_Brightnessv3.ino

```ino
#include "AK09918.h"
#include "ICM20600.h"
#include <Wire.h>
#include <ChainableLED.h>

AK09918_err_type_t err;
int32_t x, y, z;
AK09918 ak09918;
ICM20600 icm20600(true);
int32_t offset_x, offset_y, offset_z;

ChainableLED leds(4,5,1);

void setup() {
    // join I2C bus (I2Cdev library doesn't do this automatically)
    Wire.begin();

    leds.init();

    err = ak09918.initialize();
    icm20600.initialize();
    ak09918.switchMode(AK09918_POWER_DOWN);
    ak09918.switchMode(AK09918_CONTINUOUS_100HZ);
    Serial.begin(9600);

    err = ak09918.isDataReady();
    while (err != AK09918_ERR_OK) {
        Serial.println("Waiting Sensor");
        delay(100);
        err = ak09918.isDataReady();
    }
    Serial.println("Start figure-8 calibration after 10 seconds.");
    delay(2000);
    calibrate(10000, &offset_x, &offset_y, &offset_z);
    Serial.println("");
}

void loop() {
    // get gyro (speed) and make all values positive, so doesn't matter in w
    int16_t Gyro_x = icm20600.getGyroscopeX();
    int16_t Gyro_y = icm20600.getGyroscopeY();
    int16_t Gyro_z = icm20600.getGyroscopeZ();

    int16_t absGyro_x = abs(icm20600.getGyroscopeX());
    int16_t absGyro_y = abs(icm20600.getGyroscopeY());
    int16_t absGyro_z = abs(icm20600.getGyroscopeZ());

    //Serial.print("Gyro:  ");
    //Serial.print(absGyro_x);
    //Serial.print("\t");
    //Serial.print(absGyro_y);
    //Serial.print("\t");
    //Serial.print(absGyro_z);
    //Serial.println("\t mg");

    //translate the (abs)gyro values to HSL input
    float mappedGyro_x = map(absGyro_x, 0, 450, 1, 100)/100.00; //Brightness
    float mappedGyro_y = map(absGyro_y, 0, 400, 0, 100)/100.00;
    float mappedGyro_z = map(absGyro_z, 0, 400, 0, 100)/100.00;

    float mappedGyro = (mappedGyro_x + mappedGyro_y + mappedGyro_z)/3;

    //change brightness based on gyro value && change color based on acceler
    if (absGyro_y < 20 && absGyro_x < 20){
      leds.setColorHSL(0, 0.50, 1.0, mappedGyro);
      //Serial.println("phase 1");
    }
//    else if (absGyro_y >= 40 && Gyro_y < 120 && Gyro_x < 40) {
//      leds.setColorHSL(0, 0.70, 1.0, mappedGyro);
      //Serial.println("phase 2y");
//    }
    else if (absGyro_y >= 20 && absGyro_x < 20) {
      leds.setColorHSL(0, 0.90, 1, mappedGyro);
      //Serial.println("phase 3y");
    }
//    else if (absGyro_y < 40 && Gyro_x >= 40 && Gyro_x < 120 ) {
//      leds.setColorHSL(0, 0.35, 1.0, mappedGyro);
      //Serial.println("phase 2x");
//    }
    else if (absGyro_y < 40 && absGyro_x >= 20) {
      leds.setColorHSL(0, 0.20, 1, mappedGyro);
      //Serial.println("phase 3x");
    }
    else if (absGyro_y >= 120 && absGyro_x >= 120) {
      leds.setColorHSL(0, 0, 0, mappedGyro);
      //Serial.println("phase 4");
    }

    Serial.print(absGyro_z);
    Serial.print("\t");
    Serial.print(absGyro_y);
    Serial.print("\t");
    Serial.print(absGyro_x);
    Serial.print("\t");
    Serial.println(mappedGyro);

    delay(200);

}

void calibrate(uint32_t timeout, int32_t* offsetx, int32_t* offsety, int32_t t
}
```

Prototype:

