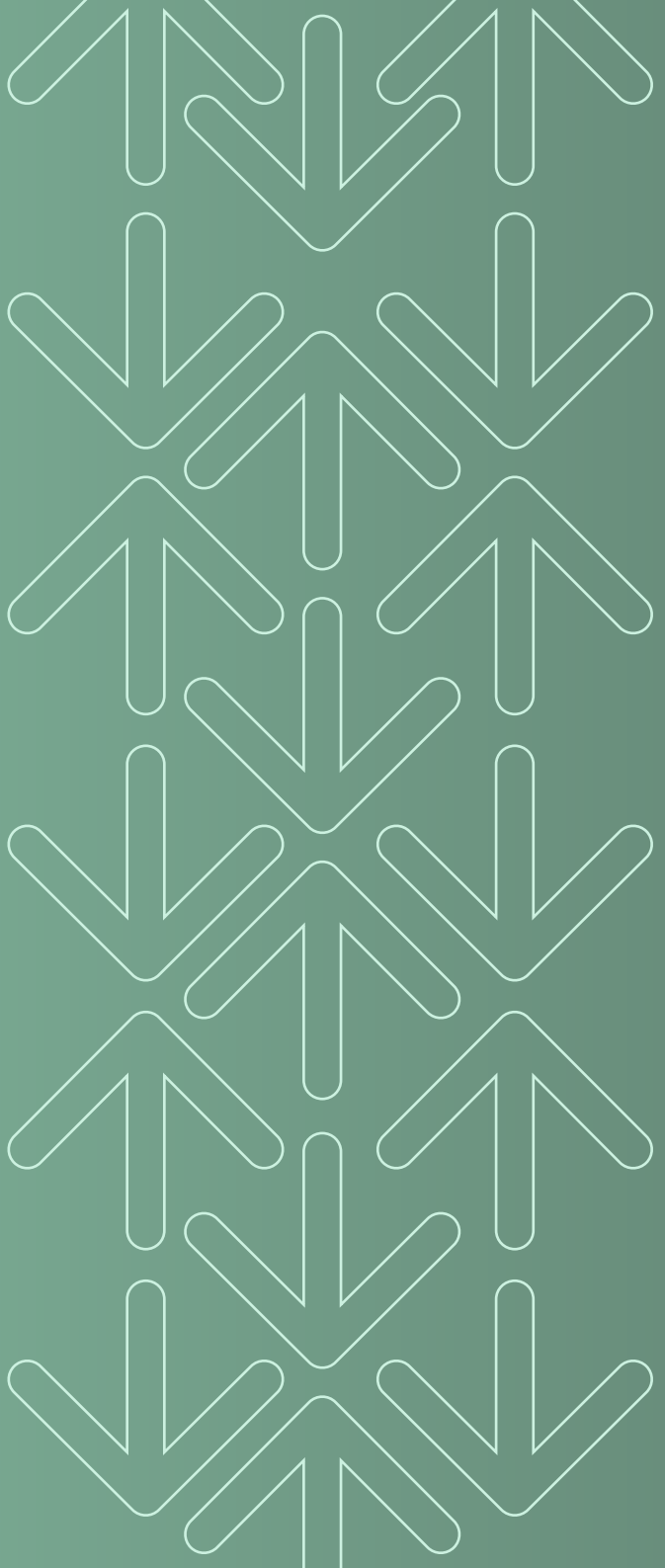
CONSIGO

Motivating older adults to follow cognitive and physical training for an active and healthy ageing

MASTER THESIS

Valentina Guadagno



Master Thesis

“CONSIGO
Motivating older adults to follow cognitive and physical training for an active and healthy ageing”

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Delft, September 6th 2024

Valentina Guadagno

Abstract

Figure 0. Older adults doing physical activity (AmareperbeneIt, 2024)

With the European population rapidly aging, addressing the vulnerabilities associated with physical and cognitive decline is essential. Promoting an active lifestyle among older individuals has proven effective in preserving health and independence. Growing evidence suggests that combining cognitive and physical exercises can significantly enhance both cognitive function and physical health, especially among sedentary elderly populations who are at increased risk due to physical inactivity.

This thesis, conducted in collaboration with the Portuguese company Neuroinova, presents the development and evaluation of a digital intervention aimed at integrating physical exercises into their platform for cognitive training COGWEB in individuals experiencing cognitive decline or impairments. The integration process started with ACTIVAS, a program developed in collaboration with researchers from the University of Aveiro, who provided guidelines for an effective physical exercise regimen based on personalization and progression. However, motivating users to adhere to the program, particularly in a remote setting, remained a challenge.

Understanding the needs and barriers of both patients and professionals was crucial to shaping a program that positively impacts user motivation. Utilizing a user-centered design approach, including generative sessions, interviews with healthcare professionals, and literature reviews, two primary user groups were identified: sedentary individuals with minimal physical activity and busy active individuals with irregular physical exercise patterns.

Despite individual differences, the insights revealed that successful integration of physical exercises into COGWEB requires clear, structured guidance from a trusted professional, such as a physiotherapist, alongside engaging and enjoyable exercise activities. Personalization of the program emerged as a key factor in addressing these needs.

The design process focused on ensuring effective guidance and engagement by iteratively testing various prototypes of exercise sessions, with special attention to interaction qualities such as being engaged, guided, proud, trusting, and in control. The final concept involved a session where cognitive tasks in the form of games—similar to the original COGWEB format—were paired with physical movements and exercises, allowing users to train both cognitive functions and their body simultaneously. Emphasis was placed on providing clear instructions and professional guidance through the presence of a physiotherapist.

Final test results showed promise in motivating sedentary individuals to participate in these sessions, achieving the design goal of ensuring guidance and engagement. While the design objective of this thesis was met within the study's scope, further work is necessary to implement and evaluate the program's long-term effectiveness in real-world settings. The findings suggest that this approach has the potential to significantly increase physical activity levels and improve adherence among elderly COGWEB users, contributing to their overall well-being.

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1. Introduction

This chapter provides the reader with an introduction to the project presented in this report, acquainting them with the topics addressed, the collaborative relationship with the company that commissioned the brief, the problem statement, the project brief, and the approach taken to carry out the project.

1.1 Context

Figure 1. Picture representing Neuroinova's digital platform COGWEB (Neuroinova, n.d.)

1.1.1 Neuroinova's ACTIVAS Introduction

This graduation project was conducted in partnership with Neuroinova, a Portuguese company specialized in technology development for cognitive rehabilitation, assessment and monitoring. The primary focus of this work was to address their program ACTIVAS, which aims to ensure an enhanced, active and healthy quality of life for the elderly population through intelligent products and services. One of ACTIVAS' areas of intervention is the development of a web-based program to promote human functionality through the integration of physical exercises into Neuroinova's main product for remote cognitive rehabilitation, COGWEB® (Figure 1).

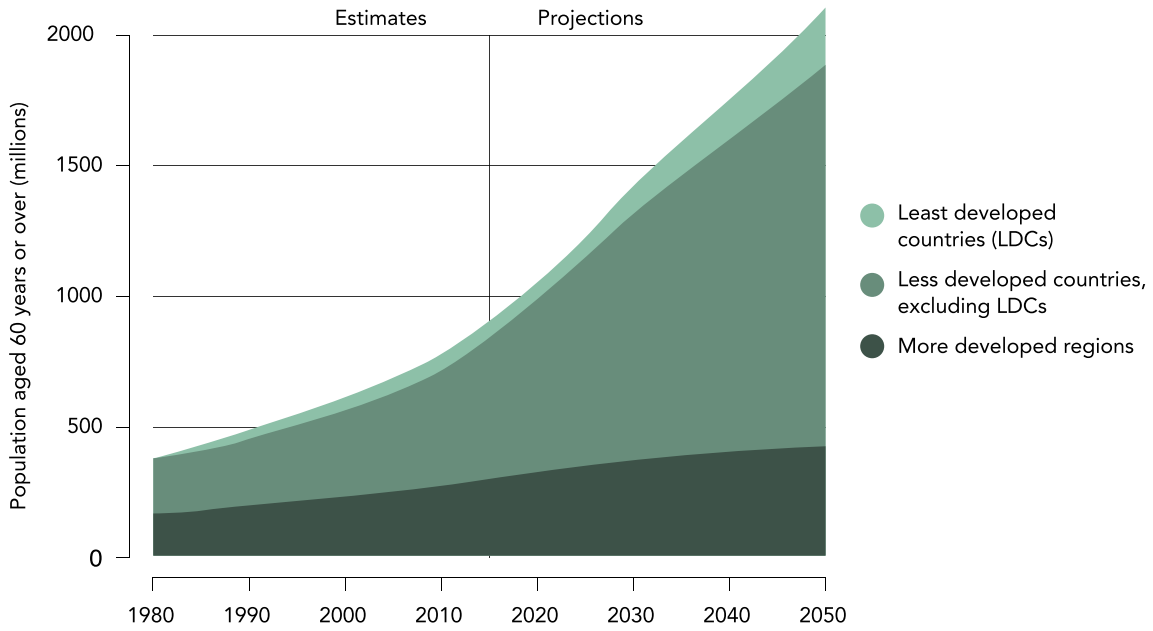
1.1.2 Problem definition

The European population is experiencing a significant demographic shift, with a growing proportion of elderly individuals, as shown in Figure 2. This increase in the elderly population brings with it various health and social challenges. As people age, they naturally face a decline in autonomy and independence, which can lead to increased vulnerability in social, physical, and cognitive domains. This heightened vulnerability is often accompanied by a higher incidence of diseases, physical disabilities, a greater risk of falls, and a general decline in quality of life, all of which contribute to increased dependency and mortality (Bernì et al., 2023).
The societal implications are significant, particularly concerning the rising costs associated with long-term care. However, these challenges can be mitigated by implementing strategies that promote a healthy lifestyle among older adults. Encouraging an active lifestyle is essential for preserving health and independence, and one promising approach involves the combination of physical and cognitive exercises.
Physical exercise plays a crucial role in enhancing the health outcomes of older individuals, particularly those at risk of clinical-functional vulnerability. Regular exercise in older adults has been shown to improve health status,

reduce risk factors for diseases, increase life expectancy, and improve bone health, among other benefits such as improving mental health and reducing stress.
On the other hand, cognitive training helps maintain and enhance cognitive functions such as memory, attention, or language, thus delaying the onset of age-related cognitive decline (Chan et al., 2020).

When physical exercises are combined with cognitive training, the benefits are even more pronounced, especially for individuals experiencing cognitive impairments (Sanchini et al., 2022). Therefore, this combination offers a comprehensive approach to improving both physical and cognitive health in older adults. However, providing the necessary care and preventive measures often requires resources and specialized personnel that may not always be readily available.
In this context, Information and Communication Technologies (ICT) present a potential solution to improve accessibility and overcome social and spacial barriers, offering remote support through web-based or mobile applications. These technological tools can be instrumental in promoting healthy behaviors, enhancing motivation, and ultimately contributing to the well-being of older populations (Vozzi et al., 2022).

Figure 2. Number of persons aged 60 years or over by development group,[1] from 1980 to 2050 (World Population Ageing 2017 Highlights | Population Division, n.d.)



[1] The source refers to “developed regions” indicating, following common practice, Europe and Northern America plus Australia, New Zealand and Japan, while the “developing regions” include all other parts of the world. The use of these terms in the reference report does not imply any judgement as to the current developmental stage of a particular country or region.

1.2 Project brief

As previously introduced, the goal of ACTIVAS project is to leverage the potential of ICT to create a program that promotes active aging through a combination of physical and cognitive training, under the remote supervision of specialized practitioners. This involved developing a software component to integrate physical exercises into Neuroinova's existing cognitive training platform, COGWEB®, with the aim of increasing the physical activity levels of elderly users of the platform.
The objective of this graduation project was to explore and investigate the factors that influence the adherence of older adults with cognitive impairments or who are experiencing cognitive decline to a remote physical exercise program integrated into cognitive training, to develop an intervention strategy aimed at guaranteeing their adherence.

1.2.1 The research team

To achieve this, the project was conducted in collaboration with the research team at the University of Aveiro (UA), who are partners with Neuroinova in the research and development of their products. This team, consisting of two physiotherapists and a gerontologist specializing in usability studies (Figure 3), developed guidelines for a personalized and progressive exercise program tailored to older adults aged 65 and above.
The author worked closely with them to ensure user adherence to the program by drawing on their expertise and understanding of the target group. Their scientific and medical knowledge was crucial in proposing effective solutions. Moreover, since the physiotherapists are directly involved in the project, guiding the program personally, their experience with patients and their perspectives were essential in understanding how to leverage this relationship to foster greater adherence.
Most of the research activities were carried out at the UA, where the team is based. Participants were mostly recruited by the team from their network of previous studies.

Figure 3. The research team

1.3 Approach

Various research and design methods were employed in this project, tailored to meet the specific needs and circumstances of the context and target group. The overarching structure of the thesis follows the Double-Diamond approach (Design Council, 2005), which is divided into four phases: Discover, Define, Develop, and Deliver. Figure 4 provides brief descriptions of each phase. Accordingly, the thesis is organized into four main chapters, each corresponding to one of these phases. The following paragraph outlines how each phase was addressed, the methods applied, and the research questions that guided each stage.

1.3.1 Project structure

This thesis is structured according to the Double-Diamond framework, with each main section further divided into chapters dedicated to specific aspects of the phase. Each section will detail the research questions that guided the inquiry, and each chapter will include a brief description of its content, offering an overview of how the research was conducted and the insights gained. Figure 5 shows how the chapters are structured according to the phases of the double diamond.

Phase 1 - Discover

The first phase was dedicated to the comprehension of the background theory related to cognitive training, physical activity and their combination, obtained through literature review, interviewing the experts of Neuroinova such as physiotherapists, neuropsychologists and gerontologists, and reviewing the materials given by the company on their products and their previous and current studies. Literature review to understand the current situation and how to increase the level of physical activity of older adults was also conducted. Moreover, the company know-how, products and expertise were explored, studied and analysed. A on-field research was conducted with elderly users from the Portuguese community through generative sessions to obtain knowledge on their routines, tastes and preferences, their attitudes towards in-person and remote physical activity, and on their perception of an ideal relationship with a guide in physical activity. This knowledge was furtherly supported by interviews and focus groups with the experts of Neuroinova, sharing their point of view and their experience on these factors, and with literature review. The obtained knowledge is addressed in chapters from 2 to 4.

Phase 2 - Define

The first phase generated valuable knowledge and insights, which were summarized and mapped to guide the subsequent ideation phase. This process involved updating the existing problem statement, establishing a series of design criteria, refining the project focus, and formulating a design goal and interaction vision. These outcomes served as a foundation for

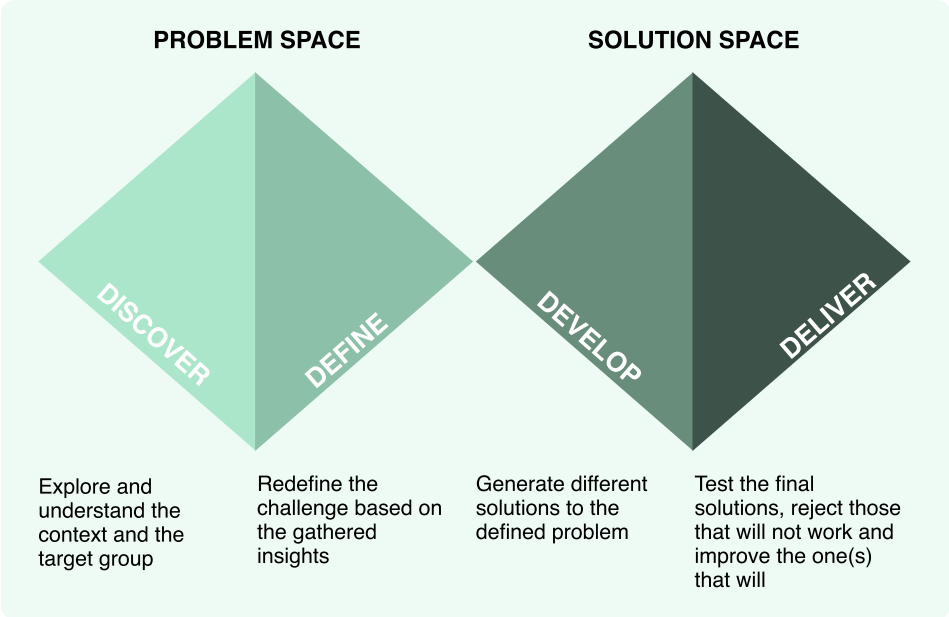


Figure 4. Visual representation of the Double Diamond design and innovation process (Design Council, 2005)

providing design directions and brainstorming ideas in the development phase, as detailed in Chapter 5.

Phase 3 - Develop
The third phase of the project focused on exploring how to translate the insights generated in the previous phase into concept ideas. Initially, idea generation activities were conducted, both individually and collaboratively with research team members. The ideation process involved brainstorming, clustering, and evaluation through the C-Box method, utilizing creative techniques such as role-playing and "How To" exercises.
The selected ideas were categorized into aspects related to the desired type of interaction and those related to the types of activities proposed for physical exercises. These ideas were then tested through the development of prototypes in two separate test sessions, using an adapted Research through Design method (Stappers & Giaccardi, n.d.). This approach involves answering research questions by testing different aspects of the concept, in this case interaction features and exercises activities, through various prototypes to gradually refine the concept into a final version. This phase is addressed in Chapters 6 and 7.

Phase 4 - Deliver
The final phase of the project focused on refining the concept emerged from the last round of testing by designing the platform for exercise sessions. After testing the final concept, the evaluation provided feedback for further improvements and assessed how well the design met the initial goals. Guidelines were proposed for long-term guidance and personalization, and recommendations for implementation were given to the company. The author also reflected on the final design and the overall process, offering suggestions for future development. Chapters 8 and 9 address this phase.

1.3.2 Language used
All the activities with users were conducted in Portuguese (and Italian): all the prototypes were consequently designed in participants' native language. In this report the produced materials from research activities and quotes will be reported literally translated into english, while the prototypes will be shown as they have been originally designed.

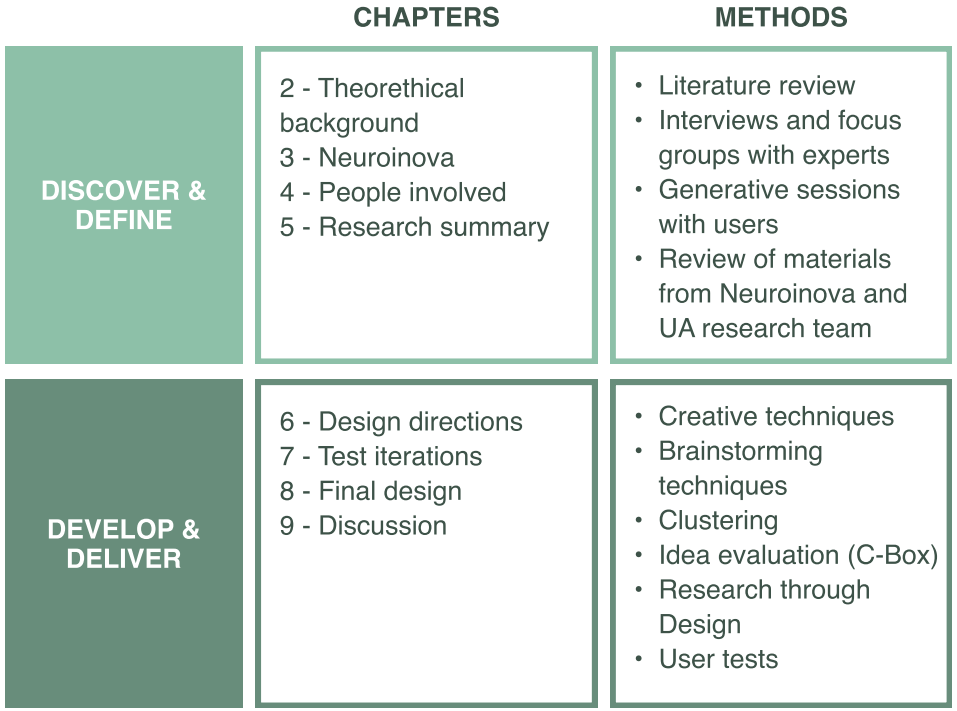


Figure 5. Structure of chapters according to the Double Diamond framework with methods used.

1.4 Terminology

Prior to delving into the project, it is helpful to clarify for the reader how the author intended the meaning of the chosen vocabulary and how she elaborated definitions or applied existing ones to this report. Specific terms will be addressed step by step throughout the report.

ACTIVE AGEING
Process of optimizing opportunities for health, participation, and security in order to enhance the quality of life as people age (WHO, 2022). It emphasizes staying physically, mentally, and socially active to maintain well-being and independence.

ADHERENCE
Extent to which individuals follow or comply with prescribed treatments, interventions, or recommendations as intended. It reflects commitment to the recommended action(s).

ATTENTION
Ability to focus on a specific task or stimulus, selected over a broad area of interest (R. Cohen et al., 1993).

BEHAVIORAL CHANGE
Process by which an individual adopts new behaviors, habits, or attitudes, often in response to external influences, internal motivations, or environmental factors.

COGNITION
Combination of various mental processes such as attention, executive functions, memory, and language, crucial for everyday functioning.

COGNITIVE ASSESSMENT
Systematic evaluation of an individual's mental processes related to cognition to identify strengths, weaknesses, and any potential cognitive impairments.

COGNITIVE CHALLENGE
Task or activity that requires mental effort, engaging mental processes to stimulate and enhance brain function.

COGNITIVE TRAINING (CT)
Interventions utilizing cognitive tasks or intellectually demanding activities to enhance overall cognitive ability (Gobet & Sala, 2022).

CONSTRUCTIVE ABILITIES
Also referred in neuropsychology as visuospatial abilities, refer to the capacity of identifying visual and spatial relationships among objects.

DUAL-TASK TRAINING
Ability to perform two tasks simultaneously, coordinating attention to both tasks while they are being performed. In this context, it refers to the simultaneous performance of cognitive and physical tasks (MacPherson, 2018).

EXECUTIVE FUNCTIONS
Cognitive process involving a range of mental abilities, including planning, working memory, inhibition, mental flexibility, and the initiation and monitoring of actions (Chan et al., 2008).

INFORMATION COMMUNICATION TECHNOLOGY (ICT)
Technologies used to transmit, store, retrieve, and manipulate information (‘Information and Communications Technology’, 2024) such as computers, smartphones, the internet, and digital communication tools.

NEUROPLASTICITY
Brain's ability to reorganize its structure, function, and connections in response to experiences, learning, and environmental influences (Cramer et al., 2011).

NEUROPSYCHOLOGIST
Psychologist who specializes in the assessment, diagnosis, and treatment of cognitive, emotional, and behavioral disorders resulting from neurological conditions or injuries affecting the brain.

OLDER ADULTS
Individuals who are advanced in age, in this context aged 65 years or older.

PHYSICAL ACTIVITY (PA)
Any bodily movement produced by skeletal muscles that requires energy expenditure (Caspersen et

al., 1985). In this project, the term will often be used to generically refer to physical activity, including physical exercises within.

PHYSICAL EXERCISE (PE)
Subset of PA and refers to planned, structured, and repetitive bodily movements performed to maintain or improve physical fitness, health, and overall well-being (Caspersen et al., 1985).

PHYSICAL FITNESS
Set of attributes described as the “ability to carry out daily tasks with vigor and alertness, without undue fatigue” (Park, 1989).

PHYSIOTHERAPIST
Also known as physical therapist, is a healthcare professional trained in assessing, diagnosing, and treating musculoskeletal and movement disorders. They use physical techniques, exercises, and interventions to promote mobility, function, and overall well-being.

PREVENTION
Measures to prevent or reduce the occurrence of health issues by identifying and addressing risk factors, promoting healthy behaviors, and implementing strategies to mitigate potential health threats before they manifest.

PROCESSING SPEED
Cognitive function expressing how quickly the brain absorbs, interprets, and reacts to incoming information.

REMOTE PLATFORM
Digital and/or online platform that allows users to access services, resources, or support remotely, typically through the internet or other communication networks.

SEDENTARY
Lifestyle characterized by zero or low levels of physical activity. It is associated with various health risks.

DISCOVER

CONTENT	RESEARCH QUESTIONS
2. Theorethical Background	What is the relevant theory to comprehend the context? How is the current situation of physical activity in the context of the project? How to improve the levels of PA among older adults?
3. Neuroinova	Who is Neuroinova, their products and their area of expertise? How do they apply and mean to apply the relevant background theory in their work?
4. People involved	Who are the people involved in the context of the project? What is user's attitude, barriers and motivators towards the envisioned program? What is the professional perception on users' attitude towards the envisioned program? How the patient-professional relationship should be shaped?

2. Theorethical background

This chapter aims to provide the reader with sufficient theory to navigate the context of the project, specifically regarding the themes of physical activity, cognitive training, combined PE and CT and their application in digital platforms, with a focus on older adults. The information presented is derived from literature review, materials provided by the company, and interviews conducted with experts involved into ACTIVAS project.

The content, presented as it follows, is the result of specific research questions outlined at the beginning of each sub-chapter. At the end of each chapter, the link with the final project is highlighted.