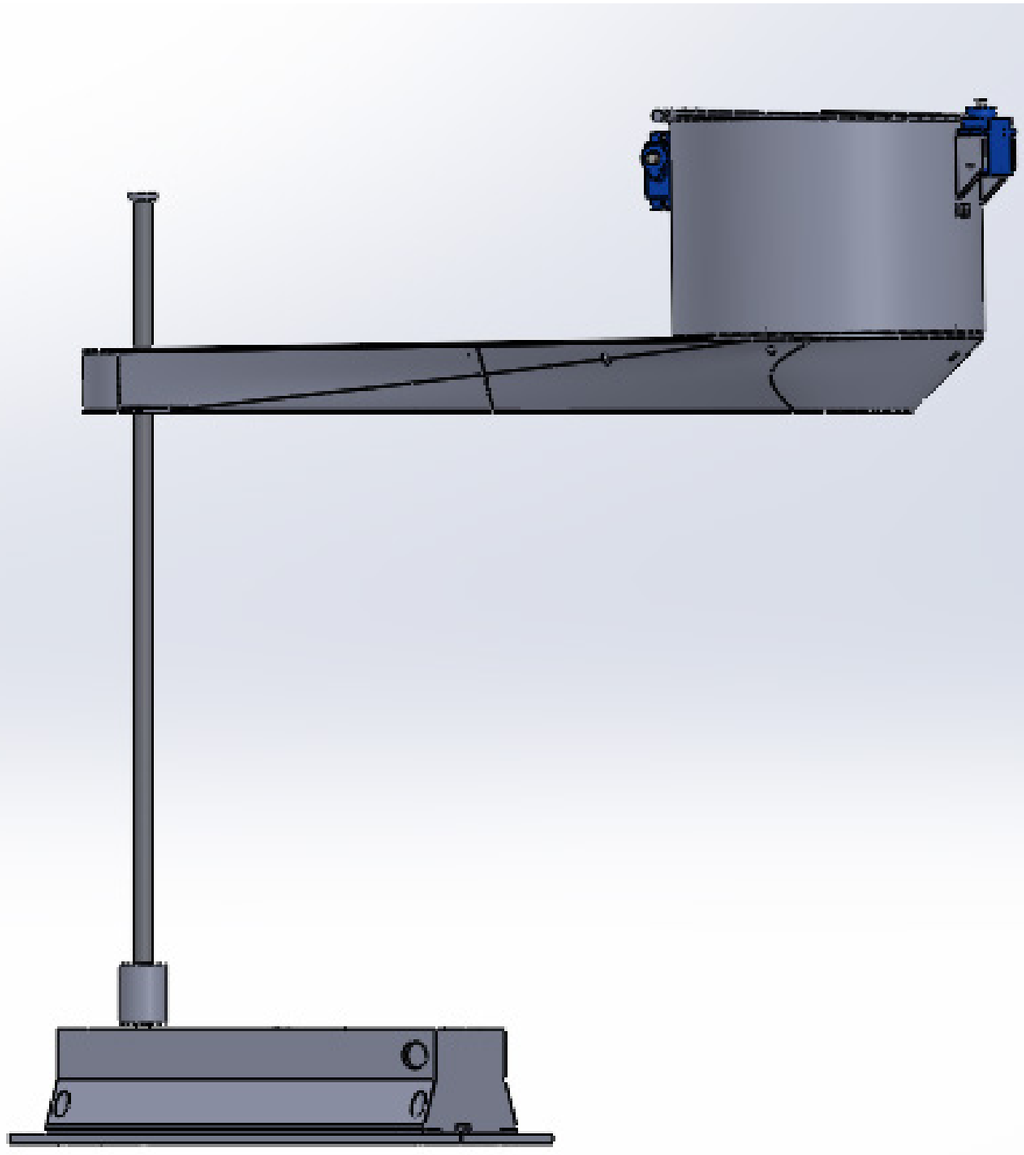


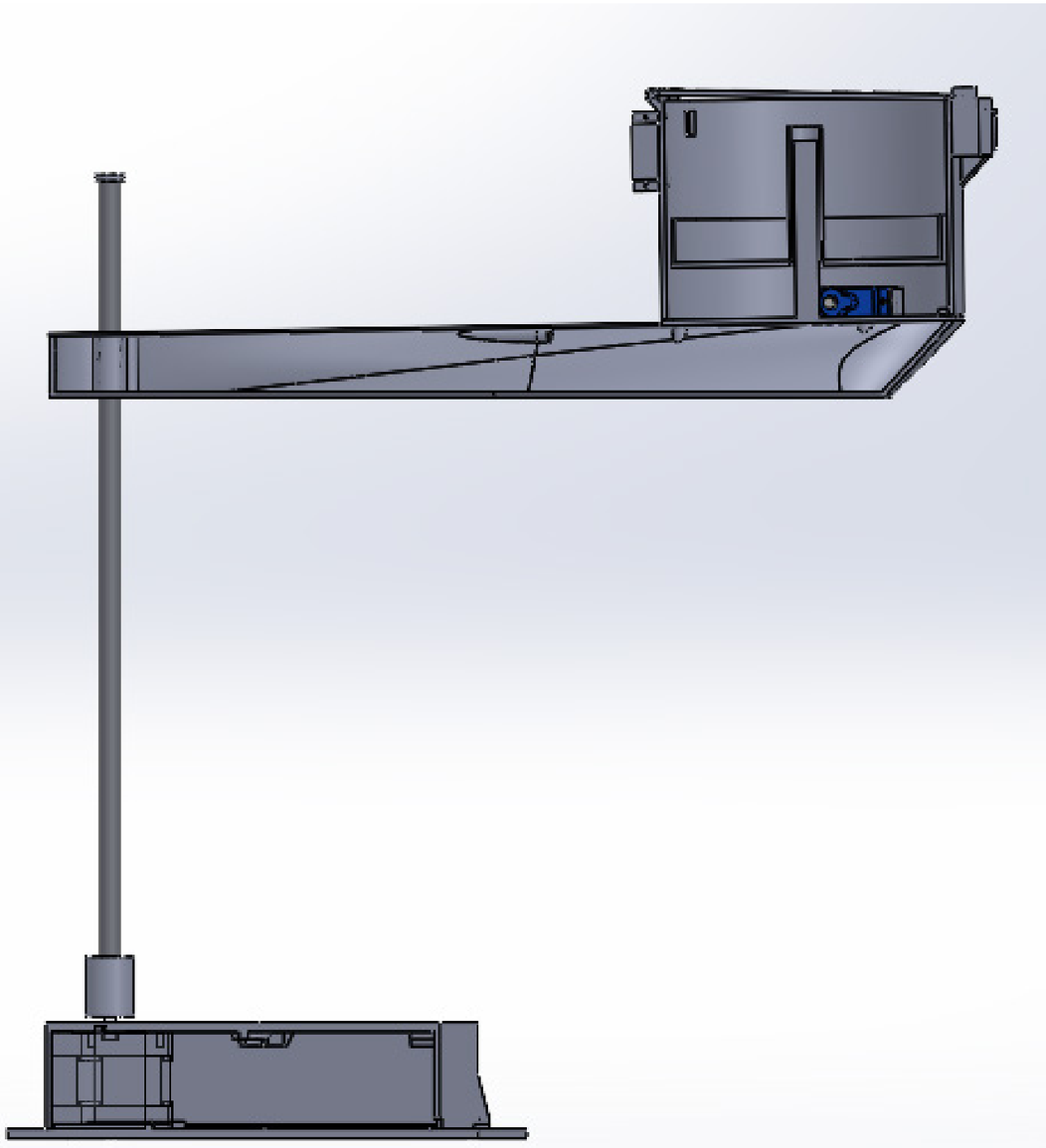


The faster the movement, the brighter the light.

Moving in a certain direction (in this case upwards) changes the color of the light.

APPENDIX F: FINAL DESIGN CROSSVIEW





APPENDIX G: FINAL DESIGN ARDUINO CODE

Stepper motor - rod system:

stepper_motor.ino

```ino
#include <SpeedyStepper.h>

//pins X
const int LED_PIN = 13;
const int MOTOR_STEP_PIN = 2;
const int MOTOR_DIR_PIN = 5;
const int STEPPERS_ENABLE_PIN = 8;

//stepper motor object
SpeedyStepper stepper;

//keeping track of rotation direction
int motorposArray[] = {-800, 800};
int arraySize = sizeof(motorposArray) / sizeof(motorposArray[0]);
int rotAmount;
int lastValue = -1;
int consecutiveCount = 0;
int maxConsecutive = 3;


void setup() {

  Serial.begin(9600);

  //setup the LED and ENABLE pin
  pinMode(LED_PIN, OUTPUT);
  pinMode(STEPPERS_ENABLE_PIN, OUTPUT);       // be sure to do this

  //connect motor to pins
  stepper.connectToPins(MOTOR_STEP_PIN, MOTOR_DIR_PIN);

  //enable motor
  digitalWrite(STEPPERS_ENABLE_PIN, LOW);

}

void loop() {

  // read the sensor value:
  int sensorReading = analogRead(A0);
  Serial.print("Potentio reading:  ");
  Serial.println(sensorReading);

  int turnOff = 1010;
  int maxDelay = 6000;
  int motorSpeed = 3000;

  if (sensorReading <= turnOff) {
    //Time between rotations
    int timeBetween = map(sensorReading, 0, turnOff, 100, maxDelay);
    Serial.print("Time between rotations:  ");
    Serial.println(timeBetween);

    //Amount of rotation
    if (consecutiveCount < maxConsecutive) {
      int randomIndex = random(arraySize);
      if (consecutiveCount < maxConsecutive) {
        int randomIndex = random(arraySize);
        rotAmount = motorposArray[randomIndex];
      } else {
        do{
        int randomIndex = random(arraySize);
        rotAmount = motorposArray[randomIndex];
      } while (rotAmount == lastValue);
      }

      if (rotAmount == lastValue){
        consecutiveCount++;
      } else {
        consecutiveCount = 1;
      }

      lastValue = rotAmount;
      Serial.print("Rotation amount:  ");
      Serial.println(rotAmount);
      Serial.print("Consecutive count:  ");
      Serial.println(consecutiveCount);

      //Activate stepper
      stepper.setSpeedInStepsPerSecond(motorSpeed);
      stepper.setAccelerationInStepsPerSecondPerSecond(motorSpeed);
      stepper.moveRelativeInSteps(rotAmount);
      Serial.println("--------------------------------------------");

      delay(timeBetween);
    }
    else {

      stepper.setSpeedInStepsPerSecond(0);
      stepper.setAccelerationInStepsPerSecondPerSecond(0);
      stepper.moveRelativeInSteps(0);
      Serial.println("--------------------------------------------");

      delay(100);
    }
}
```

Servo motors - launch system:

servo_settings_one_button.ino | readme.md

```ino
#include <Servo.h>
int potpin = A0;            // analog pin used to connect the potentiometer
int val;                    // variable to read the value from the analog pi

// Latch Servo
Servo latchServo;           // create Servo object to control a servo
const int latchButton = 7;
int latchState = 100;       // the current state of LED
int lastLatchState;         // the previous state of button
int currentLatchState;      // the current state of button

// Spring Servos
Servo springServo1;
Servo springServo2;
const int springButton = 6;
int springState ;
int lastSpringState;
int currentSpringState;

// Lid Servo
Servo lidServo;
const int lidButton = A2;
int lidState = 100;
int lastLidState;
int currentLidState;

void setup() {
  Serial.begin(9600);

  // Latch Servo config
  latchServo.attach(2);                           // attach to arduino pin
  pinMode(latchButton, INPUT_PULLUP);             // set arduino pin to inpu
  currentLatchState = digitalRead(latchButton);   // read start state
  Serial.print("Latch position: ");
  Serial.println(latchState);

  // Spring Servos config
  springServo1.attach(3);
  springServo2.attach(4);
  pinMode(springButton, INPUT_PULLUP);
  currentSpringState = digitalRead(springButton);
  Serial.print("Spring position: ");
  Serial.println(springState);

  //Lid Servo config
  lidServo.attach(5);
  pinMode(lidButton, INPUT_PULLUP);
  currentLidState = digitalRead(lidButton);
  Serial.print("Lid position: ");
  Serial.println(lidState);

}

void loop() {
  val = analogRead(potpin);            // reads the value of the potentiomet
  val = map(val, 0, 1023, 0, 180);     // scale it for use with the servo (v
  lidState = val;
  lidServo.write(lidState);
  //Serial.println(lidState);

  //one button control
  lastSpringState    = currentSpringState;      // save the last state
  currentSpringState = digitalRead(springButton); // read new state
  if (lastSpringState == HIGH && currentSpringState == LOW){

    if(latchState == 5){

      //pull platform down
      springState = 145;
      springServo1.write(springState);
      springServo2.write(springState);
      Serial.print("Spring is loaded: ");
      Serial.println(springState);
      delay (1000);

      // close latch
      latchState = 100;
      latchServo.write(latchState);
      Serial.print("Latched: ");
      Serial.println(latchState);
      delay (1000);

      // release platform
      springState = 5;
      springServo1.write(springState);
      springServo2.write(springState);
      Serial.print("Spring is released: ");
      Serial.println(springState);
      delay (1000);

      }
      else {
      // open latch
      latchState = 5;
      latchServo.write(latchState);
      Serial.print("Latch is released: ");
      Serial.println(latchState);
      delay (1000);
      }

  }
  delay(15);                           // waits for the servo to get there
```