2.1 Physical Activity

The following sub-chapter provides the reader with the necessary information related to the topic of physical activity to sufficiently understand the context. The information derive from literature review, interviews with the physiotherapists of the UA research team and materials provided by the research team and the company, and are collected to answer to the following research questions:

- Which are the health benefits of physical activity?
- How it should be performed to obtain those benefits?
- Are there specific recommendations for older adults?

2.1.1 Benefits

Regular PA is associated with numerous health benefits and serves as a protective measure against physical and cognitive decline. Its benefits include reduced cardiovascular disease mortality, incident hypertension, cancer risk, and type 2 diabetes, as well as improved mental and cognitive health (ACSM, 2018).
In older adults, PA not only fosters functional, cognitive, musculoskeletal, and cardiovascular improvements but also mitigates the risk of falls and related injuries (Bull et al., 2020; Fragala et al., 2019).
Despite these benefits, a significant proportion of older adults exhibit sedentary behavior, spending extended periods sitting at work, driving, or engaging in activities like watching TV or reading. This is a great concern as minimum PA among older adults is strongly linked to heightened cardiovascular risk, social isolation, frailty, sarcopenia, cancer, diabetes, and other disorders (Biswas et al., 2015).
Referring to the distinction between PA and PE given in the glossary (Figure 6), a significant portion of older adults engage in some form of PA, conducting active or busy lifestyles that allow them to move, but it often lacks the structure and intensity required for it to be considered PE and, therefore, for being effective enough to mitigate the risks factors prevalent in this age group (R. Andias, personal communication, April 17th 2024). Therefore, increasing the level of PA among older adults, with the aim of introducing regular PE in their daily routines, is essential for mitigating the aforementioned risks.

Figure 6. Physical activity vs physical exercises (Testoni, 2024 / Adobe Stock).

2.1.2 Guidelines

Several guidelines for the correct performance of PE have been outlined (WHO, 2020). These guidelines target policymakers in various sectors, aiding in the formulation of plans to promote PA and reduce sedentary behaviors. The guidelines addressed in the following paragraphs are those used by the UA research team to develop the PE to prescribe to COGWEB® users in the ACTIVAS program.

Settings

PE can occur in various settings, including clinical or home environments, with or without supervision, in either individual or group formats (US Department of Health and Human Services, 2018). To ensure a correct exercise prescription, the American College of Sports Medicine (ACSM, 2018) introduced the FITT-VP principles: Frequency, Intensity, Time, Type, Volume, and

Progression, explained in Table 1.

Modalities
PA is crucial to reduce risks associated with ageing, with an incremental benefit when incorporating multiple exercise modalities, such as mobility, resistance, flexibility, balance and aerobic exercises (Sherrington et al., 2020), summarized in Table 2. Regardless of exercise type, warm-up and cool-down are recommended before and after the main exercise session, with rest periods between exercise sets (US Department of
Health and Human Services, 2018). Exercises should be adaptable to different difficulty levels, adjusting factors like repetitions, resistance, or base support width, to suit individual capabilities safely (Baptista et al., 2022).

2.1.3 Specific recommendations for older adults

The WHO (2020) set up some specific recommendations targeted to different age groups (Table 3 and 4). It is important to underscore that if individuals are not meeting these guidelines, starting some PA, even in small amounts, can still yield health benefits. Gradually increasing frequency, intensity, and duration over time is encouraged. Older adults should be as active as their ability allows, adjusting the effort accordingly. Consulting with a PA specialist or healthcare professional is advised for tailored advice on appropriate types and amounts of activity based on individual needs, abilities, preferences and treatment plans. Regular self-monitoring and plan adjustments are encouraged as abilities improve or health status changes.

2.1.4 Link to the final project

The theory related to physical activity, particularly for older adults, was used to better understand the importance of performing exercises in specific ways to achieve the desired benefits in the ACTIVAS program. This knowledge, along with the guidelines, will be used in prescribing the program and will guide the selection of exercises both in testing and in concept development, ensuring they are realistic and tailored to the individual condition of each user.

Table 1. FITT-VP principle for physical exercise settings (ACSM, 2018)

Frequency	Intensity	Time	Type	Volume	Progression
How often exercises are performed each week	Level of exertion, ranging from very light to vigorous	Duration of each exercise session and total program duration	Specific category of exercise, tailored to target specific health or skill components	Total amount of exercise undertaken	How the exercise program advances over time

Table 2. Modalities to consider when prescribing exercises (Sherrington et al., 2020; US Department of Health and Human Services, 2018).

Mobility	Resistance	Balance	Flexibility	Aerobic
Aims to maximize joint range of motion, facilitating movement between different body positions	Muscle contraction against external resistance or weight, to increase muscle mass and strength	Focus on maintaining equilibrium, whether stationary (static balance) or in motion (dynamic balance)	Improve or maintain soft tissue extensibility around the joints, enhancing functional mobility	Aims to improve cardiovascular endurance by increasing heart rate

2.2 Cognitive Training

Table 3. World Health Organization (2020) recommendations for adults between 18 and 64 years old

Adults 18-64 years
Including those with chronic conditions and disabilities. • Engage in regular PA. • 150–300 minutes per week of moderate-intensity aerobic activity, or 75–150 minutes of vigorous-intensity aerobic activity, or a combination. • Muscle-strengthening activities for all major muscle groups on at least 2 a week. • Limit sedentary time and replace it with PA of any intensity. • Exceed the recommended levels of PA to increase the health benefits.

Table 4. World Health Organization (2020) recommendations for older adults of 65 and more years old

Adults 65+ years
• Same as for adults and; • More emphasis on doing varied multicomponent physical activity, with a focus on functional balance and strength training 3 or more days a week to enhance functional capacity and prevent falls.

The following sub-chapter addresses the topic of cognitive training giving the reader enough knowledge to understand the context. These information come from literature review, interviews with neuropsychologists and experts in Neuroinova and materials provided by the company. The research questions that guided the data collection were:

- What is CT and how does it work?
- Why is it beneficial and for who?
- How is it applied in older adults and cognitive decline?

2.2.1 What is CT

CT involves a series of cognitively challenging tasks and exercises designed to stimulate and strengthen overall cognitive functions. It is particularly important when cognitive functioning declines or when cognitive impairments are present. In cases of cognitive decline, individuals may begin to struggle with daily tasks and exhibit deterioration in essential mental processes such as attention, learning, memory, or language, which are crucial for everyday functioning (Kueider et al., 2014). These issues can signal conditions like dementia or Alzheimer's disease. Cognitive impairments, on the other hand, often affect specific cognitive areas and are prevalent in various neurological and psychiatric disorders, including stroke, Parkinson's disease, traumatic brain injury, and others (Patel et al., 2007; WHO, 2006). CT is based on the premise that the brain can adapt and improve even in older age (Kueider et al., 2014), leading to enhancements in brain function and overall cognitive abilities. This approach is vital for preventing and slowing the symptoms of cognitive decline, as well as for strengthening underdeveloped cognitive faculties.

2.2.2 Neuroplasticity of the brain

Cognitive training is strictly linked with the concept of '*neuroplasticity of the brain*', which refers to the nervous system's ability to reorganize itself in response to various stimuli (Cramer et al., 2011). This phenomenon is crucial for learning, normal nervous

EXAMPLES OF COGNITIVE EXERCISES

1. ATTENTION EXERCISES: in this example of exercise, the goal is to fulfill multiple coffee orders simultaneously. As the number of orders increases, the difficulty of completing them successfully also rises. This activity trains divided attention: the ability to manage and respond to multiple tasks at once. (Trouble Brewing, n.d.-b)

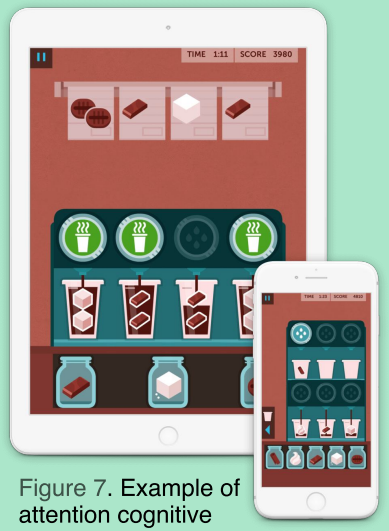


Figure 7. Example of attention cognitive exercise (Trouble Brewing, n.d.-b)

1. CARDS, BOARD GAMES AND ELECTRONIC GAMES: card games offer an affordable and enjoyable way to strengthen memory and strategy skills. Board games like Trivial Pursuit enhance factual recall, while games like Monopoly engage math, financial, and strategic thinking (Brilliant T, Nouchi, & Kawashima, 2019).

2. PUZZLES: puzzles are designed to challenge the brain, tapping into its natural abilities to recognize patterns, complete sequences, and solve problems. (Fissler et al., 2018)

3. MEMORY GAMES: in this example of exercise, the user must memorize words and their locations on the grid and then recall them, strenghtening his verbal, visual, and spatial memory skills (HappyNeuron, 2024).

Figure 8. Example of cards, board and electronic games (Mom, 2024)

Figure 9. Example of puzzle cognitive exercise (Wikipedia contributors, 2024b)

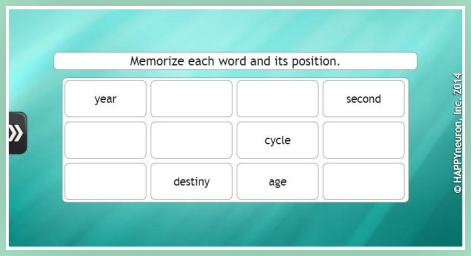


Figure 10. Example of memory cognitive exercise (Happy Neuron, 2024)

system maturation, and adapting behavior, as well as for recovering from injury or degenerative processes (Cramer et al., 2011; Selzer, 2006; Nudo & McNeal, 2013).
Neuroplasticity can occur spontaneously or be influenced by specific experiences or training, making it experience-dependent (Cruz, 2014). The primary objective of CT is to enhance cognition by engaging in carefully designed exercises that induce neuroplastic changes in dysfunctional neural systems and allow adaptive alterations (Cramer et al., 2011; Kwakkel et al., 2006).

2.2.3 Cognitive exercises

Cognitive training typically involves structured practice on specific tasks aimed at improving various cognitive functions (Clare et al., 2003). These may encompass memory tasks, attention exercises, problem-solving activities, reading and writing exercises, numerical calculations, as well as simulations of daily life situations. Figures from 7 to 10 illustrate examples of how these exercises work, showing generic activities and exercises (examples 1 and 2), and exercises designed for other CT platforms addressing specific cognitive functions (examples 3 and 4).
The premise is that practice can enhance or maintain functioning in these cognitive domains and that the benefits extend beyond the training itself. Similar to how physical training enhances physical abilities, cognitive training improves cognitive functions. (Kueider et al., 2014).
Chapter 3.3.4 presents the areas targeted by Neuroinova specialists and the kind of exercises that can be found on their product for cognitive training, COGWEB®.

2.2.4 Modalities

CT methods cover different modalities and can be offered individually or in groups, facilitated by professionals or family members, with or without therapist support. Tasks may be presented in various formats, such as paper-and-pencil or computerized, and may simulate everyday activities. These tasks typically offer a range of difficulty levels to accommodate individual needs, periodically adapted to the patient's

performance to ensure continuous challenge and improvement (Clare et al., 2003; Verhaeghen et al., 1992). However, the core approach involves repetitive exercises aimed at improving specific cognitive abilities, either individually or in combination (Kueider et al., 2014). There are some guidelines that direct the training modalities and the exercise types, durations and session lengths. However, these guidelines are adaptable to individual cases, to accommodate varying patient needs and conditions.

2.2.5 Personalization of the treatment

Treatment modalities, exercise selection, and intervention plans are tailored to each patient's symptoms and needs following clinical consultation and assessment by a neuropsychologist. The intervention plan and session protocols undergone by the patient are clinical decisions aimed at specific objectives. These decisions do not adhere to a standardized approach based on the type of deficit; rather, they focus on exercises tailored to the specific areas requiring improvement.
However, three distinct case studies can be identified:

- static deficits (e.g., stroke or traumatic brain injury): exercises are specifically targeted at areas affected by the condition with the goal of restoring initial brain functions as much as possible
- progressive deficits (e.g. Alzheimer's or Parkinson's disease): encompasses a wide range of exercises targeting various cognitive domains to either slow the progression of the disease or alleviate symptoms
- prevention: covers a broad spectrum of exercises aimed at enhancing overall cognitive health and delaying cognitive decline as much as possible.

(A. Sousa, personal communication, April 15th, 2024; Neuroinova, n.d.).

2.2.6 Cognitive interventions in older adults

Age-related changes are characterized by a decline in neuroplasticity due to biological alterations in the brain. These changes inevitably result in functional impairments, such as reduced processing speed, working memory, and sensory processing. Therefore, preventive interventions focused on preserving neuroplasticity and early detection are essential (Cruz, 2014).
CT programs, as defined, have been extensively studied across various age groups and clinical conditions, ranging from healthy older adults to those with preclinical dementia or mild cognitive impairments (MIC), to those diagnosed with Alzheimer's disease.
Three stages of Alzheimer's disease prevention have been identified according to the cognitive condition of the individuals (O' Donnell, 2023):

- primary prevention targeting disease incidence in cognitively healthy people, enhancing cognitive functions;
- secondary prevention aiming to slow the progression of the disease, often reducing the conversion of MIC to dementia;
- tertiary prevention focusing on reducing disability due to cognitive symptoms in diagnosed patients

2.2.7 Link to the final project

The theory learned about cognitive training was essential in fully understanding Neuroinova's area of expertise, as well as the methods and cases in which cognitive training is applied. Since the final design will incorporate dual-task training exercises, involving simultaneous physical and cognitive training, understanding how these exercises work was crucial for designing them in a realistic way.

2.3 Combination of CT and PA

The following sub-chapter introduces the combined approach of cognitive and physical training, highlighting its benefits compared to single-method approaches, answering to the questions: what is a combined approach? Is it more beneficial compared to physical and cognitive training alone?

2.3.1 Benefits and effects

Combined approaches, integrating PE with CT has emerged as a promising strategy for improving cognitive function and reducing cognitive decline, especially among older individuals at risk of cognitive decline and functional limitations. Numerous studies demonstrated the effectiveness on improving physical and cognitive functions of a combined approach compared with interventions that include only one component.
Associated benefits revealed from literature are:

- Physical functional improvements: improvements in physical function parameters such as gait speed, balance, strength, overall mobility, muscle strength, flexibility, and reduced risk of falls (Yu et al., 2023).
- Cognitive improvements: enhancements in cognitive domains such as memory, executive function, attention, and processing speed (Karssemeijer et al., 2017), and mitigation of risk of cognitive decline (Sanchini et al., 2022).
- Overall quality of life and well-being: reported increased satisfaction, mood improvement, and higher levels of self-perceived health and vitality (Alves et al., 2013).
- Independence and longevity: improvements in physical function and cognitive abilities consequently translate into enhanced autonomy in daily activities and reduced reliance on external assistance (Yu et al., 2023).

2.3.2 Link to the final project

The information provided help to clarify the reasons for choosing this approach. The next step is to understand how to implement it effectively and identify the strategies that will make it successful for the target group within the specific context.

2.4 Remote training platforms

This sub-chapter highlights benefits and opportunities of adopting a remote approach for combining cognitive and physical training using ITC, and informs the reader about the challenges that the project's target group could face.
The information are collected answering to the following research questions:

- Why using remote digital platforms for combined interventions?
- Which are the challenges to be aware of?

2.4.1 Benefits and opportunities

The increasing number of individuals at risk of cognitive and physical health highlights the need to develop and validate new strategies to enhance accessibility without increasing costs.
Integrating computers and ITC-based systems into current practices has the potential to optimize interventions, enhancing their intensity, patient adherence, and professional monitoring quality (Tedim Cruz et al., 2014).
Relevant advantages and opportunities of this strategy are:

- Automatization: computerized CT is easily scalable and automatically records training data and adjusts the difficulty levels based on the patient's performance.
- Enhanced indipendence and quality of life: technology adoption can enhance older adults' quality of life, support longer independent living, and help bridge the generational technological gap given by differences in the use of digital devices.
- Reduced costs and more accessibility: ITC provide potential solutions to reduce costs and to overcome spatial and social barriers, while reducing the burden on patients, families, and institutions associated with in-person treatments.
- Social inclusion: technology can assist in daily activities, reduce isolation often experienced in older age, and facilitate connections with friends and family.

2.4.2 Challenges

Despite the numerous benefits that

ICT offers, there are challenges to consider when implementing such approaches for older adults. While older individuals recognise the potential advantages of technology for maintaining independence and well-being, concerns about choice, control, privacy, and fear of reduced social interaction are significant. Additionally, technical issues like poor internet connectivity or low digital literacy can impede their access to and engagement with technology-based interventions. Face-to-face sessions are often seen as offering additional benefits (Damoradan & Olphert, 2015).

2.4.3 Link to the final project

Although efforts are being made to promote technology adoption among older adults through education, training, and user-centered design approaches (Damoradan & Olphert, 2015), it is important to note that the target users for this project are individuals with sufficient digital literacy to use COGWEB® independently. While it's crucial to consider the challenges and the generational digital divide that might exclude many potential users, the project aims to leverage ICT to achieve the health benefits that ACTIVAS seeks to deliver. A user-centered approach while doing on-field research will be essential to understanding these users' relationship with technology, ensuring that this approach is as accessible and user-friendly as possible for this demographic.

2.5 Current situation

This sub-chapter provides an overview of the current situation among the target group in relation to the project's context and highlights the gap between the potential benefits of integrating PE into CT through remote intervention, and the existing reality in Portugal. Specifically, it aims to understand:

- What is the level of PA of older adults in Portugal?
- Why is it a problem?

2.5.1 PA levels in Portugal

Sedentary behavior is a prevalent issue among older adults in Portugal, leading to serious health problems such as stroke, cardiovascular diseases, and obesity. According to Teixeira et al. (2019), nearly 47% of older adults report low or very low levels of PA, falling short of health guidelines, while only 23% meet or exceed the recommended levels. Bento et al. (2023) further support these findings, noting that although older adults engage in low-intensity activities, adherence to PA recommendations remains low, particularly among women. Despite initiatives like outdoor gyms and community programs, many older adults in Portugal remain largely sedentary, spending excessive time on activities like watching TV with little physical engagement (A. Martins, personal communication, April 17th, 2024). Tackling this issue is essential to improving the health and well-being of this demographic.

2.6 Increasing PA

Given the serious situation regarding PA levels among older adults in Portugal, it is crucial to explore ways to increase them. To do so, it is helpful to analyse the current state of the art, considering both theoretical models of behavioral change, which can provide frameworks for altering the existing habits of the target group, and practical examples of existing remote combined interventions. This exploration aims to answer the key question: how to effectively increase PA levels among older adults?

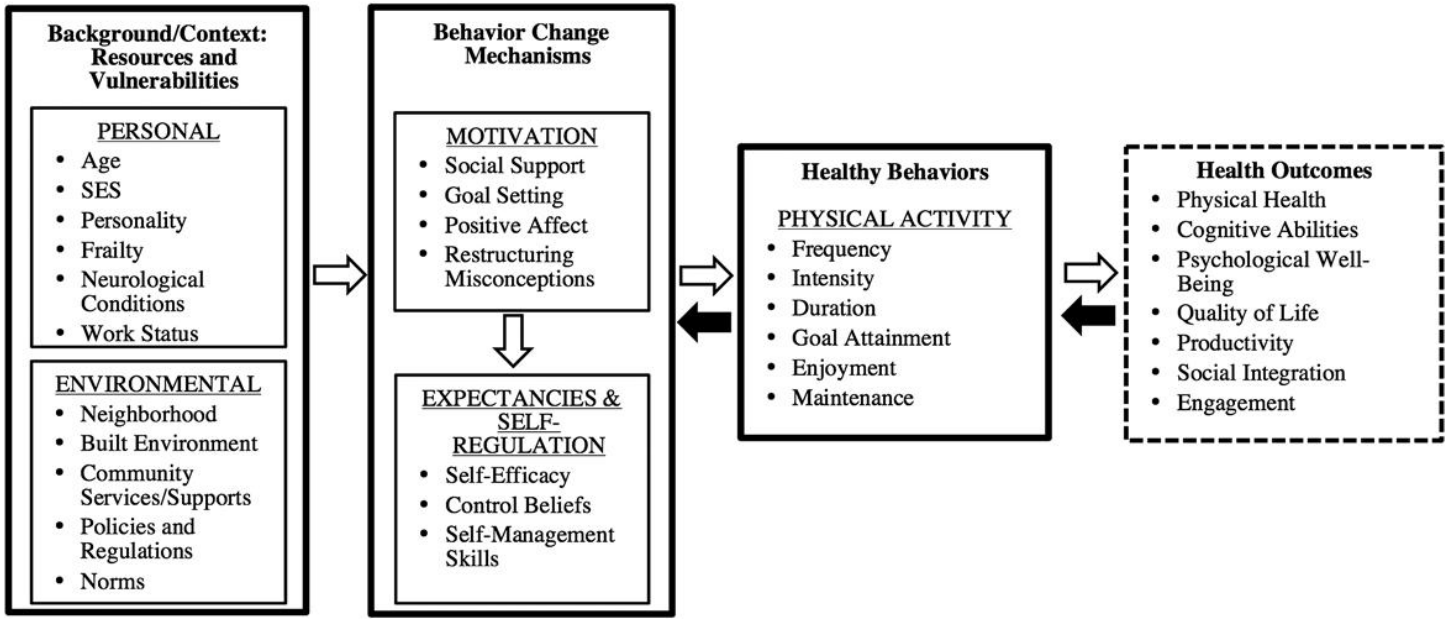
2.6.1 Looking at the theory: stimulating behavioural change

Encouraging older adult with a poor level of PA to adopt an active lifestyle requires a shift in their behavior, task that requires numerous efforts and resources and therefore reveals highly challenging. Several models and programs have been developed to facilitate behavior change and promote PA among older adults, yet despite some successful stories, they often fail to achieve long-lasting results (Antonucci et al., 2012). Many of these interventions center around formal exercise programs and regimens, which typically involve dedicating specific time slots for gym or lab visits and purchasing equipment or memberships (Lachman et al., 2018). However, asking older adults to adhere to such regimens, focused on skills training and teaching routines for exercise, has obtained only limited success, particularly in the long term (Corder et al., 2009).

Multi-component approach

An alternative to formal exercise regimens involves integrating PA into daily routines, by making gradual lifestyle improvements while minimizing drastic changes. This approach, known as the Multi-component approach (Lackman et al., 2018), focuses on personalizing the intervention plan based on environmental and individual factors, such as job, personal preferences, interests, and goals. For example, it might include simple strategies like scheduling a walk in one's calendar, cycling to the supermarket, or choosing to walk to a friend's house instead of calling (Lachman et al., 2018). This method is low-resource in terms of cost and time, and it does not require drastic changes to habits. For succeeding in promoting change, the intervention strategy must incorporate mechanisms that

Figure 11. Multi-component approach framework (Lachman et al., 2018)



influence individuals' motivation. This can include providing social and emotional support, reframing negative misconceptions about own's abilities or exercises (e.g., believing that exercises are too harmful or that people are too old or weak to do them), and setting well defined and planned goals that feel achievable. Additionally, the intervention should involve enjoyable activities, as these are more likely to be repeated and sustained, emphasizing the importance of aligning goals with individual preferences. It is crucial that people not only enhance their perceived self-efficacy but also feel they have control over their ability to succeed and develop self-regulatory skills, such as planning the necessary steps to achieve their goals. Figure 11 shows a visualization of this model.

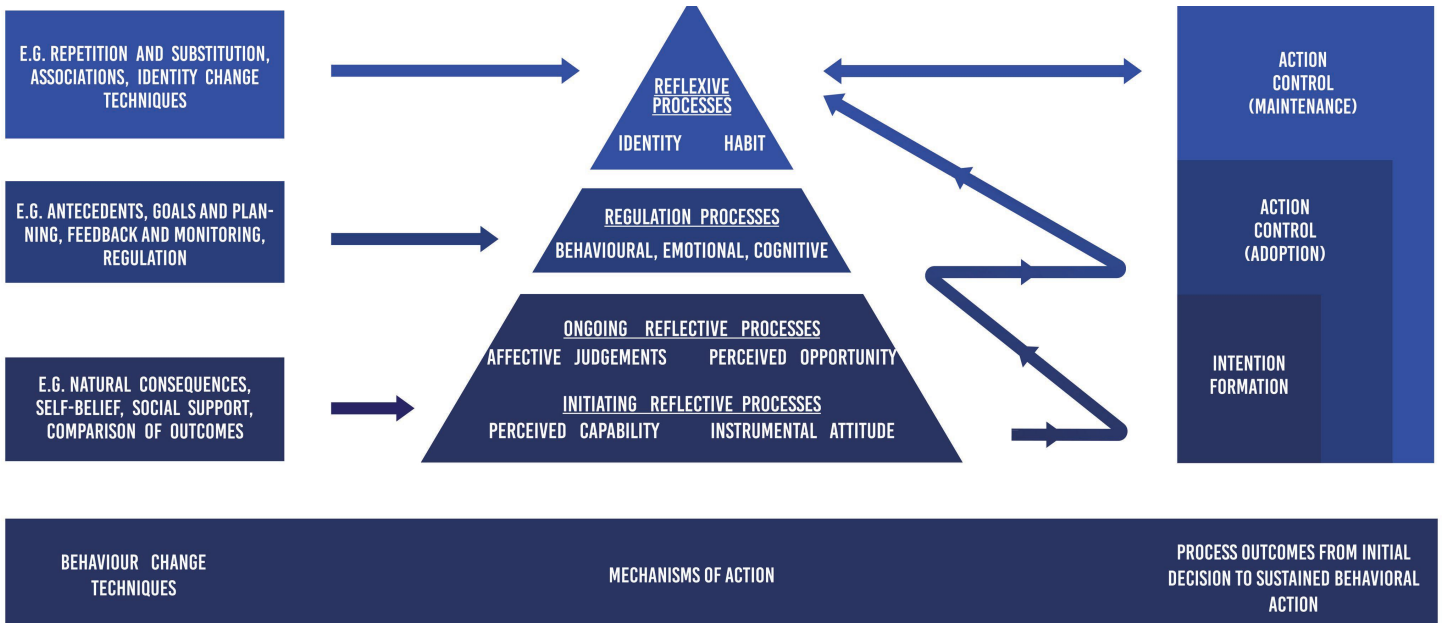
M-PAC framework

The multicomponent approach addresses key elements for promoting behavioral change in PA among older adults, but it does not specify which strategies are most effective for initiating and which ones for maintaining long-term change, crucial distinction to guide design criteria according to the specific goals of the target group. The Multi-Process Action Control Framework (M-PAC) provides this necessary distinction by identifying three interconnected layers of behavioral change: intention formation, adoption, and maintenance (Figure 12).

It proposes that sustained changes in PA habits result from the interaction of reflective, regulatory, and reflexive processes, which translate initial intentions into behavior over time (Rhodes et al., 2021).

- Reflective processes (Layer 1): this layer focuses on the initial formation of the intention to adopt a new behavior. It involves concepts like a positive perception of one's abilities and the perceived benefits of adopting the new behavior.
- Regulatory processes (Layer 2): this layer involves turning the intention into action through planning and monitoring the necessary steps over time. It also includes managing emotions proactively to overcome potential obstacles.
- Reflexive processes (Layer 3): this layer develops over time as a result of repeated actions, leading to the creation of new habits or identities.

Figure 12. Multi-process action control schematic. (Rhodes, 2021)



These theoretical models are valuable for guiding the design of interventions aimed at increasing PA levels among older adults. They emphasize key factors such as personalizing the intervention to the individual's specific situation, minimizing disruption to daily routines to facilitate gradual change, and considering elements that motivate the initial intention to engage in PA, as well as those that help establish long-term habits.

2.6.2 Looking at the practice: existing interventions

Another useful approach for implementing strategies to increase PA levels among older adults, is to look at successful interventions that combine cognitive and physical training for this target group.
According to a systematic review and meta-analysis by Gavelin et al. (2021), these interventions can be grouped into three main categories: sequential, simultaneous, and exergaming. Only digital platforms will be considered here, as the final output of the project is intended to be part of this category.

Sequential interventions
Involve delivering physical and cognitive exercises in separate sessions within the same intervention period, either on the same day or on different days. This approach allows participants to focus on each component independently.

Simultaneous interventions
Involve the concurrent delivery of PE and CT within the same session, typically in a dual-task format. In this approach, participants engage in cognitive tasks while performing physical activities, leveraging the synergistic effects of combining the two activities. An example of this type of intervention is MEMORY (Figure 13), where participants perform cognitive exercises focused on visual memory while walking on a treadmill (Eggenberger et al., 2015).

Exergaming interventions
Involves physically active video games that incorporate cognitively challenging tasks, blending entertainment with exercise to create an engaging platform for cognitive-motor training. These interventions also offer opportunities for social interaction and competition, further enhancing participant engagement and enjoyment. An example is DANCE (Figure 14), a dance video game intervention that combines an attention-demanding cognitive task with motor coordination, requiring participants to follow stepping sequences on a pressure-sensitive platform in time with music, guided by arrows on a screen indicating the timing and direction of each step (Eggenberger et al., 2016).

All these strategies have been shown to be effective in improving both cognitive and physical functions, making them scientifically relevant examples. However, determining the best combination modality remains an ongoing area of research. Moreover, identifying which of these strategies is most effective in terms of user adherence—and therefore the most successful at increasing PA levels among older adults—is still under exploration, with no definitive answers available yet.

Figure 13. Example of MEMORY simultaneous intervention (Eggenberger et al., 2015)

Figure 14. Example of DANCE exergaming intervention (Eggenberger et al., 2016)

2.7 Conclusion

2.6.3 Link to the final project

Understanding the strategies and methods for implementing an intervention aimed at increasing PA levels among the target group was essential for guiding the design process. This involved selecting the right behavioral change strategies and drawing inspiration from existing solutions.
For theoretical models on stimulating behavioral change, the Multi-component approach was used to develop guidelines for professionals on how to prescribe exercises tailored to the individual's situation and cognitive training program. The M-PAC approach was also considered to create design criteria that differentiate between those aimed at forming initial intentions (starting a new behavior) and those focused on establishing long-term habits.
In terms of existing modalities of intervention, the ACTIVAS program initially planned to use a sequential approach, incorporating PE into a COGWEB® session. However, the project remained open to exploring other options, such as exergaming and simultaneous training.
Ultimately, the final design will include a dual-task training session in the form of exergaming, to be alternated with the COGWEB® session. Having a strong theoretical foundation and relevant examples was crucial for designing the exercises effectively and with informed decisions.

In conclusion, this chapter provided insights into the context of PA and CT for older adults, particularly through combined approaches using remote platforms. It has been explored how such an approach can offer significant cognitive, physical, and social benefits, making it a promising strategy for improving the quality of life, health, and well-being of older adults. However, challenges were also identified, particularly in the context of the high levels of sedentary behavior among older adults in Portugal.
To address these challenges and improve PA levels in this group, theoretical models for behavioral change were also examined, focusing on PA in older adults with cognitive impairments and decline, as well as existing successful combined approaches. While these models and examples provide valuable guidance, they do not fully answer all the questions needed to design an effective intervention as the models are too generic and not tailored to the specific context of the project. Additionally, the examined modalities of intervention lack clear results on which approaches are most effective in fostering motivation and adherence to the program.

To bridge this research gap, two actions will be necessary: first, studying the context of the project's partner, Neuroinova, to understand how to tailor the solution to their needs and how they apply into practice the reported theory on CT, and examining the ACTIVAS program to understand how they plan to address this gap.
Second, conducting on-field research actively involving stakeholders—patients and professionals—to identify factors influencing their sedentary behavior, the barriers they face regarding PA adoption, and what might motivate them to increase their levels.

3. Neuroinova

This chapter provides an overview of the partner company collaborating on this project, detailing its operational focus, the services offered, and the application of CT within its products, COGWEB® in particular, exploring the patient journey from initial contact through treatment. Additionally, the chapter delves into the integration of PA within the ACTIVAS program, examining both what the company has done so far and what remains to be developed. This chapter highlights the opportunities and challenges at the current stage of development, setting the direction for the subsequent design phase, by answering the following research questions:

- How is CT applied from Neuroinova?
- How are PE intended to be integrated in the ACTIVAS program?
- What has been done so far and what still needs to be researched?

The information contained in this chapter are derived from interviews with experts involved in Neuroinova and ACTIVAS project, from materials and previous researches conducted by them.

3.1 Area of Intervention

Figure 15. COGWEB® and BrainOnTrack® (Neuroinova.com, n.d.)

Neuroinova is a Portuguese company specialized in cognitive health, offering services that integrate technology into traditional clinical practices. Its products aim to improve patient access to early diagnosis and supervised interventions in cognitive health. Neuroinova is responsible for the development and marketing of technology-driven systems, including COGWEB®, a web-based cognitive training platform, and Brain on Track®, a cognitive monitoring system (Figure 15). These products are distributed directly to end-users or licensed to institutions. Neuroinova offers a variety of services for cognitive health, such as:

- Neuropsychological assessment: detailed evaluations to characterize cognitive functioning and assist in the diagnosis of cognitive impairments.
- Cognitive monitoring: regular online tests to track cognitive performance over time.
- Cognitive training: personalized training programs with specialized supervision, for individuals or groups, in-person or remotely.

3.2 Cognitive Training process

This sub-chapter outlines the patient journey of a Neuroinova client undergoing a cognitive training program using COGWEB®, from the initial medical request to the program progression. Understanding this process is crucial for determining how to integrate a PE component into the patient journey.

The information presented is derived from interviews and focus groups conducted with Neuroinova professionals, including a neuropsychologist, a scientific advisor responsible for customer support, and a scientific research lead from the UA. The data collected were analyzed by the author and subsequently reworked in Figure 16.

3.2.1 Patient journey

The patient journey at Neuroinova typically begins with an initial call from the patient, who shows concerns about cognitive symptoms, such as memory issues. Often they are referred from their physician who recommends them to seek a neuropsychological assessment.

An appointment with a neuropsychologist is scheduled to conduct a comprehensive evaluation. If needed, tailored intervention plans are recommended, typically involving daily CT sessions customized to address the patient's needs and symptoms. The patient undertakes regular monitoring, using BOT, and receives a progress report every three months with a quantitative description of their progress, supplemented with a discussion with their neuropsychologist on the results. The physiotherapist regularly communicates with the patient, to address any concerns on the patient's progresses or technical issues.

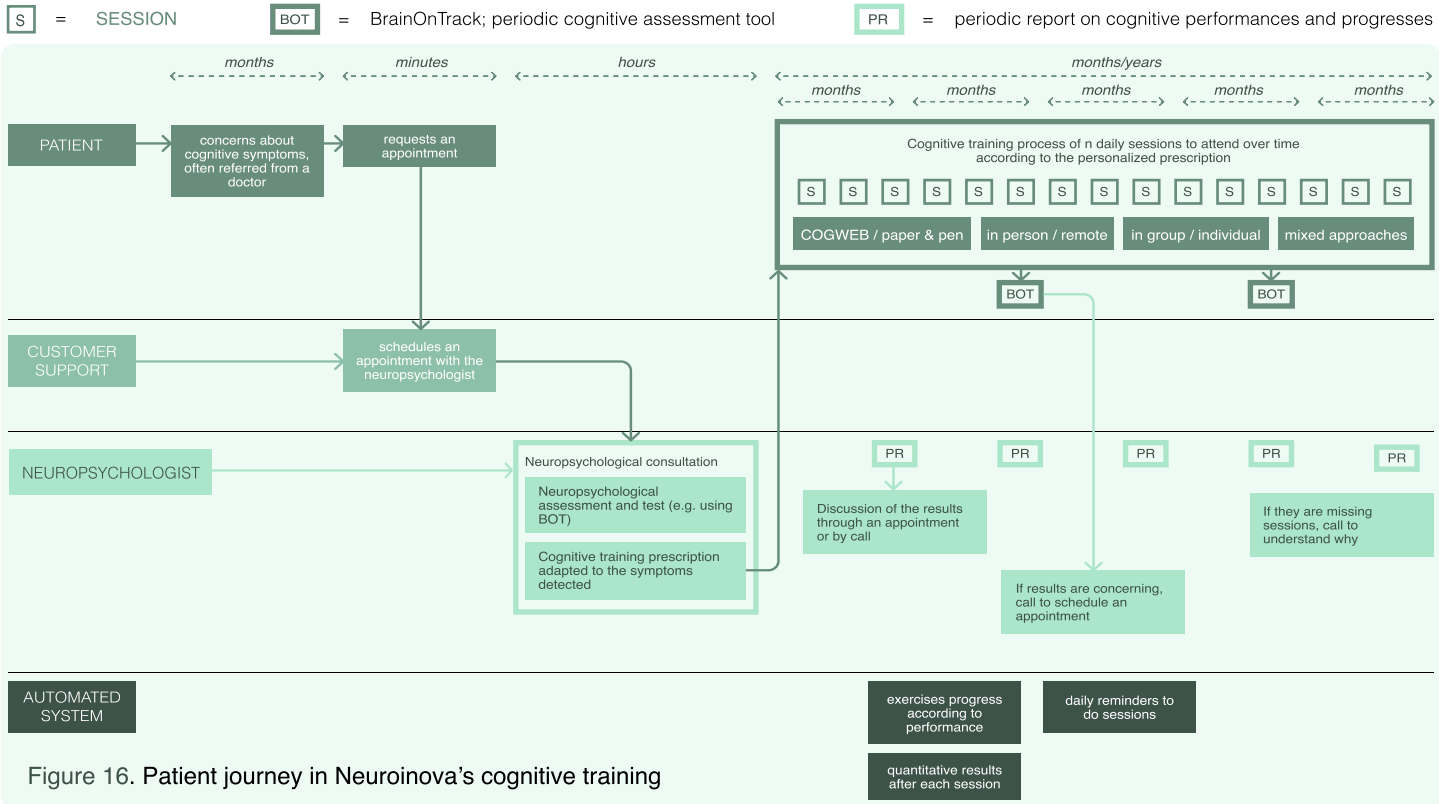


Figure 16. Patient journey in Neuroinova's cognitive training

3.2.2 Stakeholders

Figure 17 shows the stakeholders involved in the CT process with Neuroinova, and how they are connected. The main ones, besides patients, are:

- Neuropsychologists: they have a central role in patient care, conducting cognitive interventions and assessments utilizing both digital platforms like COGWEB® and BOT®, as well as traditional methods. Their responsibilities encompass guiding patients through CT sessions, monitoring progress, and addressing clinical concerns throughout the treatment process.
- Neurologists and physicians: they usually have a prior relationship with the patient, and recommend them to do a cognitive assessment or refer them to Neuroinova.
- Client support: link between Neuroinova and its users, offering assistance and addressing user requests and technical difficulties. By providing personalized support via phone or email, they ensure that users receive the necessary assistance to navigate Neuroinova's platforms effectively.
- Researchers: collaborate closely with Neuroinova to enhance the usability and effectiveness of its products. Through rigorous research and development, they aim to continuously improve Neuroinova's offerings and provide valuable insights for future innovations.
- Family and caregivers: play a crucial role in supporting patients throughout their CT journey. Their involvement can range from assisting with technical procedures to offering emotional support during training sessions. Caregivers' participation is particularly valuable for patients with low digital literacy or limited computer access, as it helps mitigate barriers.
- Software developers: involved in the design and development of Neuroinova's digital products.

The professionals working in and for Neuroinova are all responsible of the design, development of the company's digital platforms, ensuring their efficacy and usability in clinical practice.

3.2.3 Intervention plan

The intervention plan can be tailored to the patient's individual needs and symptoms, with a variety of modalities, including in-person or remote sessions, traditional paper and pencil methods or the COGWEB® platform, and may be conducted individually or in groups. Moreover,

a combination or mixed approach of these options is also possible, with flexibility built into the plan to accommodate changes as needed. While clinical decisions guide the choice of modality, patient preferences are also considered. However, the plan remains adaptable, allowing for adjustments over time. Figure 18 illustrates the framework guiding the decision-making process behind plan programming. Within Neuroinova, several guidelines inform personalized treatment prescription, involving time intervals, session duration, number of exercises, kind of stimuli, types of exercises and difficulty levels.

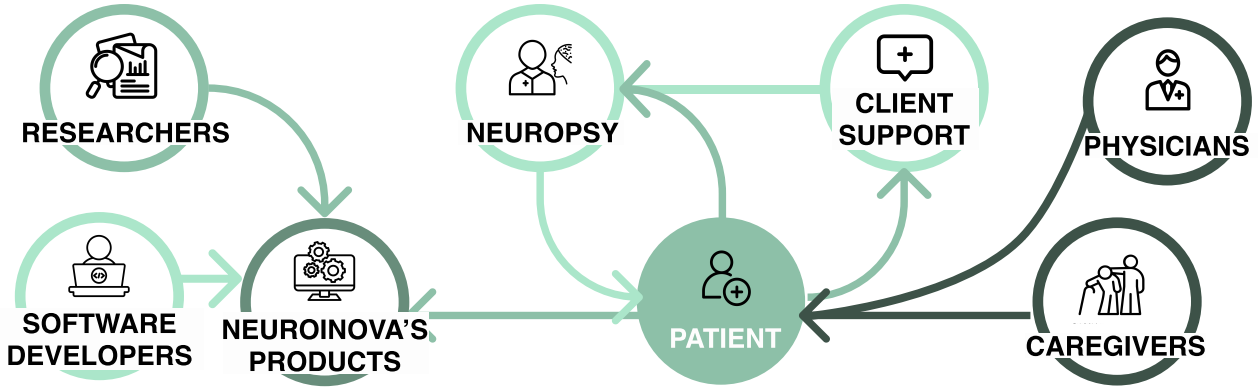


Figure 17. Main stakeholders involved in Neuroinova's cognitive training

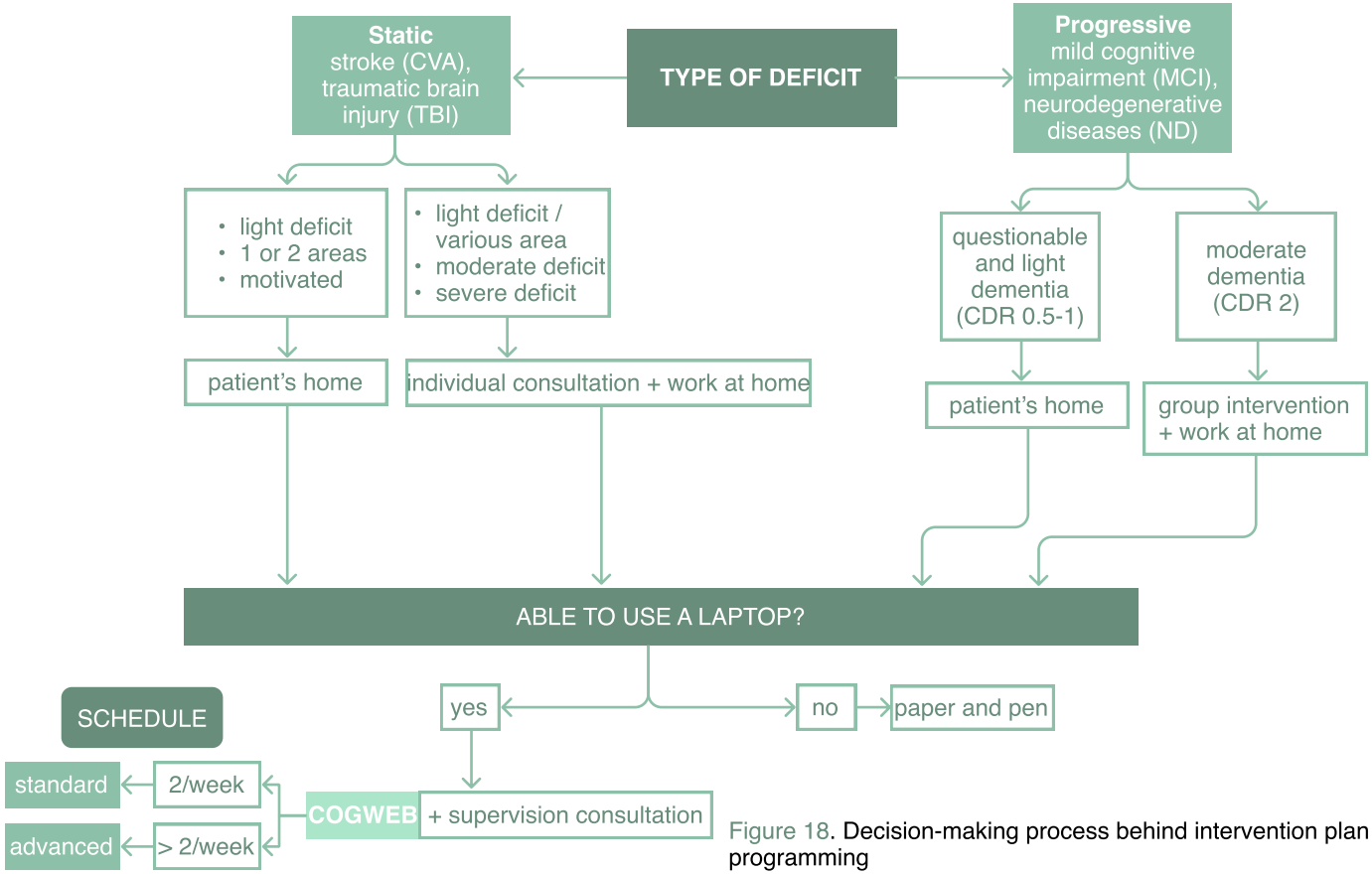


Figure 18. Decision-making process behind intervention plan programming

3.3 COGWEB®

3.3.1 What it is

COGWEB® is Neuroinova's core cognitive training program, designed to be implemented remotely within the patient's home environment under the supervision of experienced neuropsychologists. The system consists of 108 independent exercises that address various levels of cognitive impairment, from mild to severe, by targeting specific cognitive functions, such as memory, attention, executive functions, language, calculus and constructive abilities. Each exercise is designed in a computerized game format and incorporates automatic progression through multiple difficulty levels based on the patient's performance. To maintain engagement and prevent memorization, stimuli within each exercise are randomized and non-sequential.

3.3.2 Cognitive Exercises

The cognitive exercises within COGWEB® are tailored to challenge different cognitive areas, often engaging multiple areas simultaneously within a single task. The program adjusts the difficulty of exercises by manipulating elements such as the number and complexity of items and the interval between stimuli. Progress graphs tracking performance metrics, such as correct versus incorrect answers, completed levels, overall training time, and access frequency, are provided to motivate patients, with professional review ensuring personalized adjustments to the training regimen. Figures 19 to 21 show examples of these exercises.

EXAMPLES OF COGWEB'S COGNITIVE EXERCISES

1. EXECUTIVE FUNCTIONS, *'Contrary'*

In this exercise, four arrows are displayed along with a traffic light. If the light is green, the user should press the corresponding arrow on the keyboard. If the light is red, they must press the arrow pointing in the opposite direction.

Figure 19. 'Contrary' COGWEB® exercise

2. MEMORY, *'Restless cubes'*

In this exercise, cubes light up one by one. Then, the same cubes are displayed in a stationary position, and the user must click on them in the correct sequence in which they lit up. As the exercise progresses, the difficulty increases, and the number of cubes to remember grows.

Figure 20. 'Restless cubes' COGWEB® exercise

3. LANGUAGE, *'Follow the orders'*

In this exercise, a text describes an image, specifically detailing the color and position of the elements in the picture. The user must select the image that matches the description.

Figure 21. 'Follow the orders' COGWEB® exercise

3.4 ACTIVAS

This sub-chapter delves deeper into the development and current status of the ACTIVAS project as conceived by the research team. It specifically outlines the patient journey (Figure 22) for COGWEB® users and illustrates how it would change with the prescription and implementation of a PE program, and with the introduction of a physical therapist to monitor this part. Additionally, guidelines for prescription are presented, based on personalisation and progressive difficulty.

The information provided is based on interviews and focus groups with the research team members introduced in Chapter 1.2, and on materials and literature they provided.

With the introduction of PE into COGWEB®, the goal is to integrate active breaks within CT sessions. These exercises would be personalized and prescribed by a physical therapist based on individual needs and factors. The exercises would begin at a baseline level tailored to each patient, considering factors such as risk factors, age, current PA levels, physical abilities, personal preferences, and desired outcomes. As the program progresses, patients would be regularly evaluated, and the exercise regimen would be adjusted accordingly.
In this comprehensive program, patients would receive support both for CT, as already established in COGWEB®, and for the PE component, with the addition of a physical therapist to guide them at the same time.

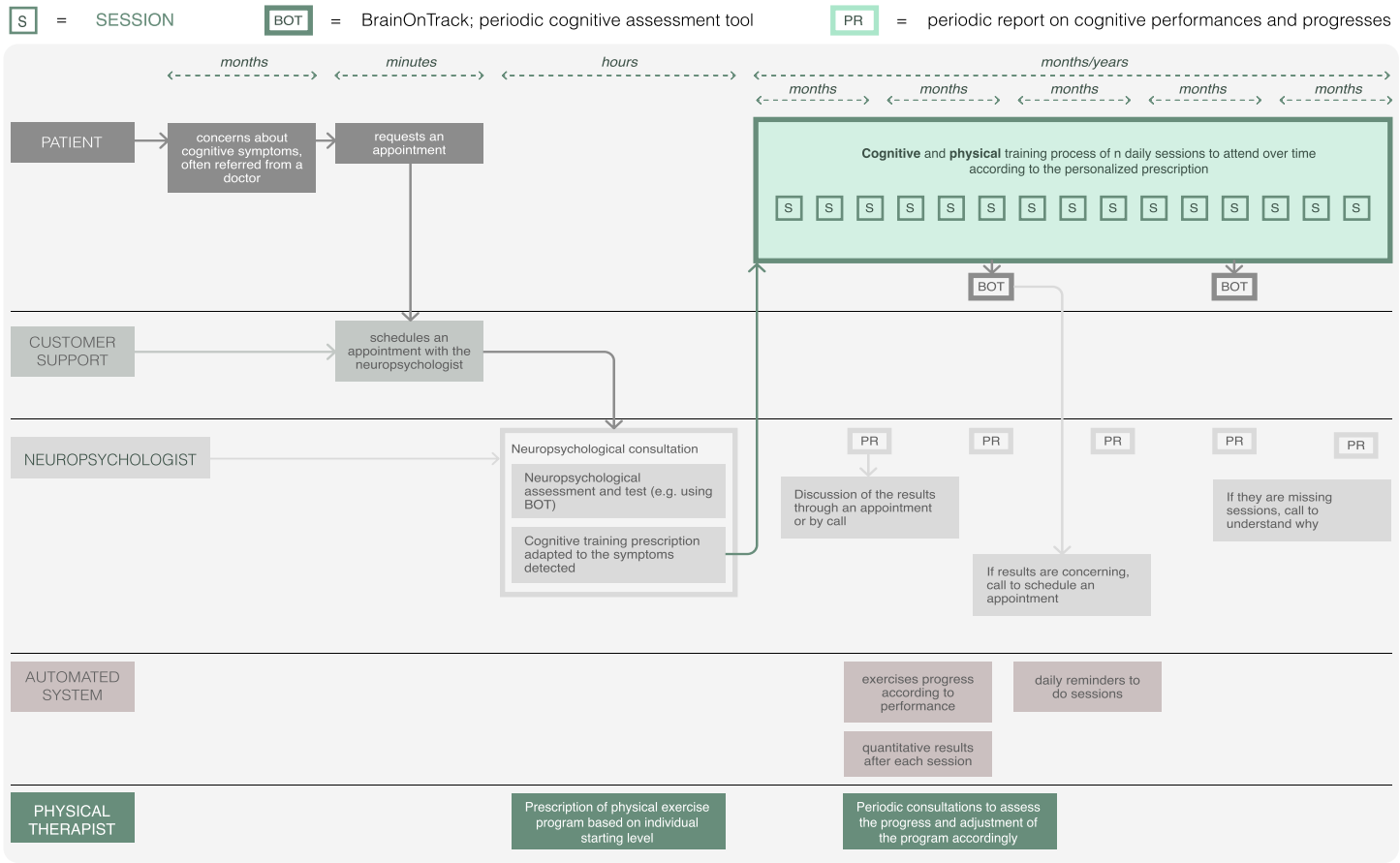


Figure 22. Patient journey with the introduction of ACTIVAS in COGWEB®

3.4.1 Role of the physiotherapist

In this scenario, the physiotherapist would be an additional stakeholder involved. The primary professional figure overseeing the program remains the neuropsychologist, who is responsible for the entire program as the patient engages in CT for clinical cognitive needs. The physiotherapist plays a complementary role, assessing the patient's physical performance and prescribing remote PE at the beginning and throughout the program, adjusting them as needed. Their connection with the other stakeholders is visualized in Figure 23.

3.4.2 Theoretical background

The PE program for older adults is based on the scientific evidence guidelines and recommendations explained in Chapters 2.1.2 and 2.1.3.

3.4.3 Program prescription

Utilizing established theory and evidence, frameworks for prescription were defined for both the overarching PE program and the constituent exercises within it. This program unfolds over time and consists of a variable number of exercises, organized in sessions and performed in sets and repetitions, with prescribed rest periods. Exercises are grouped into modalities: functional exercises, aerobic training, muscle strengthening, and balance exercises, each addressing different primary objectives. Individual exercises within the program need detailed participant instructions and consideration of various parameters, such as intensity or load, describing the exercise difficulty level. To accommodate varying levels of difficulty across exercises, different difficulty levels are established. The formalized framework are visualized for both the program in Figure 24 and the physical exercise in Figure 25. (Baptista et al., 2023)

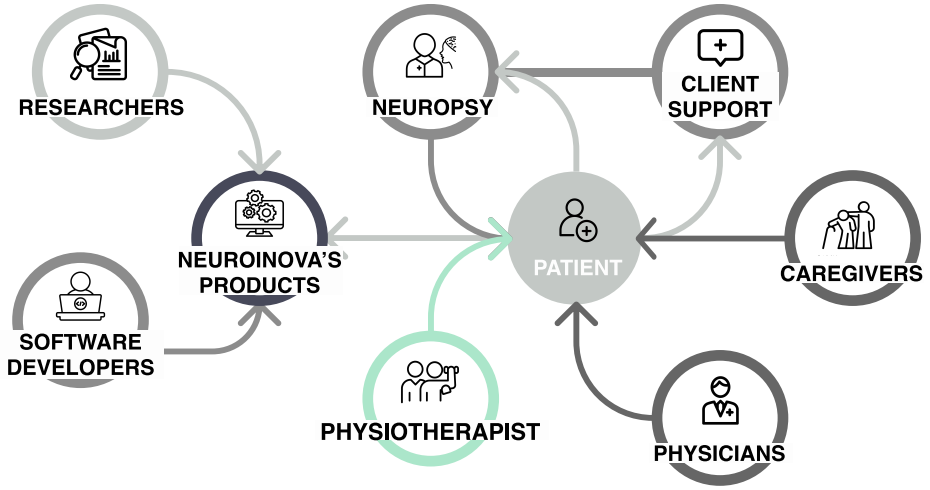


Figure 23. Main stakeholders involved in Neuroinova's cognitive training with the addition of the physiotherapist.

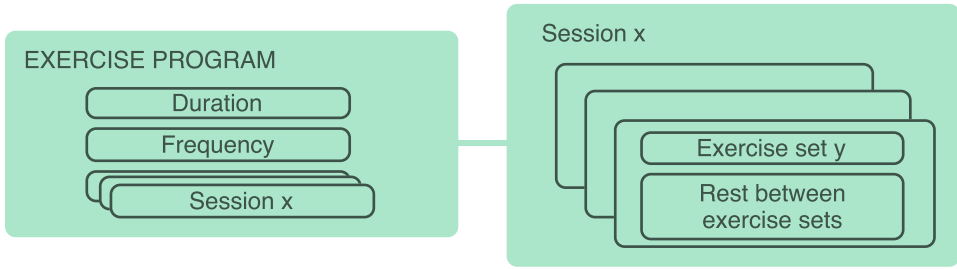


Figure 24. Framework of the physical exercise program (Baptista et al., 2023)

3.5 Conclusion

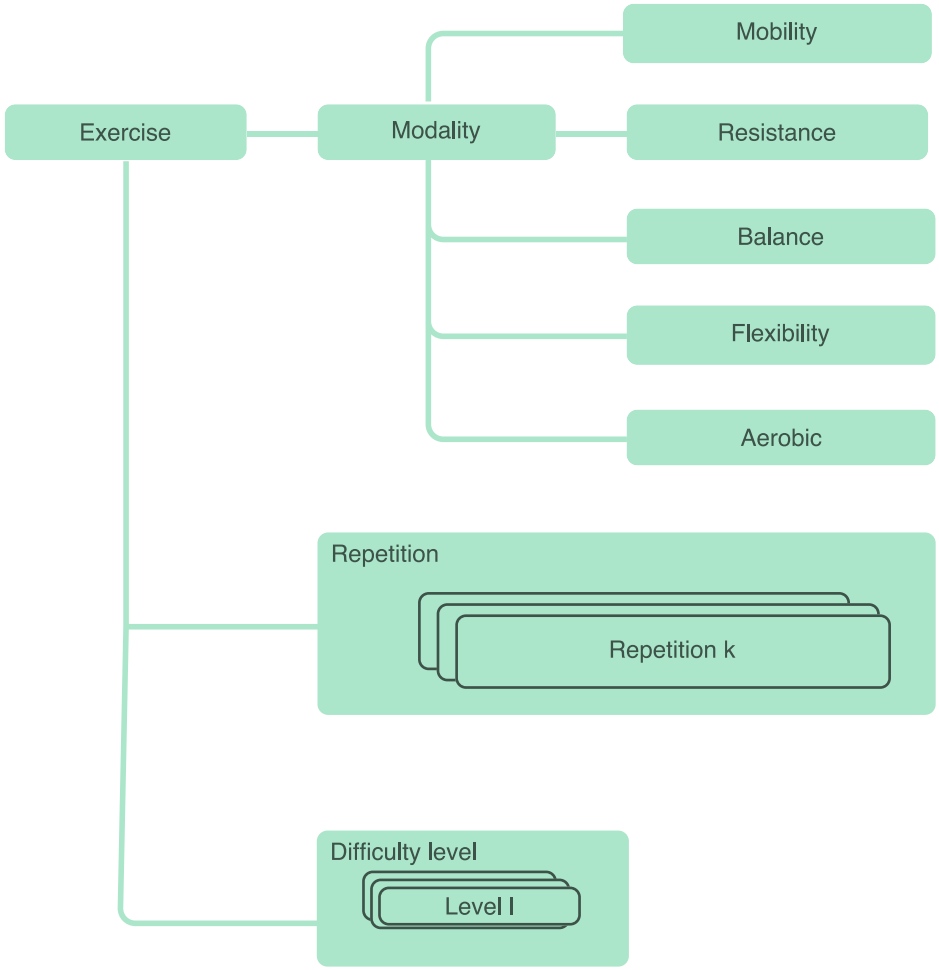


Figure 25. Framework of the physical exercise (Baptista et al., 2023)

This chapter provided an overview of the PE modalities incorporated into the ACTIVAS program, the framework for prescribing these exercises, and their integration into the COGWEB® patient journey. As a remote program, ACTIVAS offers several advantages, including improved accessibility without additional costs and features designed to promote long-term adherence. These features include structured guidance on exercise execution developed by healthcare professionals, clear communication with patients, and a personalized progression based on individual performance.
What remains to be explored is how to ensure the program effectively motivates users to adhere. To design an effective program for adherence, it is essential to involve users in research to understand their barriers and motivators regarding remote PE. This includes investigating their habits, experiences, and attitudes towards PA, as well as their expectations for interacting with a professional figure who guide the program, such as a physical therapist.

The next chapter will present the on-field research conducted by the author with participants from the Portuguese community who have characteristics relevant to the target group and with the professionals involved, and it will discuss the results obtained.

4. People involved

This section presents the research activities conducted with the stakeholders mainly involved in the project (namely the users and the professionals affiliated with Neuroinova), and the knowledge and insights derived from them.
The focus of this chapter will be understanding about the users:

- Who are the target users of this project?
- What are their habits related to PA?
- What are their barriers and motivators towards a remote PE program?
- How do they envision their relationship with a guide for PA and how much would this impact their adherence and motivation?

The perspective of the professionals involved is also crucial and aims to understand:

- Who are the professionals involved in this project?
- How is their relationship with their patients?
- How do they perceive their barriers and motivators towards CT and PA, in their professional experience?

This chapter is structured by first discussing the research conducted with the users and the results obtained, followed by the research conducted with the professionals and their corresponding outcomes. Finally, it summarizes the insights gathered from both groups and supports them with a literature review.
The comprehension of these themes is crucial for guiding future design phases.

4.1 Users

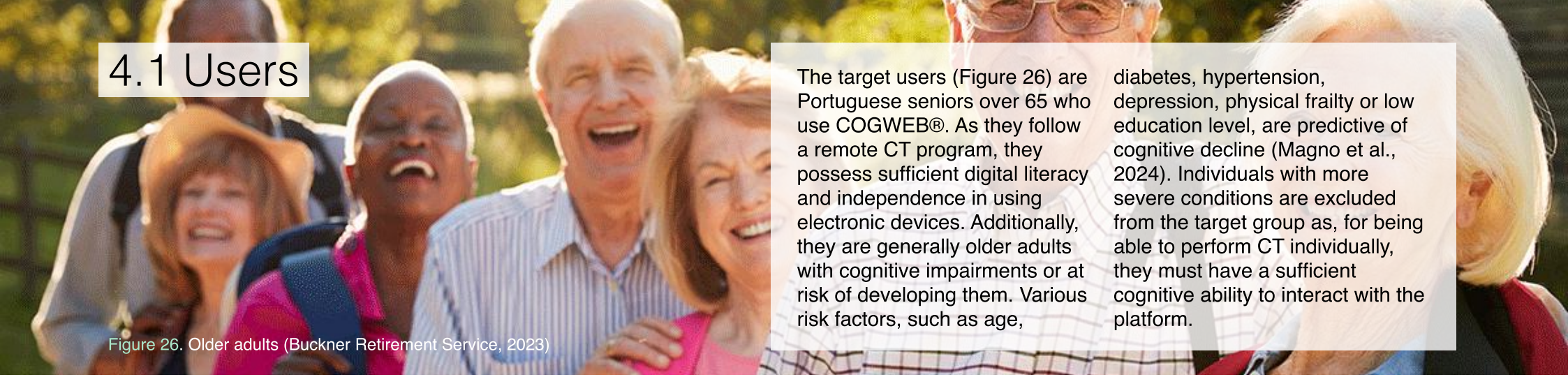


Figure 26. Older adults (Buckner Retirement Service, 2023)

The target users (Figure 26) are Portuguese seniors over 65 who use COGWEB®. As they follow a remote CT program, they possess sufficient digital literacy and independence in using electronic devices. Additionally, they are generally older adults with cognitive impairments or at risk of developing them. Various risk factors, such as age, diabetes, hypertension, depression, physical frailty or low education level, are predictive of cognitive decline (Magno et al., 2024). Individuals with more severe conditions are excluded from the target group as, for being able to perform CT individually, they must have a sufficient cognitive ability to interact with the platform.

user research

The participants involved in this phase were individuals with characteristics relevant to the target group, such as age, sedentary lifestyle or cognitive condition.
The data collection was done after ethics approval from the Delft Human Research Ethics Committee. Participants familiar with the research team from previous studies were invited, along with individuals recruited from the university or the research team's network.
This chapter presents the on-field research conducted with the users, including data analysis and the resulting outcomes.

4.1.1 Research activities: generative sessions

Generative sessions were conducted with older adults from the Portuguese community. The aim was to gather insights into their routines, tastes, preferences, attitudes towards PA and remote PE, and into their perceptions of an ideal relationship with a PA guide.
It is important to note that while the program focuses on structured PE, the research aimed to understand participants' general views on PA. Given their varying levels of PA, it was crucial to first explore their overall perceptions of PA and what they generally enjoy about being active. This understanding would help in applying those motivations to the structured exercise program under consideration.
The sessions involved a series of activities where participants discussed their experiences and viewpoints on the proposed topics, and created artifacts such as collages.
Specifically, they were asked to:

1. Create a collage about their daily routine while discussing it, highlighting the activities they enjoy, those they do not, and those they feel neutral about, with a focus on PA.
2. Watch a video of a person performing PE by following a video on a laptop, sharing their opinions and feelings about this scenario.
3. Create a collage representing their ideal relationship with a hypothetical physiotherapist or instructor.

Figure 27 illustrates the session set-up.

4.1.2 Data analysis

Each session was recorded, and photos were taken of each participant's work. The recordings were transcribed, and the most relevant statements addressing the initial research questions were highlighted. Since the participants explained their work while creating it, the worksheets served as a visual aid to their verbal explanations. Using thematic analysis (Braun & Clarke, 2006), common themes were identified, leading to valuable insights. The materials for this activity are visible in Appendix A (session guide, produced materials and analysis process).
The insights from these sessions were organized into barriers and motivators related to both remote and general PA. Additionally, a list of characteristics describing how participants envision an ideal relationship with their PA guide was developed. The information about their routines and PA habits are complemented by insights from professionals and literature, as the research lacked participants

with a sedentary lifestyle—a key characteristic of the target group. These complementary insights will be presented in the conclusions of this chapter.

4.1.3 Participants

The participants were four older adults from the Portuguese community, aged between 65 and 74 years. They were technologically autonomous, had no cognitive impairments, and maintained moderate to active levels of PA. Table 5 provides an overview of the participants' demographic characteristics.

Figure 27. Scheme representing the generative sessions' set-up

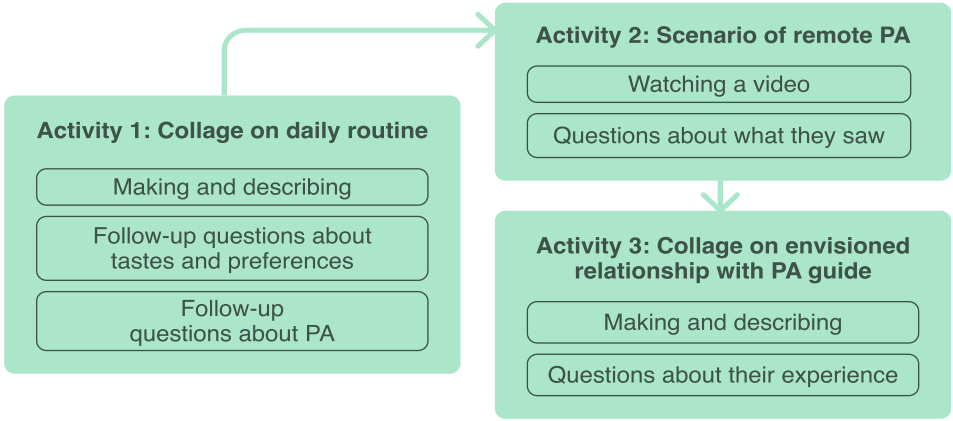


Table 5. Generative session participants' demographic overview

Participant	Age	Gender	Nationality	Health condition	PA level	Technology level
P1	65	F	Brazilian	Healthy	Moderately active	Autonomous (phone, laptop)
P2	74	F	Brazilian	Knee arthrosis	Highly active	Autonomous (phone, laptop)
P3	73	M	Portuguese	Hypertention, no physical issues	Highly active	Medium autonomy
P4	68	F	Portuguese	Healthy	Moderately active	Autonomous (phone, laptop)

ACTIVITY 1
COLLAGE ON DAILY ROUTINES

Goal
The objective of this activity was to gain insights into the following research questions:

1. **Daily routine**: What does their typical day look like? What are their tastes and preferences? Which activities do they enjoy? Can the activities they enjoy be used as motivators to start or increase their PA?
2. **Attitude towards PA**: What are their views on PA and PE? How is it incorporated into their daily lives? What do they like and dislike about it? What are the barriers and motivators related to PA?
3. **Attitude towards technology**: How is technology integrated into their daily lives?

Materials
Participants were provided with a sheet featuring an empty timeline of a typical day, divided into three sections to distinguish between activities they liked, disliked, and felt neutral about (Figure 28). Alongside, they received a set of pre-cut figures representing various activities to place on the timeline in chronological order, from waking up to going to bed. The figures also included specific representations of physical activities (e.g., dancing, going to the gym, biking) and technological devices to gather information on these aspects of their routines. The materials were designed and crafted by the author.

Choice of the activity
This structured approach, using worksheets with specific instructions and labeled images, was chosen over open-ended questions to ensure clear and organized responses. The research team at the UA, experienced in working with elderly participants, emphasizes the need for concrete materials and guidance. Elderly participants often struggle with abstract thinking and may provide divergent answers. Therefore, asking brief, clear questions requiring specific, closed-ended responses helps maintain focus and directs their answers by presenting predefined options.

Set-Up
The activity was conducted as follows:

1. Filling in the worksheet: participants were asked to fill in the worksheet with the images of the activities while discussing their daily routine. They could also draw or write down any activities not represented by the provided images.
2. Follow-up questions: after placing the images, participants were asked about the activities they liked or disliked. If they did not choose certain images, they were asked if there were activities they enjoyed but did not do daily.
3. Focus on physical activities: the discussion then focused on images representing physical activities, exploring their attitudes and habits towards them. If no related images were placed, participants were asked about any physical activities they might engage in.

Figure 29 shows an example of the outputs produced by the participants along with a picture from a session.

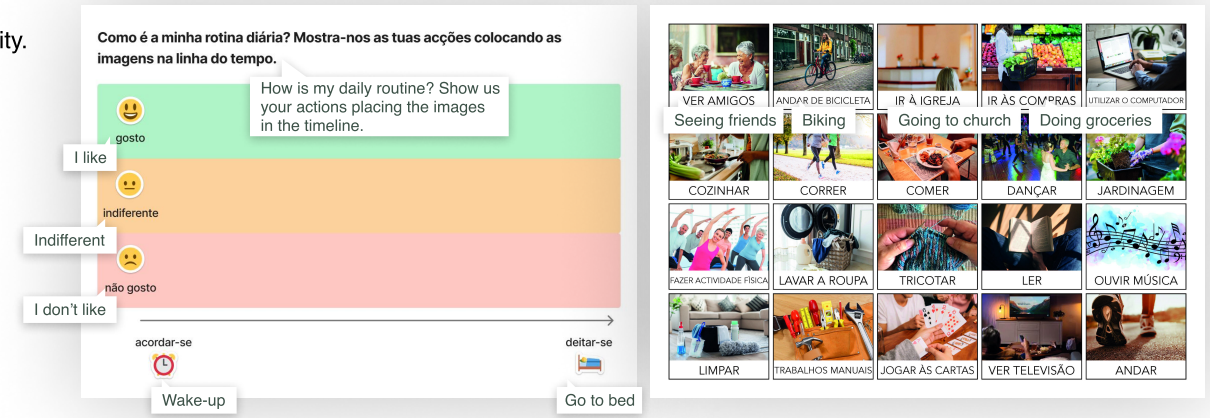


Figure 28. Materials provided to participants to fill in for the first activity. On the left, the daily routine timeline to fill in; on the right, the pre-cut images with the names of the activity to place in the timeline.

Insights
The participants generally have active routines. Many engage in regular exercise, while others prefer less structured activities that still keep them physically active, such as walking, cycling, or staying active throughout the day by performing various tasks that involve movement.
What motivates them and gives them enjoyment in these activities is the feeling of energy and vitality they experience through exercise. They feel younger and more vigorous, viewing PA as an antidote to aging and fatigue. They find pleasure, happiness, and enjoyment in the activities themselves and in how these activities make them feel in their daily lives. They all have a good level of autonomy with technological devices and they are integrated into their lives.

Implications for further design
People who already engage in regular exercise are not the target group, as they do not need additional motivation to start an online program. However, understanding their motivations for being physically active will be crucial in learning how to motivate users who do not have the same level of PA.
For those who lead active lives but do not engage in regular exercise, it was insightful to understand what they enjoy about their physical activities. This information can be applied to designing structured exercise programs in a way that these individuals will find equally enjoyable.

"If I don't do physical activity, I feel depressed. When I do it, I feel good. My biggest sadness is having to stop running, because of knee surgery. So I compensate with other things." - P2

"I go to the gym to keep myself alive, to feel more energetic. To get smarter. Because if I don't do anything, I'm going to atrophy." - P1

Figure 29. Pictures from the generative sessions; on the left, a team member from UA conducting the session with a participant; on the right, an output from a participant of the first activity.

"I see my peers who don't do any movement and they don't even have the energy to get up from the sofa. We have the same age and I see the difference between us. That's why I keep exercising." - P3

"Sometimes I ride my bike with my husband or with a friend, or I walk. I prefer to ride my bike than to walk, just to get some fresh air and spend some quality time togheter." - P4

ACTIVITY 2
SCENARIO OF REMOTE PHYSICAL EXERCISES

Goal
The goal of this activity was to address the following question: How would participants feel about performing remote PE by watching a video that represents the scenario envisioned by ACTIVAS?

Materials
A pre-recorded video was shown, depicting a person performing PE while following instructions from a video on a laptop. Figure 30 displays a frame from this video.

Choice of the activity
Similar to the previous activity, providing a concrete scenario was useful to offer participants a tangible example to observe, ensuring direct feedback on what they saw and their initial attitude towards remote PA.

Set-Up
Participants were asked to watch the video, describe the scenario, and share their opinions. Specifically, they were asked whether they liked the idea of incorporating such an activity into their lives and why. The scenario was presented as it would appear in ACTIVAS: a personalized program with exercises prescribed by a physiotherapist, tailored to their conditions and goals, to be performed at their convenience in their own home.

Insights
Participants generally found the idea of remote PE appealing due to the convenience and flexibility it offers in terms of time and cost. They appreciated the possibility of having a program adapted to their physical needs, goals, and circumstances. However, they expressed concerns about the lack of personal guidance, decreased engagement from being alone, the absence of equipment and social interaction typical of a gym setting, and a perception of reduced effectiveness.

Implications for further design
The motivators could be used in the design to make remote PE more appealing. Flexibility and adaptability are key strengths that should be emphasized. It is essential to address the barriers and find ways to ensure that the online program provides guidance, remains effective, and is engaging.

Figure 30. Frame from the video shown to participants for the second activity.

“I find it interesting and innovative, because you do the activity without needing a person, a professional. And you don't even have to go to the gym. I think it's a matter of comfort, of time. You adapt your time to a program like this.” - P1

“It’s interesting but I would lack the presence of other people, it is a solitary activity in the house. It is logical that in a gym, in a group, it would be more fun and I would exercise more. ” - P3

ACTIVITY 3
COLLAGE ABOUT THEIR IDEAL RELATIONSHIP WITH A GUIDE FOR PHYSICAL EXERCISE

Goal
The goal of this activity was to gather insights addressing the following research questions:

1. How do users envision their ideal relationship with a guide for physical exercises (e.g., a physiotherapist or gym instructor)?
2. What are their experiences with these professional figures?
3. How important is this relationship in influencing their adherence?

Materials
Participants were given a blank worksheet titled "*my ideal relationship with my physical activity guide"*. They also received pre-cut images representing abstract and concrete concepts, words, and emojis reflecting various emotions. The selection of images and words was based on literature review findings and included more generic concepts to allow for subjective interpretation.

Figure 31 shows the materials designed and prepared for the session.

Choice of the activity
This method employs a generative technique (Stappers & Sanders, 2012) designed to collect tacit and latent knowledge, as illustrated in Figure 32. Such knowledge encompasses deeper understandings of participants' feelings, dreams, and values which are difficult to obtain through observations and interviews alone. Generative techniques, such as creating collages, help participants express ideas and emotions that are challenging to verbalize. The images serve as stimuli, triggering feelings and visions that might otherwise remain unexpressed. This approach is particularly useful for older adults, who may find abstract thinking challenging and benefit from external prompts to articulate their feelings.

Set-Up
Participants were asked to create the collage while explaining their thoughts. They used words and images to convey their ideas, with

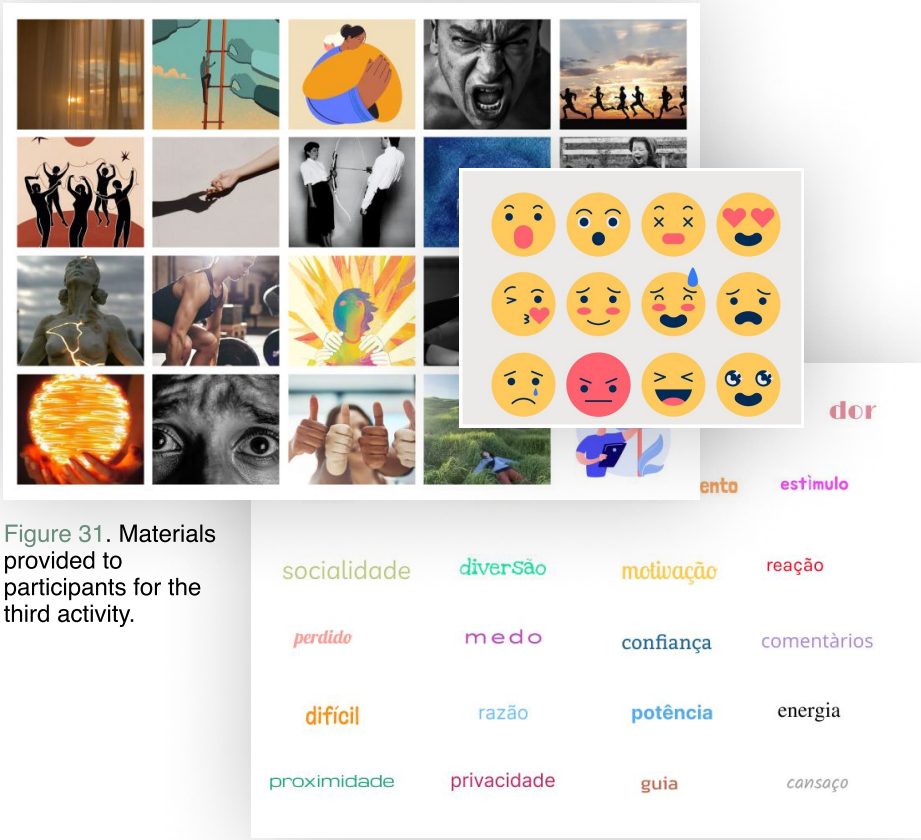


Figure 31. Materials provided to participants for the third activity.

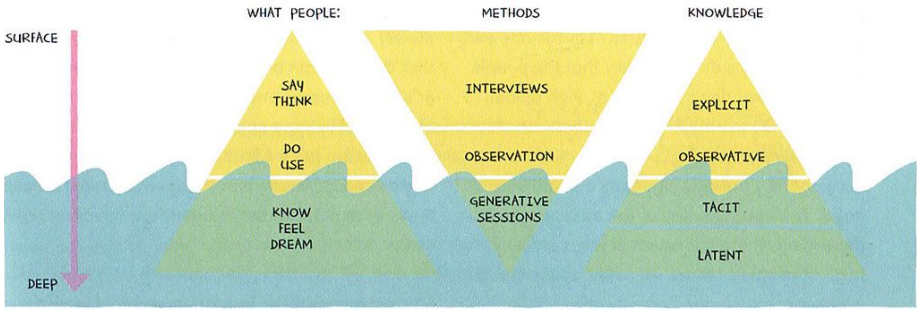


Figure 32. How different research methods can address different levels of knowledge (Sanders & Stappers, 2012).

the researcher providing guidance to ensure clarity. Initially, participants were asked about their experiences with physiotherapists or gym instructors to identify their specific “PA guide”. They then shared their experiences and feelings about these professionals. Once the guide was identified, participants proceeded with the collage-making process.
Figure 33 shows an example of the outputs produced by the participants.

Insights
Participants mostly chosen for their collages and mentioned the following qualities in an ideal PA guide: trust and confidence, motivation and encouragement, goal setting and progress tracking, clear communication, personalization, respect for autonomy, and professionalism. They valued a relationship where they felt comfortable sharing concerns, received positive reinforcement, and had tailored workout plans. They also emphasized the importance of knowledgeable and credible guidance, along with the freedom to make decisions about their exercise routines.

Implications for further design
The identified characteristics will inform future design criteria to develop a platform that allows a close relationship and guidance between patients and physiotherapists. These characteristics will be explored further to determine how best to integrate them into the design.

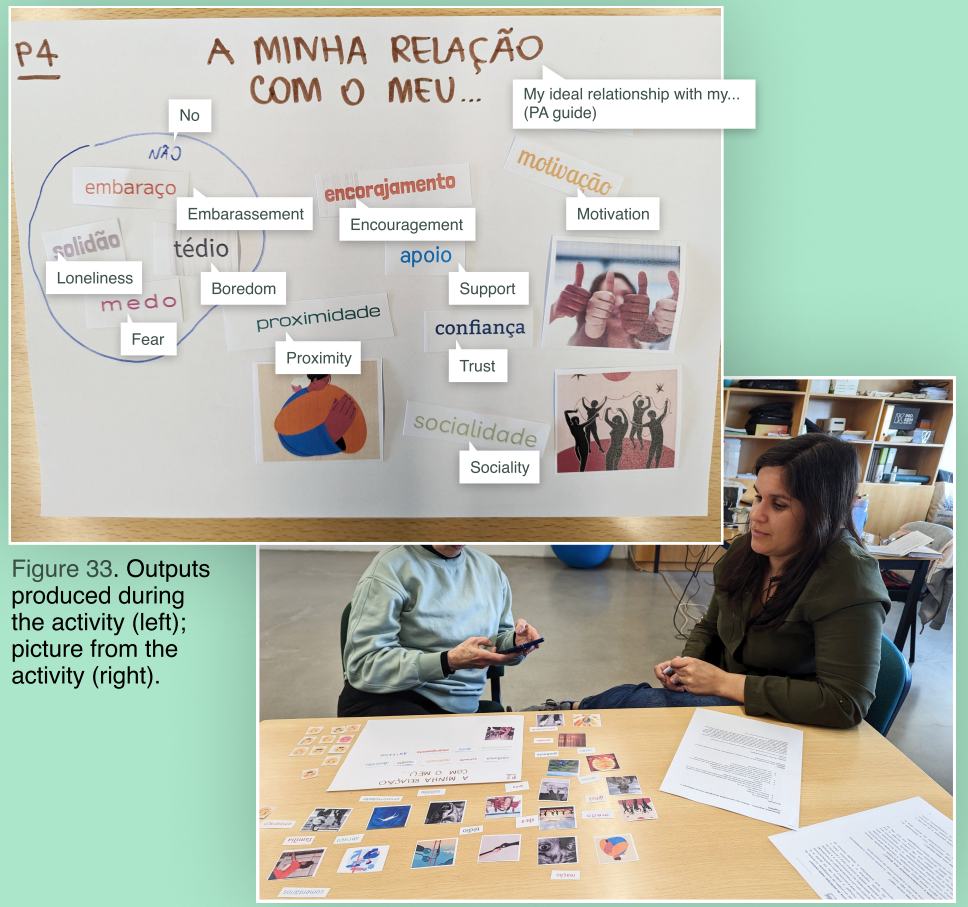


Figure 33. Outputs produced during the activity (left); picture from the activity (right).

“I usually choose the class from the instructor. This shows that the person who is on the other side is important. Even if I had to choose classes at home, I would like to have the same instructor.” - P2

“Communication is important. I want them to tell me if I’m doing right or wrong. If I’m getting better. I like the dialogue, I think that a clear and honest communication is very important. ” - P3

“I have to trust the teacher. If you don't trust, you won't deliver.
I think motivation and encouragement.” - P1

The insights from the user research were summarized and organized into barriers and motivators for PA, along with a list of key factors for establishing an ideal relationship between the patient and the PA professional.

4.1.4 Barriers and motivators

The research activities provided insights into the factors influencing adherence to PA, particularly remote exercise. Since the participants were all conducting active lifestyles, therefore already motivated to perform PA, the information collected focused on understanding why they are motivated to do PA, and which are their barriers and motivators regarding specifically remote exercises. Table 6 summarizes the motivators and barriers identified from the generative sessions.

Barriers

Participants reported several barriers to remote PE, including the absence of a professional to provide personal and individual guidance, lack of equipment, and reduced engagement and easy distractions due to the lack of a social and interactive setting. Other barriers include social isolation and a perception of lower effectiveness, derived from decreased engagement and the limited opportunity for personal motivation and instruction.

Motivators

Motivating factors for participating in a remote exercise program include flexibility and convenience in scheduling and cost savings, as well as the ability to choose and adapt the program to their needs. Participants generally appreciate PA for the feelings of vitality, energy, and health it provides, as well as recognizing its beneficial effects on aging and overall well-being.

Table 6. Barriers and motivators of participants derived from generative sessions

BARRIERS	Remote PA	Lack of personal guidance
		Equipment limitations
		Distraction and lack of engagement
		Absence of social interaction
		Perception of lower effectiveness
MOTIVATORS	Remote PA	Convenience and flexibility
		Cost-saving
		Customization and adaptation to their needs and physical condition
	PA in general	Feeling healthy, active and energetic
		Antidote against getting older and ill

4.1.5 Envisioned relationship with PA guide

As ACTIVAS involves the prescription and ongoing guidance of a personalized exercise plan by a physiotherapist, it has been crucial to understand how the patient-physiotherapist relationship should be structured by investigating the qualities desired by users. The factors outlined derive from the third activity in the generative sessions and are significant motivators for adherence and will serve as a crucial starting point in the design phase.

Trust and confidence Trusting and confident relationship, where they feel comfortable sharing their concerns, goals, and expectations

Motivation, encouragements and positive reinforcements to help them stay committed to their routine and achieve their goals

Social engagement opportunities during workouts, whether in-person or remotely, as it enhances their overall exercise experience

Goal setting and progress tracking to provide constant direction and guidance throughout their journey

Clear communication with instructions, explanations, and feedback on their performance, to ensure proper technique and minimize the risk of injury

Personalization They seek a PA guide who understands their individual needs, preferences, and limitations, and provides workout plans tailored to their specific goals and capabilities

Respect for autonomy and boundaries allowing them to make decisions about their workout routine and pace without feeling pressured or controlled

Professionalism and credibility They expect their PA guide to be knowledgeable, skilled, and credible in their field

4.2 Professionals

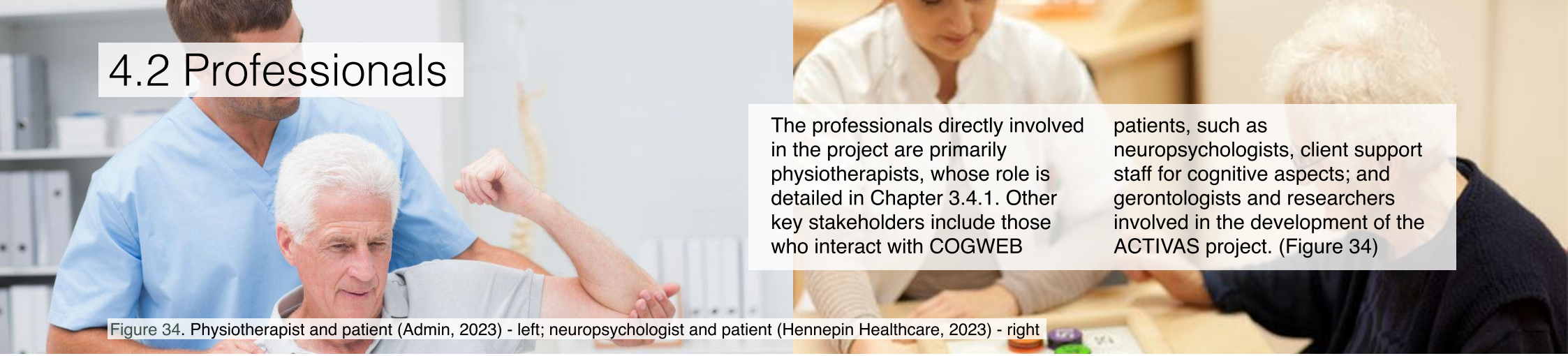


Figure 34. Physiotherapist and patient (Admin, 2023) - left; neuropsychologist and patient (Hennepin Healthcare, 2023) - right

The professionals directly involved in the project are primarily physiotherapists, whose role is detailed in Chapter 3.4.1. Other key stakeholders include those who interact with COGWEB patients, such as neuropsychologists, client support staff for cognitive aspects; and gerontologists and researchers involved in the development of the ACTIVAS project. (Figure 34)

research

The research included the aforementioned stakeholders: a neuropsychologist, a client support specialist, and the three members of the research team presented in the Project Brief chapter. The goal was to understand their perspectives of their patients' barriers and motivators for PA and their perception of how users experience COGWEB® and PA, particularly within a remote program.

4.2.1 Research activities

Two focus groups were conducted:

1. The first one with a neuropsychologist, a client support specialist, and a gerontologist. The aim was to understand their relationship with patients, their perception of barriers and motivators their elderly patients face regarding cognitive training, and to gather information on Neuroinova, COGWEB®, and cognitive training, which contributed to the insights presented in Chapters 2.2 and 3.
1. The second one included the research team members (two physiotherapists and a gerontologist). The focus was on understanding their relationship with elderly patients and users, based on their experience in research and physiotherapy. The group also discussed their perception of barriers and motivators related to PE and general PA. Additional questions about the ACTIVAS program and its development, as well as theory regarding PA, were also explored, contributing to the knowledge presented in Chapters 2.1 and 3.4.

The full interview guides are visible in Appendix B.

4.2.2 Data analysis

The focus groups were recorded, transcribed, and subsequently analyzed. Key phrases relevant to the research questions were highlighted and grouped through thematic analysis. These insights were then summarized and reorganized, focusing on their views about their relationship with patients, as well as identifying barriers and motivators, which are presented in the following paragraphs.

research insights

4.2.3 Cognitive Training: Neuropsychologists and Client Support

Key stakeholders involved in cognitive training who have direct interactions with patients include neuropsychologists and client support personnel. The neuropsychologist plays a central role in overseeing the training program, conducting cognitive assessments, and supporting the patient throughout the process by communicating and explaining results, identifying areas for improvement, and encouraging participation in sessions. On the other hand, client support primarily provides technical assistance related to technology and software and is the initial point of contact for the patient. Analyzing their perspectives is insightful, considering that ACTIVAS

serves as a complement to the primary tool, COGWEB®.

Relationship with patients
Patients typically reach out for technical assistance or when they feel their performance is lower than expected. The professionals perception of their patients can be summarized in the following points:

- some patients are very pleasant and enthusiastic about the technology and find the exercises engaging, eager to share their positive experiences
- many ask numerous questions, often regarding technology, and may call frequently
- some feel lonely and seek conversation about their lives and family problems, digressing from the original reason for calling
- some need assistance but feel embarrassed or afraid to bother

In response of the different needs and patients outreachs, they typically follow a case-by-case approach based on friendliness, approachability, empathy, and consistent communication, even assisting with unrelated issues. This approach, supported by credibility and medical validation, creates a strong sense of trust among their patients, reported as an important factor influencing their long-term adherence.

Perception on barriers and motivators
Professionals' perception of barriers and motivators is crucial to understanding their perspective on factors that facilitate or hinder adherence to CT. These factors are synthesized in Table 7.

- Barriers: it is important to distinguish between factors influencing initial adherence, related to both external and internal factors, such as the fear of discovering a cognitive deficit to confront; and those undermining long-term adherence, linked to issues with technology, internal motivation, or external causes often beyond their control. Depending on the nature or severity of the problem, patients either seek help, particularly for technical difficulties, or temporarily suspend or reduce session frequency, or abandon training altogether.
- Motivators: the perception of legitimacy from sources recommending CT, such as a doctor or family member, plays a crucial role in initiating the program. Factors fostering long-term adherence include the sense of empowerment of taking proactive steps for their health. Even without immediate improvements, only the participation creates a sense of control and accomplishment. Family support, guidance, and practical assistance, as well as a supportive relationship with professionals, are fundamental in sustaining the program over time. Finally, the recognition of the importance and benefits of CT, particularly in the prevention of conditions like dementia, facilitates both initial and long-term adherence to the program.

4.2.4 Physical Activity: Physiotherapist

The role that the physiotherapist would assume in ACTIVAS is explained in Chapter 3.4.1. To gain insights into the ideal relationship between physiotherapist and patient in the program, their perspective on patients and their experience was investigated.

Relationship with patients
Similar to neuropsychologists and client support, physiotherapists emphasize the importance of building a positive relationship based on friendship, connection, empathy, and willingness to listen and support even on matters not strictly related to medical issues. They highlight how older adults express positive feelings and gratitude towards the professional, and how the trust established with this approach is crucial for continuity and an overall positive experience. Patients feel valued and important in this dynamic. Encouragement also plays a fundamental role, based on a playful and gradual approach to motivate them to

perform exercises they initially thought they could not do.

Barriers and motivators

- Barriers: according to the professionals experts on PA interviewed, patients often face significant barriers to starting and maintaining PA. These include a lack of internal motivation, feeling tired or lazy to the idea of making physical efforts, giving explanations such as 'today I already did my household chores, I already worked out sufficiently'. They also find physical activities boring or misaligned with their interests. Additionally, fear of starting due to perceived

"Let's give it a try together. If you don't enjoy it, we can stop."

- Ana, citing an example of motivational encouragement they give to users

Table 7. CT's professionals perception on users' barriers and motivators towards CT

BARRIERS	MAINTAIN	Technology related	Log-in, lack of internet, technical issues
		Personal feelings	Feeling of not performing well, demotivation, repetitive and boring exercises
		External barriers	Vacation, illnesses, death
	START	Personal feelings	Fear of knowing the results and facing negative outcomes
		External barriers	Low digital literacy, lack of digital devices or connection, costs
MOTIVATORS	START	Predictors of adherence	Higher education levels
		Perceived legitimacy	Trust in doctors and family opinion
	MAINTAIN	Role of caregivers	Practical help, support and encouragement, trust
		Positive feelings	Sense of empowerment, control and accomplishment
	BOTH	Perceived usefulness	Recognize importance of cognitive training, expecially for prevention of dementia and cog decline

PATIENTS' REACTIONS

→ Call for help

→ Interrupt

→ Abandon

physical limitations or potential pain, and external barriers such as lack of time, adverse weather conditions, and financial constraints further hinder their participation. Specific barriers to remote PA include the absence of in-person supervision, lack of social interaction, and low digital literacy, which discourages older adults from using necessary digital devices.

- Motivators: having supportive family or caregivers is crucial for initiating PA. Encouragement, support and practical help, such as transportation, along with advices from a person they trust, can significantly boost motivation. Knowing that exercises are safe and adaptable also helps to help them to gain confidence to try. For long-term adherence, the relationship with a professional covers a fundamental role. Ongoing support, guidance, and encouragement from a trusted professional, along with visible progress and positive results, are strong motivators. Engaging, fun and enjoyable exercises that meet their interests and tastes, social interactions from group activities, and the desire to improve or maintain health are key factors that influence both initial and continuous participation in PA.

Table 8 shows an overview of barriers and motivators.

BARRIERS To start and maintain	Remote PA	No real time supervision, lack of personal guidance
		Social isolation and lack of social engagement
		Digital literacy
	PA in general	Lack of internal motivation: feeling tired, lazy or lack of interest in the proposed activities
		Hesitation to start: fear of pain, fear of not being able
		External barriers: lack of time, weather, economic constraints
MOTIVATORS	START	Family members: motivation, support, practical help, trust
		See that the exercises are safe and adaptable
	MAINTAIN	Positive relationship with professionals: support, guidance, encouragement, connection
		See progresses and positive results
	BOTH	Engagement: enjoyable and fun activities, meeting their interests and tastes
		Social interaction: exercising together, social occasion, friendly competition
		Desire to improve or maintain health

Table 8. physiotherapists's professionals perception on users' barriers and motivators towards PA

4.3 Literature review

The on-field research was supplemented with a literature review to gather additional data on barriers and motivators specifically related to the target group, namely older adults with sedentary lifestyles and cognitive impairments.

4.3.1 Barriers

Barriers to exercise include the dependence on caregivers, which can be exacerbated if the caregiver themselves is in poor health or lacks the necessary support to encourage participation. Additionally, stigma and the fear of public embarrassment often deter individuals with dementia or MCI from engaging in activities, as they may be perceived as incapable of participating effectively. The lack of accessible exercise programs specifically tailored to their needs further aggravate the issue as, for instance, available programs may be too low in intensity for those who are still physically capable. Physical and mental challenges, such as reduced mobility, pain, memory problems, confusion, fatigue, low mood, and depression, also are significant obstacles. Moreover, a lack of intrinsic motivation, apathy, and even laziness can prevent regular exercise engagement. The situation is further complicated by exercise providers who often lack the training or knowledge to effectively support individuals with dementia (Hobson et al., 2020).

4.3.2 Motivators

On the other hand, several motivators can encourage PA among this group. The diagnosis itself can be a motivator, as individuals may trust in the benefits of PA to contribute to their well-being and help maintain their identity. Support from caregivers, including encouragement and transportation, plays a crucial role in facilitating participation (Hobson et al., 2020). Access to enjoyable and inclusive exercises, particularly those that align with personal preferences, such as outdoor group activities, is another strong motivator. Social engagement with peers of similar cognitive conditions can also be highly motivating, as it fosters a sense of community. Positive expectations of outcomes from PA, improved education and awareness about its benefits, and encouragement from physicians or exercise providers further contribute to higher participation (Hobson et al., 2020). Additionally, having safe and accessible community infrastructure and exercise programs tailored to their needs, as well as reliable transportation options, are essential factors that support ongoing engagement in physical activity (Hobson et al., 2020).

4.4 Summary and conclusions

The insights from this chapter shed light on the diverse stakeholders involved in the ACTIVAS project, focusing on both users and professionals.
The following paragraphs will give an overview and summarize the insights from the different research activities to build a basis for the further design phase.

4.4.1 User groups

The target users of the ACTIVAS project are Portuguese seniors over 65 who use COGWEB®, possessing sufficient digital literacy and autonomy in using electronic devices. These individuals generally have cognitive impairments or are at risk of developing them, with the project excluding those with more severe conditions who cannot interact with the platform independently.
Through research and expert insights, three main user groups have been identified based on their daily activity levels: sedentary, busy active, and physically active. Sedentary individuals engage in minimal physical activity, busy active individuals perform daily tasks with little to no structured exercise or engage in physical activities inconsistently, and physically active individuals regularly participate in structured physical exercises. These groups are positioned on a spectrum reflecting the amount of physical activity integrated into their daily

SEDENTARY
minimum or no level of PA

Figure 35. Sedentary user (BBC news, 2019)

These individuals lead sedentary lives, spending much of their time watching TV with minimal activity, except for occasional weekend engagements. They are the most concerning user group.

BUSY ACTIVE
medium-moderate level of PA

Figure 36. Busy active user (How to prevent malnutrition in older adults, 2021)

They lead busy lifestyles, engaging in daily activities such as house chores, family care, or meeting friends at the bar in the afternoon. While they engage in PA, they do minimal structured exercises.

PHYSICALLY ACTIVE
high level of PA

Figure 37. Physically active user (McFaul, 2023)

These individuals lead active lifestyles and regularly engage in structured physical exercises. This is fundamental for them to feel energetic, active, and to control their perception of aging.

routines, as illustrated in Figures 35 to 37. Since Physically Active group already meets the desirable levels of PA to reach health outcomes, people with PA levels until Busy Active groups are those targeted by the project. Appendix C presents personas corresponding to each target group.

4.4.2 Professionals involved

Key professionals involved in the project include neuropsychologists, who manage the CT programs, and physiotherapists, who oversee the physical exercises. Neuropsychologists conduct assessments, provide continuous support, and encourage patient participation by explaining results and identifying areas for improvement. Physiotherapists assess physical performance, prescribe remote physical exercises, and adjust these as needed throughout the program.

4.4.3 Patient-professional relationship

Both groups of professionals stress the importance of building positive relationships with patients, characterized by trust, confidence, empathy, and consistent communication. This relationship is crucial for ensuring adherence to the program and motivating patients to stay engaged and committed to their training, an aspect also highlighted by the patients themselves.

4.4.4 Barriers and motivators

Investigating the barriers and motivators among user groups on PA, CT and remote PA was crucial to effect behavioral change aimed at increasing PA levels in a program that involves cognitive and physical training.
Table 9 show a framework representing an overview of the user groups barriers and motivators of PA, cognitive training and remote PA summarizing the information obtained from user research, experts interviews and literature review.
Common factors among CT, PA, and remote PA are highlighted in bold. This framework will be useful to direct the further design phase, addressing identified barriers and using motivators to understand which strategies could be effective to formulate design criteria.

The overall barriers and motivators are summarized as following.

Barriers

The absence of professional guidance is a major barrier for remote PA, as both users and professionals highlight the need for personal and individual guidance. Users also reported the lack of necessary equipment and the reduced engagement and increased distractions due to the lack of a social and interactive setting. Social isolation, perceived lower effectiveness of remote activities, and a lack of internal motivation, fatigue, and boredom further hinder participation. Concerning PA participation in general, users often fear they might not be able to perform exercises or might experience pain. External factors such as lack of time, adverse weather conditions, and financial constraints, along with low digital literacy and usability issues with technology devices, also pose significant challenges.

Motivators

Flexibility and convenience are strong motivators for remote PA. Users value the adaptability of programs, allowing them to choose and tailor exercises to their specific needs and preferences. The health and well-being benefits of PA in general, providing feelings of vitality, energy, and overall health improvements, are the main reasons that motivate older adults to conduct active lifestyles. Support from family and caregivers, encouragement, practical help, and trust in doctors or family recommendations play crucial roles in initiating and maintaining activity. Ongoing support, guidance, and encouragement from trusted professionals are fundamental for long-term adherence. Seeing tangible progress and outcomes motivate users to continue, while engaging and enjoyable exercises aligned with users' interests and tastes enhance motivation. Social engagement and interactions in group activities are other significant drivers for both initial and continuous participation in PA.

		START	MAINTAIN	BOTH
MOTIVATORS	CT	• **Trust in reputable sources**	• **Guidance, support and positive relationships with professionals** • **Perception of positive results and control** • **Role of caregivers**	• **Engaging and enjoyable exercises** • **Desire to improve or maintain health**
	PA	• **Trust in reputable sources** • See that the exercises are safe and adaptable	• **Guidance, support and positive relationships with professionals** • **Perception of positive results and control** • **Role of caregivers**	• **Engaging and enjoyable exercises** • **Desire to improve or maintain health** • Social interaction
	REMOTE PA			• Convenience and flexibility • Customization on individual's needs
		START	**MAINTAIN**	**BOTH**
BARRIERS	CT	• Fear of knowing the results • **External barriers** • Technology constraints	• Demotivation due to personal feelings	
	PA	• Fear of pain • Fear of not being able • **External barriers**		• Lack of internal motivation: feeling tired, lazy or lack of interest in the proposed activities
	REMOTE PA	• Lack of equipment • Lack of guidance • Perceived lower effectiveness • Social isolation • Technology constraints		

Table 9. framework representing all the barriers and motivators found through research towards PA, remote PA and CT

DEFINE

CONTENT	RESEARCH QUESTIONS
5. From research to design	What is the big picture from the research phase relevant for the subsequent design phase?

5. From research to design

This chapter bridges the knowledge obtained from the Discover phase to the subsequent design directions, giving an interpretation of the relevant insights to convey the big picture from which the ideation phase will start.
In particular, the problem statement was reframed from the beginning, considering all aspects that emerged in the research phase and customizing it to the two target groups, with reference to all barriers found towards the expected level of PA for them. Accordingly, some design criteria were formulated, and the project scope was refined. Finally, the design goal was stated, as well as the desired interaction vision for the concept.

5.1 Problem statement

In this chapter, the insights from the research considering the perceived barriers of the two identified target groups, Busy Active and Sedentary, have been reformulated into a problem statement that will serve as the starting point for the ideation phase.

Since ACTIVAS aims to introduce PE on a remote platform, it considers the barriers that prevent the two target groups from following a remote exercise program. It is important to specify that the sedentary group faces additional barriers related to incorporating any physical activity into their routine: before being motivated to follow a remote program, they need to change their perception of physical activity in general.

Additionally, ACTIVAS aims to achieve optimal benefits for active aging by introducing structured and regular physical exercises as described in Chapter 2.1. Since sedentary individuals do not engage in physical activity in general, and according to WHO principles (2022), starting any type of PA and reducing sedentary behaviors is better than doing nothing, the possibilities of introducing some PA to reduce barriers, or starting with mild and adapted PE aligned with the FITT-VP principles described in Chapter 2.1, will be explored.

The problem statements for each target group are formulated as follows.

BUSY ACTIVE

Elderly individuals who lead an active lifestyle, engage in some level of physical activity, yet sporadic and unstructured. They potentially find the idea of adhering to a remote physical exercise program appealing due to the flexibility and convenience it offers. However, they are skeptical about their adherence due to barriers such as **lack of social engagement, disinterest in proposed activities, absence of personalized guidance, and perceived lower engagement** with the activity itself.

SEDENTARY

Elderly individuals with a sedentary lifestyle lack motivation to start physical exercises due to **negative misconceptions about their abilities, fear of pain, lack of internal motivation and disenterest in the expected activities.** To motivate them to start a remote physical exercises program, it is first needed to change their perception of physical exercises in general.

5.2 Design criteria

To start concretely guiding the ideation phase, a list of design criteria has been created. These criteria derive from the barriers, motivators, envisioned qualities (of the patient-physiotherapist relationship), and theoretical models emerged and analyzed during the research phase. The criteria have been further clustered into three main aspects of the program: those related to long-term guidance, those related to personalization, and those related to exercise sessions (Table 10), according to what aspect they refer to. The exercise sessions are divided into Concept & Activities (how the concept should be) and Interaction & User Experience (how the user should feel interacting with the concept). Figure 38 provides an example of how these criteria were developed by combining insights and subsequently grouping them into areas. These criteria will serve as a basis to inspire the subsequent divergent phases of brainstorming and ideation.

Figure 38. Example of integration of research insights into design criteria

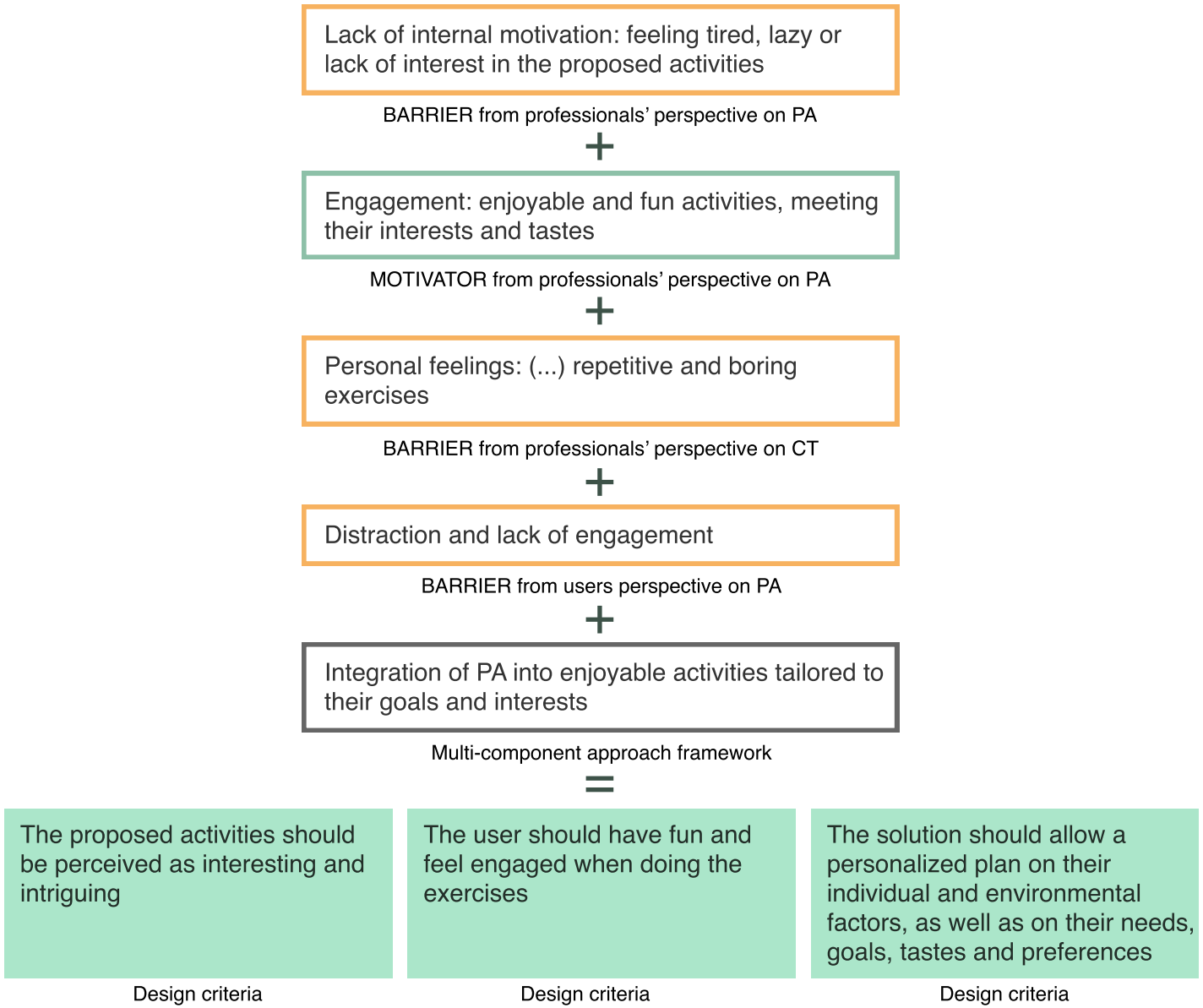


Table 10. Design criteria

PERSONALIZATION		The solution should allow a personalized plan on their individual and environmental factors, as well as on their needs, goals, tastes and preferences
LONG-TERM GUIDANCE		The solution should offer a clear and structured guidance through goal setting, progressive action plan, clear instructions, constant feedback, progress overview
SESSION	**INTERACTION & USER EXPERIENCE**	The user should feel supported, comfortable and trust the PA guide
		The communication should be friendly, approachable and empathic
		The user should feel encouraged and proud of their success
		The user should have fun and feel engaged when doing the exercises
		The user should feel safe and capable to perform the exercises
		The user should feel healthy, active and energetic
		The user should feel improvements on his health
	CONCEPT & ACTIVITIES	The concept should allow social engagement and connection even if remotely
		The concept should offer activities that meet the users' tastes and preferences
		The proposed activities should be perceived as interesting and intriguing

5.3 Focus of the project

Before defining the design goal for this project, it was essential to consider which factors and dynamics identified during the research phase could be included in the design focus and tested, and which ones deprioritized from the design focus but still to consider. Three main areas were identified—long-term guidance, personalization, and sessions—and the following conclusions were made.

- **Long-term guidance**: this aspect includes only one criterion: "The concept should offer clear and structured guidance through goal setting, a progressive action plan, clear instructions, constant feedback, and a progress overview." This criterion aims to enhance long-term adherence and should be applied to the user's interaction with the concept over time. However, it is not feasible to test these within the project's available timeframe, but guidelines for its application in the design can be defined, and will be detailed in Chapter 8.3.
- **Personalization**: this aspect also includes a single criterion: "The concept should allow a personalized plan based on individual and environmental factors, as well as on the user's needs, goals, tastes, and preferences." This primarily relates to the type of exercise prescription by the physiotherapist, involving medical and professional decisions that go beyond the design concept. Nonetheless, guidelines for its application will emerge and be explained in detail in Chapter 8.3.
- **Session**: this aspect involves criteria related to the concept itself, the activities to be performed, and the type of interaction with the concept. These are areas where design can intervene and where the related criteria can be tested within the project's timeframe.

In conclusion, session-related aspects will be the focus of the project as they can be tested with users in the short term. Meanwhile, aspects related to long-term guidance and personalization will still be explored during the ideation phase with professionals to develop appropriate guidelines and to determine if any of these aspects can be applied to the session design. Figure 39 shows a visual representation of what aforementioned.

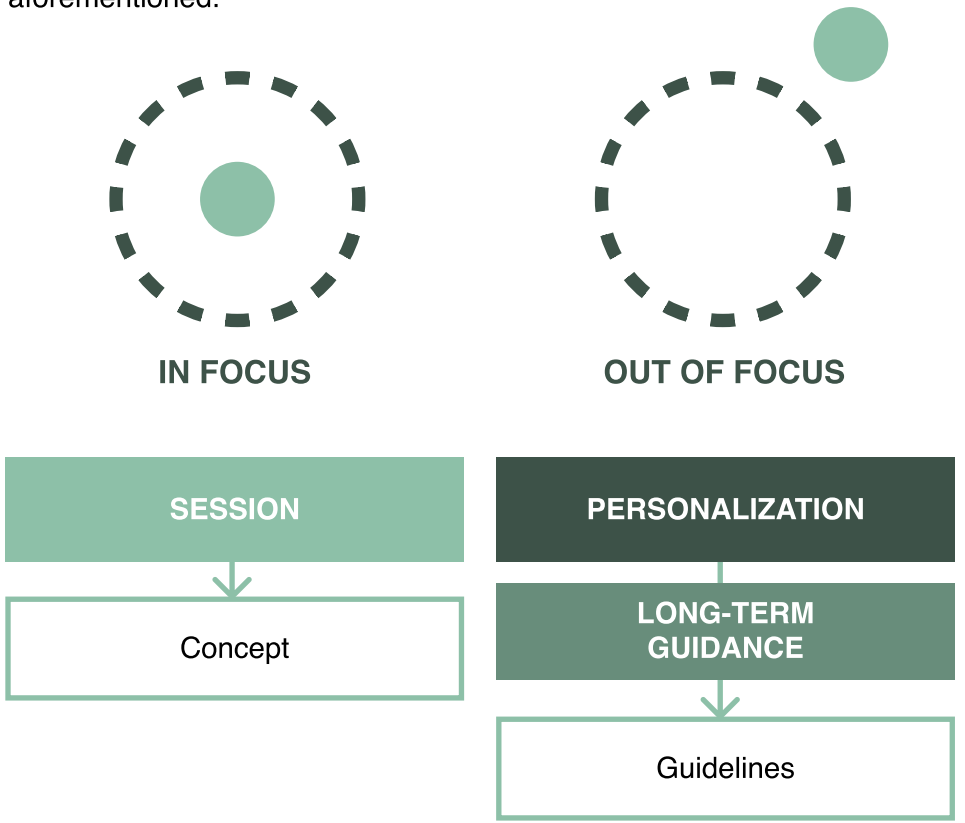


Figure 39. Visual representation of the focus of the project considering the three areas identified.

5.4 Design goal

Based on the design criteria and the directions for the project, the design goal was formulated as follows:

The design goal is to **motivate** older adults who follow the COGWEB® training to adhere to a prescribed **physical exercise session** tailored to their **individual and environmental factors**, providing **clear and structured guidance** along with **engaging and enjoyable activities**.

The aim is to leverage motivational factors to encourage users to adhere to the proposed activity.

The focus is on the exercise session, which is within the scope of the project.

Although personalization will not be the primary focus of the design, it will remain a fundamental requirement that professionals will apply when prescribing exercises.

Ensuring clear guidance from both the system and the physiotherapist will be crucial in the user's interaction with the concept.

The activities proposed will be a key focus, as they need to be appealing to users to motivate them to continue exercising.

5.5 Interaction vision

The feeling of engaging with the concept can be envisioned through an interaction vision (IV). This vision is created by identifying an event or activity outside the project context, that shares similarities in interaction dynamics with the envisioned interaction with the concept (Pasman et al., 2011). Subsequently, the diverse qualities of the interaction are listed and can serve as inspiration for shaping the concept. This section introduces the IV for this project: "*The interaction with the concept should feel like participating in a dance class with an experienced teacher*." (Figure 40)

ENGAGED
Learning to dance is an engaging experience if the activity resonates with the student and they find it enjoyable. Likewise, the session should present activities that engage the user in a similar way, making them enjoyable, entertaining, and fun. The user should feel motivated to continue due to the sense of involvement experienced during the session.

GUIDED
Learning to dance from scratch can be scary, often leaving one feeling lost, confused, and inadequate. It's crucial to have a guiding presence that reassures the student, leading them step-by-step through the learning process with patience and clarity, enabling them to proceed independently. The concept should provide clear, reassuring, structured, and comprehensive guidance to prevent any confusion.

TRUSTING
In a dance class participants feel trusting as they follow the lead of their teacher, knowing they are in capable hands and supported throughout the session. In this context, the trust should arise from recognizing the expertise and capability of their physiotherapist and the validity of the program.

PROUD
In a dance class, participants learn new dance moves and sequences with each step, feeling a sense of accomplishment as they improve their skills. In the concept, the same should be felt when users reach their goals and see their progress.

IN CONTROL
In a dance class, students feel in control of their movements when they realize they are capable of performing them. Similarly, the concept should aim to instill a sense of mastery in users by offering exercises that are adapted to their abilities yet challenging enough to require focused control to overcome.

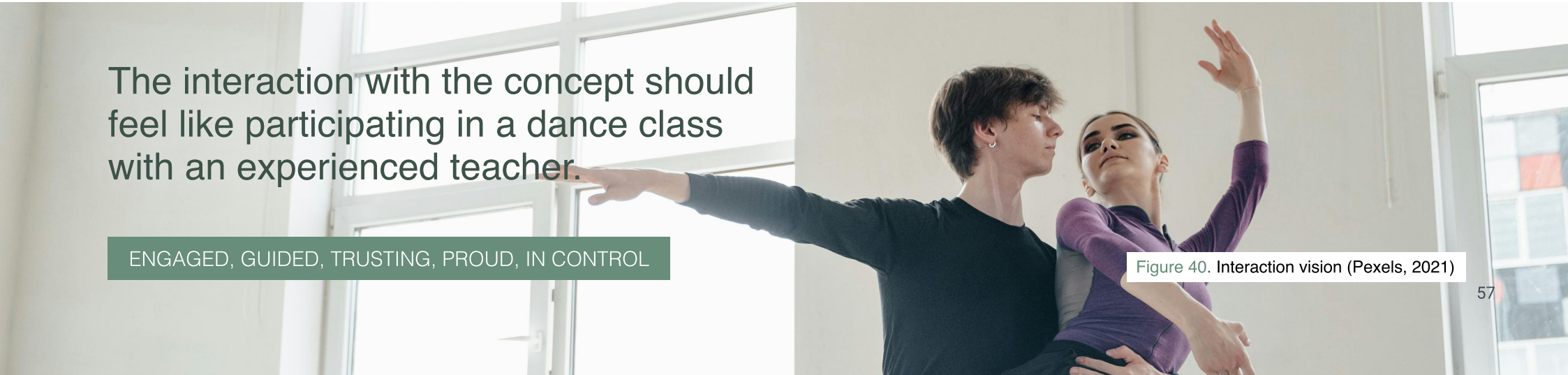


Figure 40. Interaction vision (Pexels, 2021)

DEVELOP

CONTENT	RESEARCH QUESTIONS
6. Design directions	How can the physiotherapists' expertise be used to generate ideas? How would they act in the context of ACTIVAS in the role of professionals? How to generate ideas applying the design criteria to personalization, long-term guidance and the exercise session?
7. Test iterations	How to ensure clear, structured, and continuous guidance? How to make the exercises engaging and enjoyable? How to make the user feel guided and engaged?

6. Design directions

This chapter marks the beginning of the second phase of the double diamond framework, where the insights gained from the research phase are used to explore potential solutions to the design goal. Specifically, this chapter details two ideation activities aimed at generating a wide range of ideas before narrowing them down to a more defined design direction.
The first activity focused on exploring the role of physiotherapists and leveraging their expertise to generate initial ideas. These ideas considered the patient-professional relationship, personalized exercise prescriptions, and how to apply a more professional perspective to shape the context. The outcomes of this activity provided valuable guidelines and methodological advice on how to apply personalization and establish reliable long-term guidance.
The second activity aimed to develop more concrete and practical concepts to test and evaluate, applying design criteria to the three main aspects of the context: long-term guidance, personalization, and exercise sessions.
Finally, the generated ideas were evaluated and selected based on feasibility and desirability criteria. The most promising ideas related to the exercise session were retained for testing. The ideation phase concluded with the objective of testing the selected ideas to determine how well they aligned with the design goal and interaction qualities, thus opening the test iteration phase.

6.1 Ideation Activity #1: involving the physiotherapists

6.1.1 Goal

The first ideation activity aimed to involve the physiotherapists working on ACTIVAS to leverage their knowledge and expertise in generating initial ideas and understanding key concepts. In particular, the research questions that guided the activity were:

- How would the physiotherapists motivate the target group to follow a PE plan addressing their initial barriers?
- How do they approach building a relationship with the patient?
- How would they prescribe a personalized PE plan based on the individual needs and situation of the patient?

6.1.2 Method

The experts were involved in a creative session consisting of two activities: role playing and brainstorming.

Role-Playing

Two physiotherapists from the research team simulated an initial consultation with three personas representing the target group (one busy active and two sedentary individuals). The personas, each with specific characteristics (detailed in Appendix D), were patients following COGWEB® who had been advised by their neuropsychologist to start a PE program. Figure 41 shows an example of a persona portrayed by the participants. The personas were portrayed by other research team members and an external participant recruited from UA. In the role-playing scenario, each persona expressed skepticism about starting the program, reflecting the main barriers identified for the target groups. The physiotherapists' role was to address these concerns, provide solutions, and ultimately prescribe a tailored exercise program. The aim was to leverage the relationship between physiotherapists and patients to build trust and adherence, answering the initial research questions using the physiotherapists' expertise. Figure 42 shows images and quotes from this activity.

Brainstorming

Following the role-playing activity, a brainstorming session was

Figure 42. Images and quotes from role-playing activity

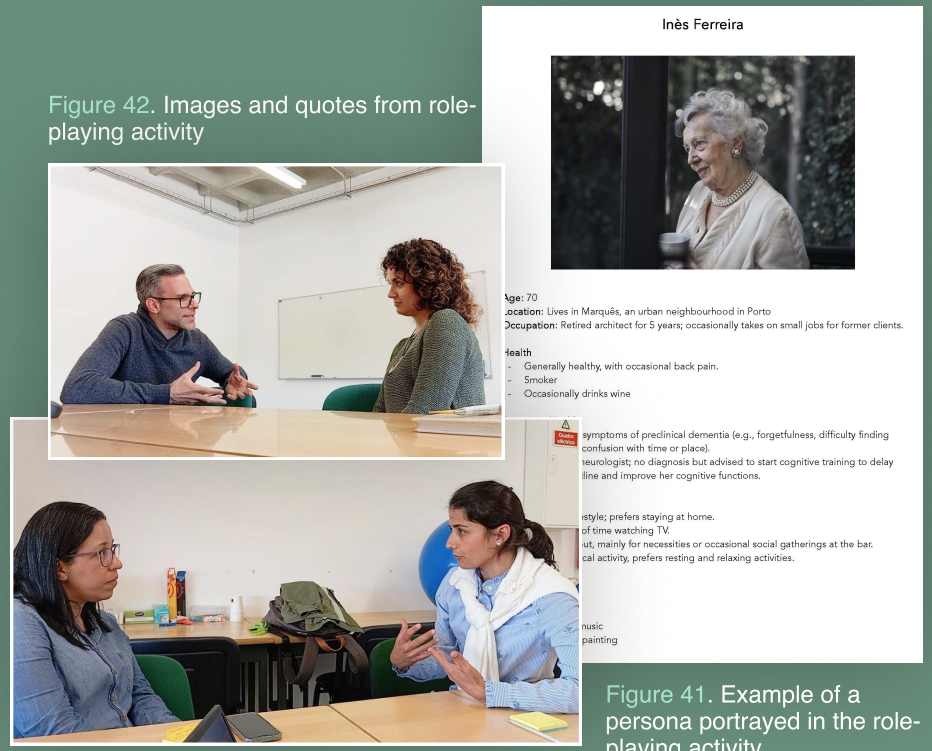
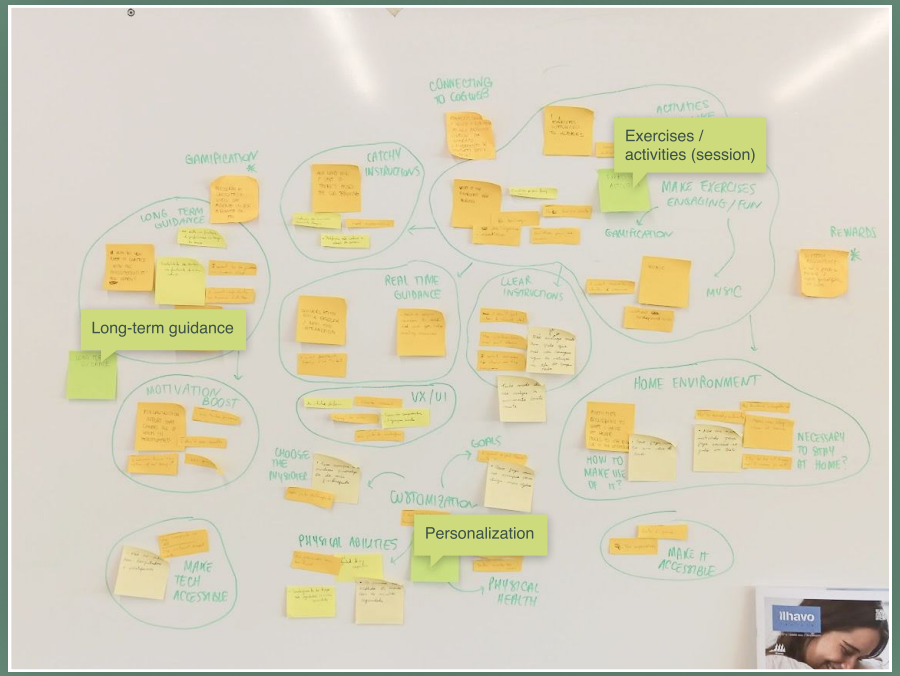


Figure 41. Example of a persona portrayed in the role-playing activity

Physiotherapist: “How is your daily routine? What do you do in a normal day?”
Patient: “I wake up very early, like at 5. Because I can’t sleep.” (...)
Physiotherapist: “So you have some problems with sleeping?”
Patient: “Yes, because I’m old.” (...)
Physiotherapist: “How do you feel during the day? Do you feel tired?”
Patient: “Yes.”
(...) Physiotherapist: “So if you start doing some PE, it can help you to sleep better, to get more energy during the day and relieve your pain.”

Figure 43. Images from the brainstorming process

Figure 44. Results from brainstorming clustered and mapped



conducted, inspired by what emerged during the made-up consultations. The initial prompt was to generate ideas related to the three identified project areas – long-term guidance, personalization, and sessions – using an adaptation of the Disney Creative Strategy (Dilts, 1995) creative technique. Participants first thought as "dreamers" (expressing ideas freely without considering feasibility or limitations) and then as "critics" (considering potential problems). Figure 43 shows images from the process.

6.1.3 Results

The ideas generated were clustered and mapped by the author (Figure 44). Most results were methodologically stated ideas or reflections on how to address certain aspects of prescription in a general sense, rather than concrete concepts. Examples include "Possibility of receiving long-term progress feedback" and "I'm afraid of not performing exercises correctly." The main clusters resulted from this activity were related to long-term guidance, personalization, and aspects to be aware of when designing the session about the exercises and the activities. These results were set aside to be revisited after the second ideation phase and then used for constructing frameworks on long-term guidance and personalization. Since the session did not yield concrete concept ideas, another session guided by a different method will follow. The outputs from both sessions will be combined to guide subsequent phases.

6.2 Ideation Activity #2: How To

6.2.1 Goal

Since the initial ideation activity provided general direction and guidelines but no concrete concept ideas, a more structured session was conducted to generate specific ideas addressing defined questions and criteria. The primary question guiding this activity was: How can the design criteria be applied to concrete concept ideas?

6.2.2 Method

The creative technique "How To" (Tassoul, 2006) was employed, which involves asking a series of questions on how to achieve specific aspects. These aspects were framed as multiple problem statements in the form of questions. For this project, the questions were defined for each area – long-term guidance, personalization, and session – based on the design criteria and interaction qualities. The aim was to understand how to practically implement these aspects. The list of questions is shown in Table 11. The activity involved two research team members (a gerontologist and a physiotherapist) and the author, who acted as the moderator, posing questions and managing the allotted time for each response. For each question, participants freely generated as many ideas as possible within the set time, suspending judgment and criticism.

6.3.3 Results

The ideas generated for each area were first grouped by response. This process is shown in Figure 45.
It became evident that ideas from each of the three areas (long-term guidance, personalization, and session) could be applied to one another, not necessarily being strictly confined to a single area. For example, ideas related to personalization included ways to integrate personal routines, preferences, home environments, and other factors into exercise activities within the session, such as "Create new tools to exercise with what you have at home." This led to further clustering of ideas into specific features of the concept, distinguishing between platform design aspects and general guidelines. Table 12 illustrates the groups resulted from the clustering, with subcategories from each group, without showing the specific ideas.

PERSONALIZATION	LONG-TERM GUIDANCE	SESSION

• How to personalize the plan and the exercises to the patient's goals?
• How to personalize the plan on the patient's routine?
• How to personalize the plan on the patient's interests and tastes?
• How to personalize the plan on the patient's living environment (house and neighbourhood)?
• How to personalize the plan on the patient's neurological conditions?
	• How to periodically check the patient motivation and enjoyment?
	• How to give motivating and clear feedback on the patient performance?
	  • After each session
	  • Overall
	• How to make the patient motivated in the long term?
		• How to make the exercises engaging and fun?
		• How to make the instructions clear?
		• How to make the instructions catchy and captivating?
		• How to motivate the patient during the exercises?
		• How to track the performance real time?
		• How to let the user know if they're doing the exercise correctly?
		• How to connect it to COGWEB?

Table 11. List of questions asked in the How To session

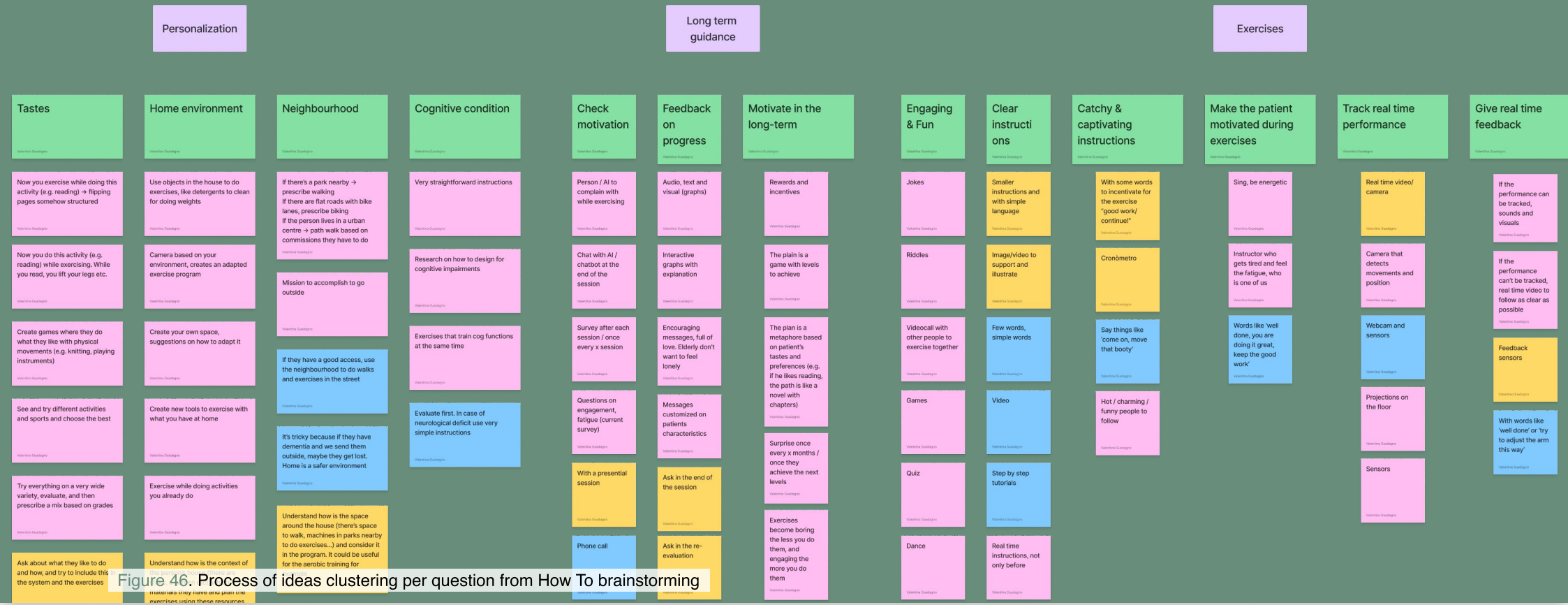


Figure 46. Process of ideas clustering per question from How To brainstorming

Table 12. Groups resulted from clustering according to concept's features

GENERAL GUIDELINES		PLATFORM		
Personalization of the prescription • Based on preferences • Based on goals • Personal space adaptation • Based on schedule • Based on cognitive condition	**Exercises session** • Ensure variety and change regularly **Long-term guidance** • Periodic report on feedback • Presential sessions • Long-term motivation	**Exercises activity** • Activities based on people's hobbies • Including additional objects and materials • Sports • Games (quiz, riddles, cognitive challenges) • Routine based • Allowing social connection • Outdoor activities	**Motivational features** **Goal setting** **Plan metaphoric representation** **Feedback from patient**	**Feedback to patient** **Tonality** **Instructions** • Medium • Instructor representation • Modality

6.3 Idea evaluation and selection

To categorize and evaluate the numerous ideas resulted from the previous ideation activity, a C-Box grid (Tassoul, 2006), shown in Figure 46, was used. This method consists in using a 2x2 matrix determining two criteria according to which ideas are evaluated. These criteria are attributed to the two axes of the matrix. In this case the two criteria used were: 'feasibility' and 'desirability'. Feasibility indicates how practical the concept is, considering available technology and resources, time constraints, and whether the ideas can be tested within the project's timeframe. Desirability reflects how inspiring an idea is and its potential to align with the design goal.
Decisions were made with a research team member to have her point of view on what is actually possible and desirable from the company's side.
Key considerations during the decision-making process included:

- Company resources and technology: ideas requiring unavailable resources or technologies were excluded, such as those needing real-time feedback or live performance tracking, as the company wants to extend cognitive training sessions without requiring additional equipment.
- Physical activities beyond sessions: ideas involving activities outside of the sessions were excluded due to the need for precise, real-time instructions for patients with cognitive impairments. This included excluding activities outside the home due to safety concerns.
- General guidelines and long-term guidance: ideas in the form of general guidelines related to long-term guidance and personalized prescriptions were excluded but frameworks on their application in the overall patient journey of ACTIVAS were developed and detailed in Chapter 8.3.
- Untestable aspects: aspects like goal setting and continuity tricks, interesting but testable only in the long-term, were excluded.

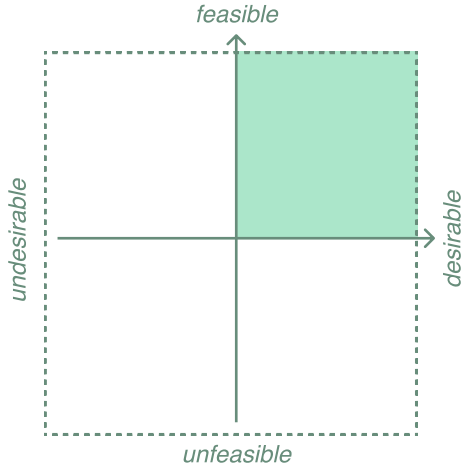


Figure 46. C-Box matrix (Tassoul, 2006)

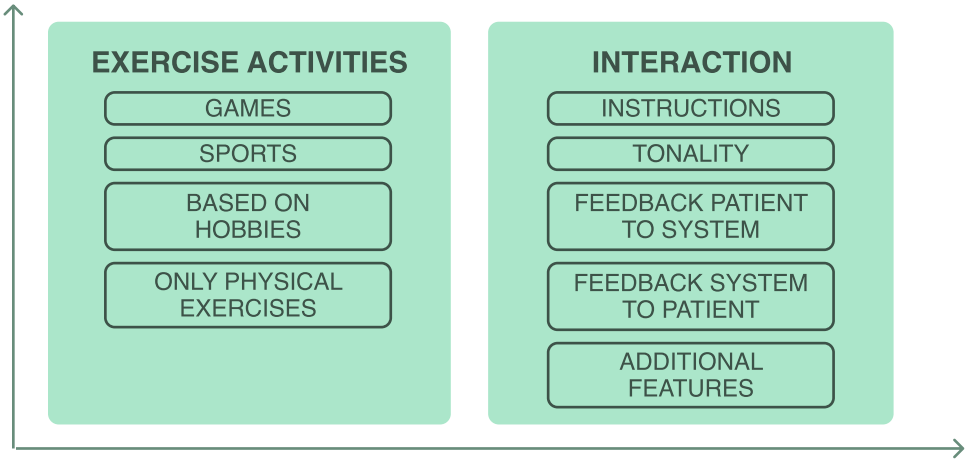


Figure 47. Ideas selected according to the C-Box method grouped into different aspects of the exercise session.

The ideas generated from this method focused on the testable aspects of the exercise session. Specifically, they addressed the type of interaction, including tonality, instruction methods, and feedback mechanisms, as well as the types of activities to be performed during the exercises, as shown in Figure 47. Detailed ideas and the clustering process from Ideation Activity #2 can be found in Appendix E.

6.4 Conclusion

The main conclusions from the ideation phase, based on decisions made using the C-Box method, are as follows:

- All aspects related to long-term guidance and personalization will not be tested but will result in guidelines detailed in Chapter 8.3.
- Among the exercise session aspects, concrete ideas related to interaction with the concept and proposed activities will be explored further through user tests, as detailed in the upcoming Chapter 7.

7. Test iterations

This chapter presents the three test iterations conducted with participants, where the design directions resulting from the previous activities were evaluated. In the first two iterations, different and complementary aspects of the concept were tested separately, which were then combined into a single concept that incorporated the features that received the most positive feedback from the earlier tests. The chapter concludes by defining the characteristics that the final design must have to achieve the design goal and reflect the desired interaction qualities, based on the feedback and results obtained.

7.1 Test iterations

The previous ideation phase led to the selection of ideas, which can be categorized into two groups: those related to interaction aspects and those concerning the type of exercise activities. The next phase aimed to test these ideas.
The goal of the testing phase was to iteratively test different prototypes until arriving at a concept that best reflected the design goal and interaction qualities. The iterative process is visualized in Figure 48. The central question guiding this phase was: How to provide clear and structured guidance along with engaging and enjoyable activities? To address this question, three test iterations were conducted, applying and adapting the Research through Design method:

- The first test iteration focused on evaluating guidance by testing a prototype that presented various interaction modalities between the user and the platform, assessing which methods made users feel the most guided. This is discussed in Chapter 7.2.
- The second iteration tested engagement by offering a prototype with different physical exercise activities, such as games, sports, hobbies and only PE, having users evaluate which activities they found most engaging and enjoyable, and why. Details of this test are provided in Chapter 7.3.
- The third iteration aimed to merge insights from the previous tests into a concept that featured the most effective interaction methods for guidance and the most engaging exercise activities.

This process is detailed in Chapter 7.4. Throughout each iteration, interaction qualities were also assessed.
Insights from the third iteration allowed for the development of the final concept, integrating the feedback from users and the results from the evaluation into a final version of the proposed concept.

7.1.1 Design for cognitive impairments

Involving older adults in user tests requires careful consideration of their unique needs, especially when cognitive impairments are present. Prior to designing the prototypes and the tests settings, research was conducted on guidelines for involving this audience. Being part of an experienced research team accostumed to work with this population was fundamental to create a comfortable environment and building trust with participants. Key considerations included:

- Being aware of potential age-related deficits, such as visual, hearing, motor, or cognitive impairments (Chan, 2024). For example, using written, visual, and spoken instructions helps compensate for any sensory limitations. Instructions were kept short, simple, and clear, and were repeated as necessary to ensure full understanding. Tasks were designed to be physically easy, adapted to their condition, and, in severe cases, participants were asked to describe what they would do rather than perform the tasks themselves.
- Giving realistic tasks and prototypes, as older adults often struggle with abstract thinking; it was important to observe their reactions directly rather than ask them to imagine scenarios (Chan, 2024).
- Building trust and making participants feel comfortable (Chan, 2024).
- Familiarity with the research team made their participation easier, and the main researcher's friendly, empathetic, patient, and supportive attitude built an environment where participants felt free to express themselves.
- Instructions were explained carefully, and participants were guided throughout the process rather than being left to navigate on their own.
- Participants were also encouraged to give their opinion without restriction, the researchers made it clear that criticism was welcomed and very important for the development of the solution.

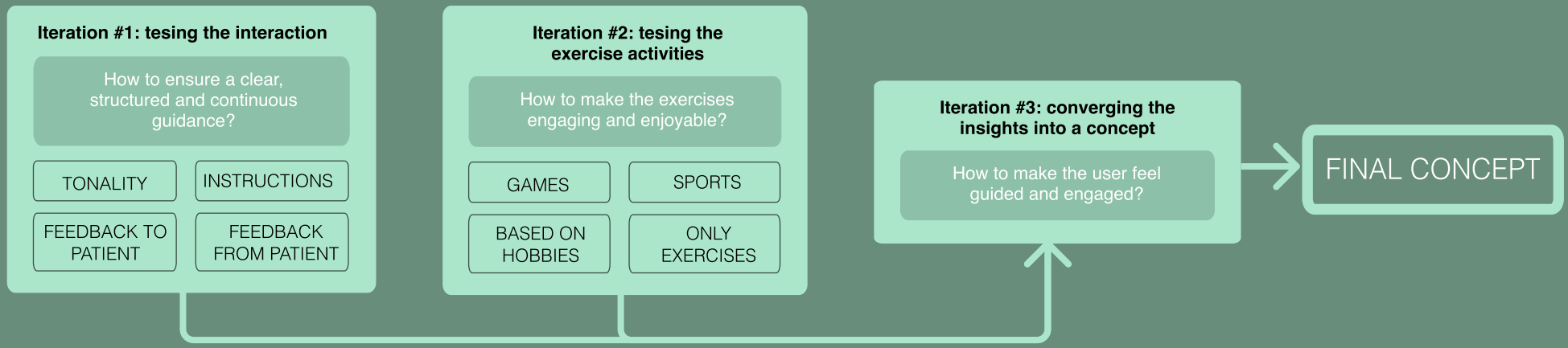


Figure 48. Overview of the test iterations

7.2 Iteration #1: testing the interaction

7.2.1 Goal

The first testing iteration aimed to evaluate the interaction between the user and the platform, focusing on aspects such as types of instructions, feedback mechanisms from the user to the system and from the system to the user, platform or instructor tonality, and additional features like countdowns and music. The goal was to understand how to ensure clear, structured, and continuous guidance.

Sub-research questions included:

- Which aspects of the proposed options best reflect the desired interaction qualities?
- Which modalities were preferred for each aspect and why?

7.2.2 Set-Up and Prototype

An interactive prototype of the platform, created with mockups (Figure 50), was developed to simulate a session of three exercises and test various ways of delivering instructions, feedback, and tonalities. Each exercise used a different approach. For instance, the first exercise featured a step-by-step explanation with 2D animations, a clear and neutral tonality, and a feedback mechanism that involved recording audio. The second exercise presented an energetic gym instructor in a single video, accompanied by music. The third combined a step-by-step explanation with both a video of a person representing a physiotherapist and text, using kind and scientific language to explain benefits and necessary information. Figure 49 illustrates the test setup. Participants were instructed to simulate the session, by following the on-screen instructions while describing their actions and expressing their thoughts out loud. Figure 46 captures participants during the test. The session concluded with an evaluation form, which included questions related to interaction qualities, sub-research questions, and open-ended qualitative feedback. Full set-up, evaluation form, full prototype and insights for each participant are shown in Appendix F.

6.2.3 Participants

Participants were three older adults from the Portuguese community, with little, moderate and high levels of PA. One of them was a COGWEB® user with first-stage Alzheimer disease. Their demographics are visible in Table 13.

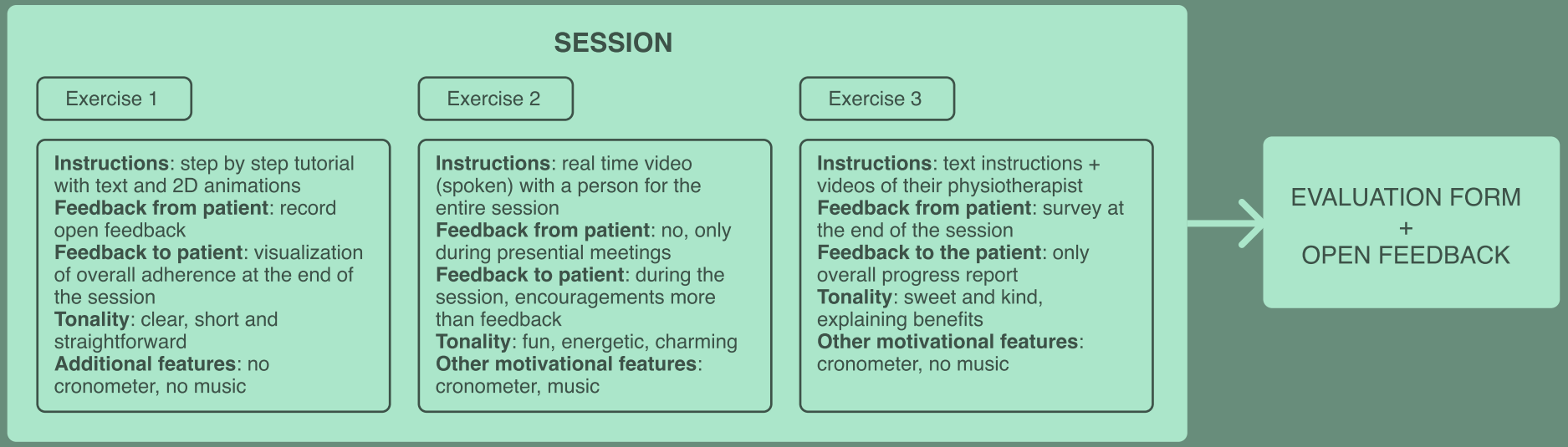


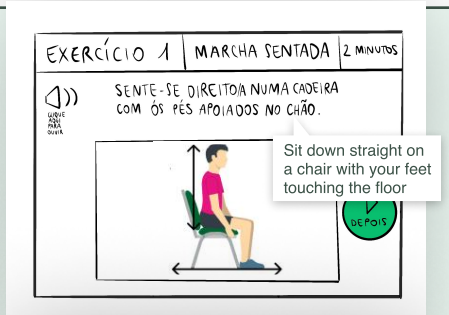
Figure 49. Set-Up scheme of test 1

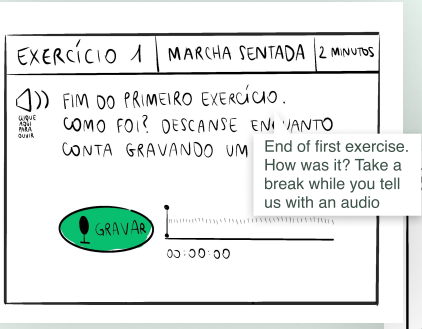
Participant	Age	Gender	Nationality	Physical health condition	Cognitive impairment	PA level	Technology level
P1 COGWEB® user	68	M	Portuguese	Healthy	Alzheimer Disease, first stage	Moderate PA	Autonomous (phone, laptop)
P2	74	F	Brazilian	Knee arthrosis	Healthy	Highly PA	Autonomous (phone, laptop)
P3	81	F	Portuguese	Healthy	Healthy	Little PA	Medium autonomy

Table 13. Test #1 participants' demographic overview

Exercise 1

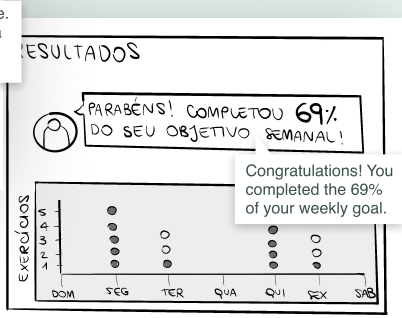
Tonality: clear, short and straightforward
Additional features: no cronometer, no music





Feedback from patient: record open feedback
Instructions: step by step tutorial with text and 2D animations

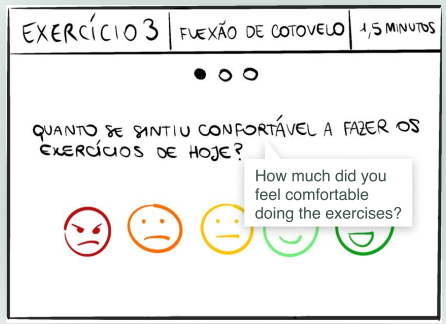
Feedback to patient: visualization of overall adherence at the end of the session



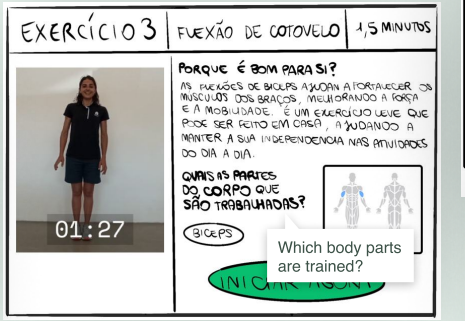
Exercise 2

Instructions: real time video (spoken) with a person for the entire session
Tonality: fun, energetic, charming
Other motivational features: cronometer, music

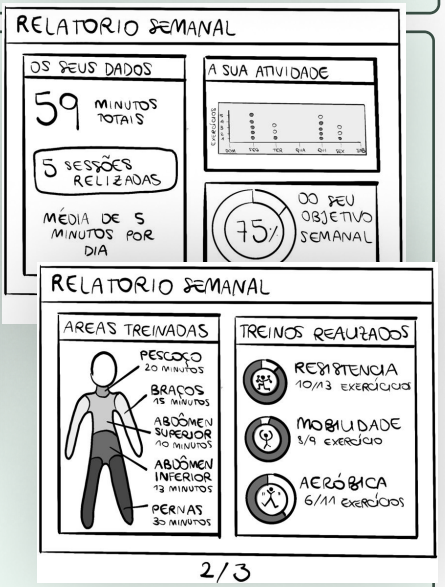
Exercise 3



Feedback from patient: survey at the end of the session



Instructions: text instructions + videos of their physiotherapist
Tonality: sweet and kind, explaining benefits
Other motivational features: cronometer, no music



Feedback to the patient: overall progress report

Figure 50. Prototype screens and descriptions

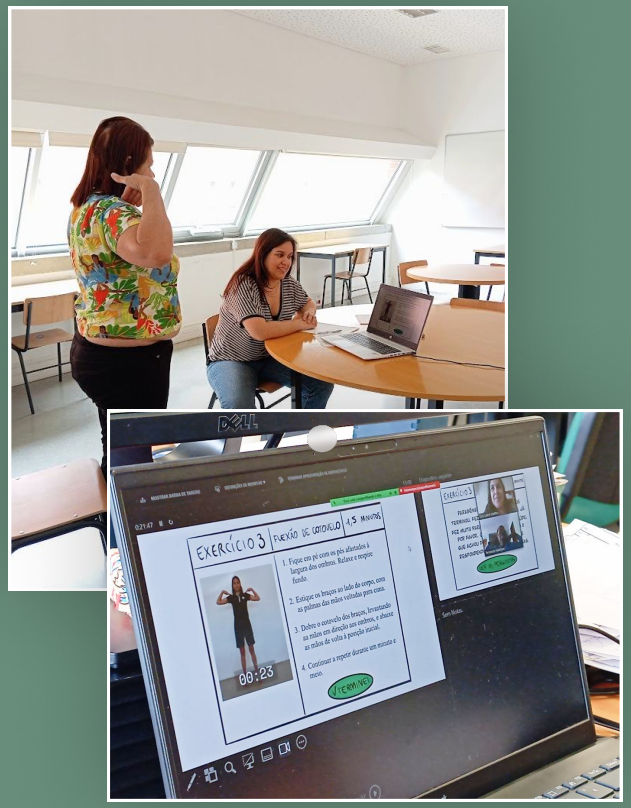


Figure 51. Images of participants performing the test.

“I like the way she talks, she is nice, clear and slow. I can follow her and do the exercises while she explains. ” - P3

“I can’t follow the video and read at the same time if I have to do the exercise. It’s confusing. ” - P2

7.2.4 Insights

The key insights from the tests highlight the preferences and needs of participants. They preferred clear, professional instructions delivered by a real person, ideally a familiar physiotherapist, as this enhances trust and credibility. They favored videos over step-by-step instructions, though visual animations paired with concise explanations were appreciated for their clarity. Instructions should be straightforward, avoiding abstract language or excessive information, and should include an overview of necessary materials and session duration. In terms of tonality, participants responded best to a kind but concise approach, rather than energetic encouragement. They valued the sense of accomplishment from seeing their progress in clear, comprehensive reports but found some feedback modalities confusing. Closed questions with simple, understandable options were preferred, as they were easier to process than open-ended prompts. Overall, the platform should ensure exceptionally clear guidance using multi-media formats like voice, images, and videos to accommodate potential sensory impairments. Navigation should be linear, avoiding screens that require selecting multiple options. The design must focus on delivering practical, concrete information about the benefits of exercises, which is more motivating for this target group than scientific explanations.

7.2.5 Design implications

The insights from this test brought to understand that, to ensure clear and structured guidance, the following features should be applied for further design:

- Step by step explanation
- Presence of physiotherapist
- Complete instructions with diversity of media: video, text, voice, visuals
- Clear, short and concise instructions
- Overview with materials and info
- Linear navigation
- Explanation of benefits and why an exercise is good for their health

7.3 Iteration #2: testing the exercise activities

7.3.1 Goal

The clustering after brainstorming session 2 led to the generation of various ideas for different approaches to exercise activities. These ideas were grouped into four main areas:

- games, including cognitive tasks, quizzes, and riddles;
- sports, such as tennis, baseball, bowling, and dancing;
- activities based on hobbies and personal interests;
- purely physical exercises.

For this test, several exercises were designed for each category and presented in a single session. The goal was to understand how to stimulate engagement and enjoyment. The following research questions were also addressed:

- Which activities users found most engaging and enjoyable and why?
- Which activities would motivate them to perform PE and why?
- In which activities users could successfully perform both the PE and the side task?

7.3.2 Set-Up and Prototype

The test set-up involved a session with 11 tasks, each integrating a PE or activity into one of the categories, as illustrated in Figure 52. The participants performed the session and completed the tasks, which included (4) game tasks, (4) sport-based tasks, (3) hobbie-based tasks, and (1) PE.
Figure 53 shows the prototype built for this test session, along with the explanation of each exercise task. The difficulty level of both physical and cognitive tasks was intentionally kept low to ensure that everyone could easily perform them, regardless of individual skills and abilities. After each exercise, participants rated the task on a scale from 1 to 5 based on engagement, ease of understanding and execution, and whether they would do it again. They also provided their opinions and thoughts on each task. At the end of the session, participants indicated their preferred category and provided general feedback. The complete set-up, full prototype, evaluation form and insights for each participant, are available in Appendix G. Figure 54 shows a picture from the tests.

7.3.3 Participants

For this stage of the project, as can be seen in their demographics in Table 14, participants were not chosen from the target group for some challenges in the recruiting process. Instead, the research team recruited from personal networks and from UA individuals with some characteristics in common with the target group or

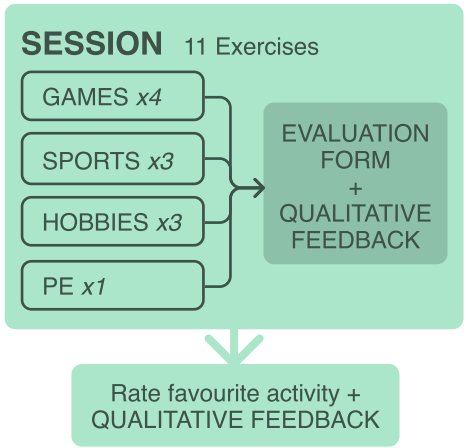


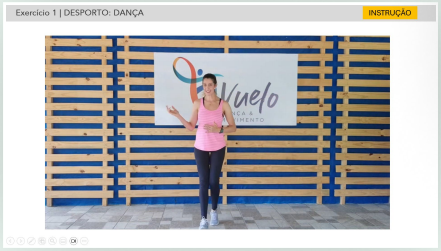
Figure 52. Set-Up scheme of test #2

Participant	Age	Gender	Nationality	Physical health condition	Cognitive impairment	PA level	Technology level
P1	65	M	Portuguese	Healthy	Healthy	Little PA	Autonomous
P2	33	F	Portuguese	Healthy	Healthy	High PA	Autonomous
P3	37	F	Portuguese	Healthy	Healthy	High PA	Autonomous
P4	63	F	Italian	Back pain	Healthy	No/little PA	Autonomous
P5	57	M	Italian	Healthy	Stroke in 2010	Moderate PA	Autonomous

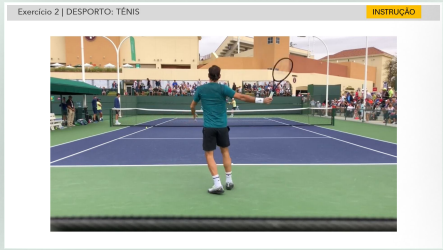
Table 14. Test #2 participants' demographic overview

with sufficient expertise to understand the target users' needs. These included two individuals approaching the age target group, two with sedentary habits, one who experienced cognitive impairments, and two professionals with expertise in physiotherapy and working with older adults.

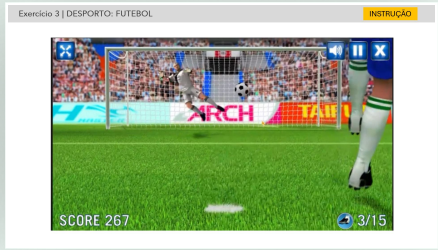
Exercises based on sports



Dance: users followed and repeated dance steps shown in a video with accompanying music.



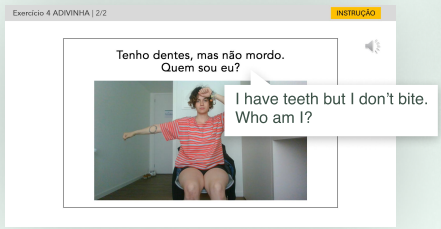
Tennis: users imitated the movements of a tennis player, moving their arm to hit the ball.



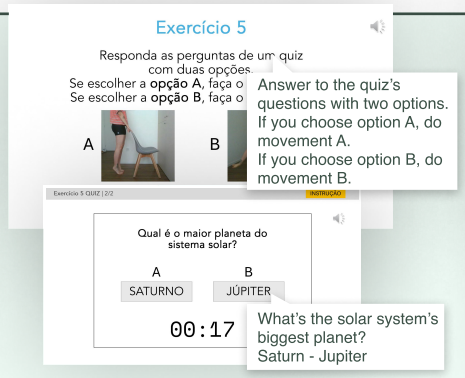
Football: users imitated a football player taking penalties by "kicking" the air.

The sports-based exercises included dance, tennis, and football. These exercises focused on imitation, requiring users to replicate the movements shown in videos taken from YouTube. Due to technological constraints, no feedback system was implemented to score points or track performance, so the concept was adapted to engage users without real time feedback.

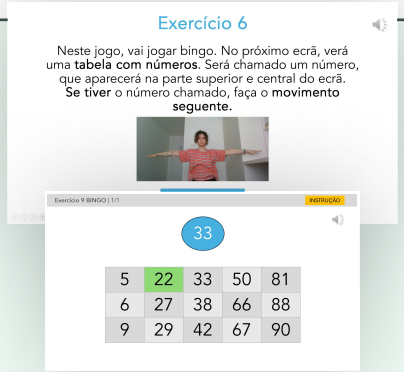
Exercises based on games



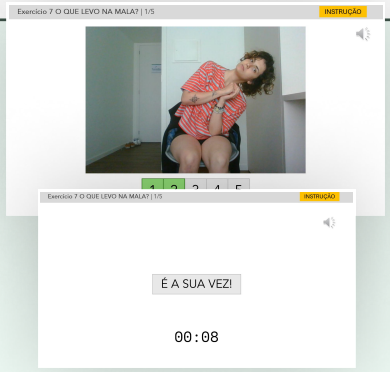
Riddles: users answered riddles by imitating movements that served as hints, such as mimicking the gesture of brushing hair for the riddle "I have teeth but I don't bite."



Quizzes: users chose the answers of a quiz by performing the movement associated with the correct option.



Bingo: users performed movements if they found the called number on their bingo card.

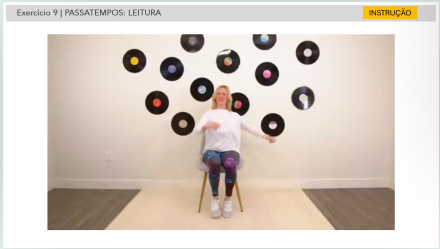


Remember the sequence: users memorized and repeated increasingly longer sequences of movements.

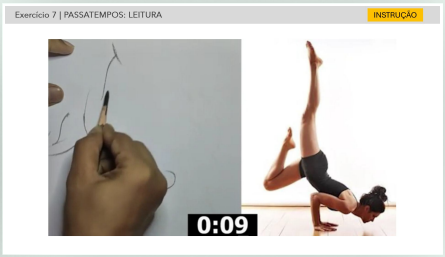
The game-based exercises combined cognitive challenges where the user was supposed to answer to the task with a movement, exploring exergaming and simultaneous combinations.

Figure 53. Prototype screens and descriptions

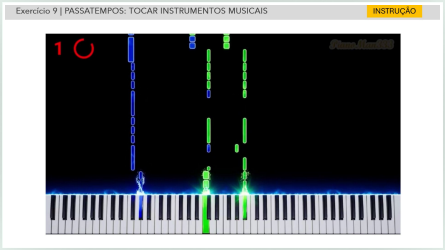
Exercises based on hobbies



Reading: users performed physical exercises while listening to a story read aloud, distracting them from the physical effort with an activity they could enjoy.



Drawing: users followed and repeated hand movements shown in a video to simulate drawing.



Playing musical instruments: users followed the rhythm of a piano melody by tapping their feet.

These tasks explored the possibility to carry out activities based on people's hobbies or interests while performing PE symultaneously.

Purely physical exercises

This category included a single task where users followed a person explaining and demonstrating a series of physical exercises without any additional tasks. This approach explored whether users might prefer straightforward physical exercises if explained effectively, compared to exercises with additional tasks.

Figure 48. Prototype screens and descriptions

7.3.4 Quantitative results

The quantitative results derived from an evaluation form using a Likert scale from 1 to 5.
Participants rated:

- How engaging and enjoyable they found each exercise
- How easy each exercise was to understand and perform

A score of '1' corresponds to 'not engaging or enjoyable at all' and 'not easy at all,' while a score of '5' corresponds to 'very engaging and enjoyable' and 'very easy to understand and perform.'
Table 15 presents the average scores given by participants for each exercise on both questions.

7.3.5 Insights

The insights gathered from the tests reveal that participants did not have a preference for specific categories of activities like games or sports but rather favored exercises that incorporated cognitive challenges, interactive elements, and tasks that combined physical movement with non-physical challenges, such as playing bingo while exercising. Participants expressed varying opinions on the difficulty of these challenges, indicating the need for exercises to be tailored to individual cognitive and physical levels, with options for progression.
Exercises requiring participants to focus on two tasks simultaneously, like guessing a riddle while performing a movement, proved challenging, as they often only managed to complete one of the tasks. Although games were seen as promising and interesting, they require clear instructions to effectively combine both physical and cognitive demands. Physically active participants were more motivated by straightforward PE or dance, whereas sedentary participants engaged more when additional tasks were included.
In conclusion, combining PE with cognitive challenges was found to be the most enjoyable and engaging approach, particularly if adapted to the users' abilities and clearly explained. This method has the potential to keep users in a state of 'flow,' which will be explored further in the final design. While instructional videos may motivate active individuals, adding fun tasks could help engage

sedentary users who need extra motivation to enjoy PE. These insights, along with those from the first iteration, will guide the next phase of development.

7.3.6 Design implications

The insights and results from this test brought to the conclusion that, to stimulate engagement and enjoyment, the following features should be applied and further explored:

- PE integrated with games based on cognitive tasks
- Variety of games and exercises; the more they are, the more the session will be engaging
- Levels of PE and cognitive tasks adjusted on the patient's physical and cognitive abilities
- Very clear instructions throughout the whole exercise, mindful of cognitive impairments
- Exercises that require one task at the time (e.g. instead of 'give the answer to the quiz' *and* 'do the movement' > 'move *when* you find the called number in your bingo card')

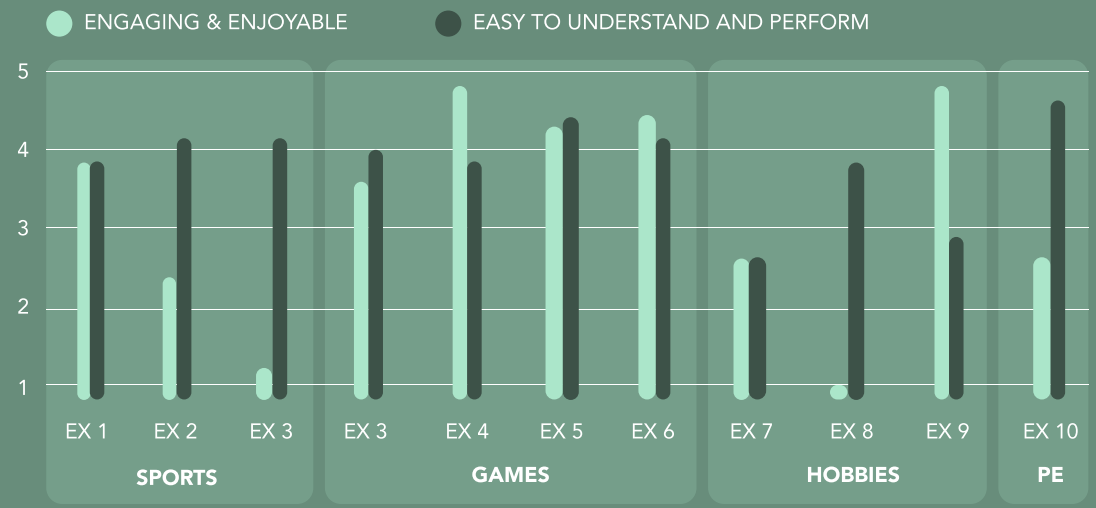
"Tennis and football are boring because there is no interaction or involvement. You just have to imitate something. I feel stupid. " - P1

"Now I find the bingo fun and easy enough. But when I was recovering from the stroke I would have never been able. It's important that this exercise is adapted for every condition. " - P4

Figure 54. Images of participants performing the test.

"I really enjoyed the one with the music, but it was difficult to follow. I'd like it more if it was with songs I know " - P2

Table 15 Bar chart representing the average participants' score for each exercise given in the evaluation form.



7.4 Iteration #3: converging the insights into one concept

7.4.1 Goal

The third test iteration aims to converge the desired exercise activities and the desired interaction, integrating insights from the previous iterations to develop a final concept. Figure 55 summarizes the design elements derived from earlier tests to be incorporated into the third prototype.

The elements 'progress report' and 'feedback survey', originated from the first iteration, are external to the exercise session itself, therefore they do not need integration with insights from test two. However, they will be included in the final design.

The goal of this iteration was to determine:

1. Does the concept provide clear guidance and engagement at the same time?
2. How well does the concept reflect the desired interaction qualities?

7.4.2 Set-Up and Prototype

For this test, the focus was on optimizing the interaction and clarity of a single exercise rather than multiple activities. Although the final design will include various exercise activities, this test aimed to refine the combination of elements within one exercise to ensure effectiveness. The prototype, illustrated and described in Figure 57, simulated a session including:

- An introduction with an overview of essential information, such as exercise details, duration, materials needed, and expected benefits
- Instructions for the exercise, accompanied by an example
- The exercise itself

Figure 56 illustrates this setup. Participants provided open feedback on each session and the overall concept after the test, rating the desired interaction qualities as well. The exercise chosen for this prototype was "Remember the sequence," a game introduced in the second iteration. The full evaluation form, complete prototype screens, and the script of the videos with an English translation can be found in Appendix H.

Figure 58 shows a picture from the test.

Figure 55. Designed elements from previous iterations to integrate into final design.

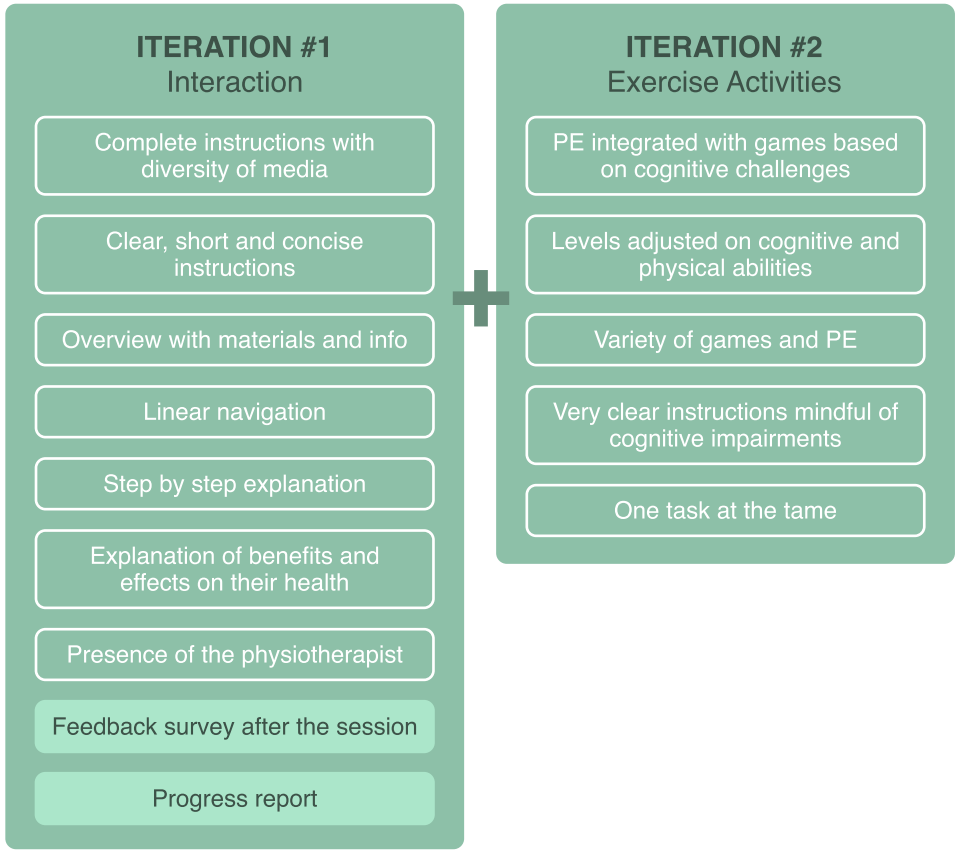
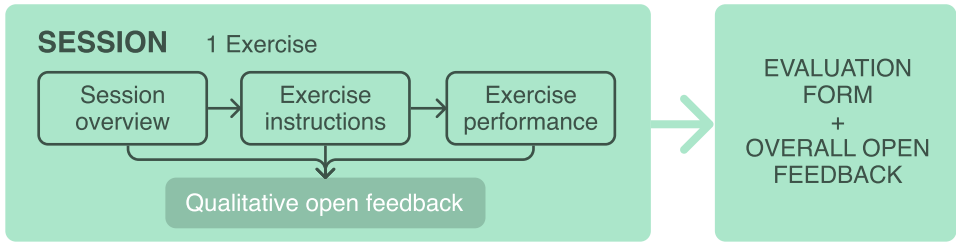


Figure 56. Set-Up scheme of test #2



7.4.3 Participants

The test began with a pilot session involving an author's friend with opposite characteristics from the target group—a 22-year-old, physically active, and without cognitive impairments. This was done to compare her insights with those expected from the target group. The main participants were italian older adults from the author's personal network who shared some characteristics with the target user group, such as age or levels of PA. To ensure that participants could fully understand and engage with the content, the prototype was designed in their native language, Italian. Table 16 provides an overview of the participants' demographics.

Table 16. Test #3 participants' demographic overview.

Participant	Age	Gender	Nationality	Physical health condition	Cognitive impairment	PA level	Technology level
P1 (Pilot)	22	F	Italian	Healthy	Healthy	High PA	Autonomous
P2	63	F	Italian	Back pain	Healthy	No/little PA	Autonomous
P3	63	F	Italian	Sight impairment	Stroke in 1998	Moderate PA	Autonomous
P4	73	M	Italian	Back pain	Healthy	High PA	Autonomous

7.4.4 Quantitative results

The quantitative results come from an evaluation form provided at the end of the session where participants had to rate with a Likert scale from 1 to 5 how much they felt the concept embodied the interaction qualities. A score of '1' corresponds to 'not at all' and a score of '5' corresponds to 'very much'.

Table 17 presents the average scores given by participants for each question.

7.4.5 Insights

All participants found the overview clear and appreciated the use of words, images, and animations during the video explanation. However, they found the instructions for the exercise task confusing and suggested improvements, such as refining the language and syntax, keeping the use of examples, providing reminders during the "it's your turn" phase, and designing simpler tasks. Additionally, most participants considered the PE too easy and boring for their current activity level. They appreciated the concept of combining PE with cognitive challenges but emphasized the need to adjust both aspects to match the user's physical abilities. The test reinforced the promise of integrating PE with cognitive games, but it highlighted the importance of conveying very clear instructions to ensure proper guidance and to include a variety of exercises and difficulty levels.

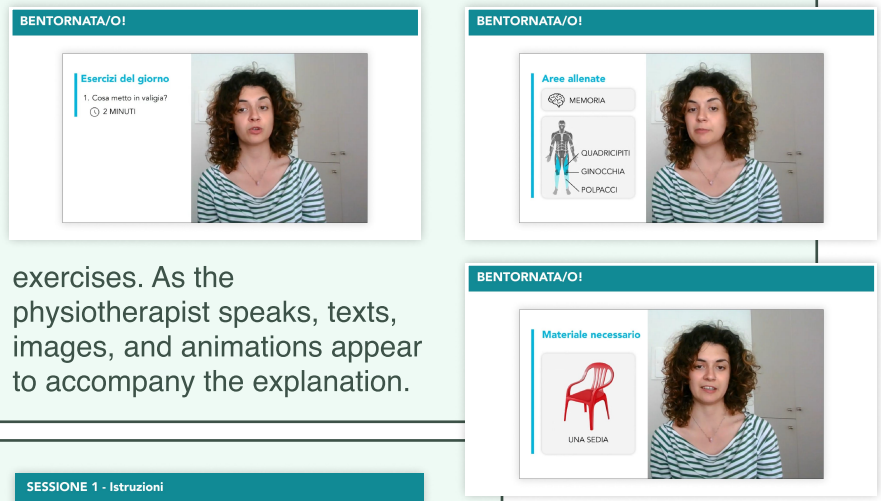
7.4.6 Design implications

The results and insights from the third iteration brought to the understanding that for the final design and evaluation the following features should be applied:

- provide more and varied exercises
- design two difficulty levels of exercises and cognitive tasks and ask to the final participants which level they'd like to choose
- work on the instructions to make them clear, before and during the exercise
- simplify the exercise(s).

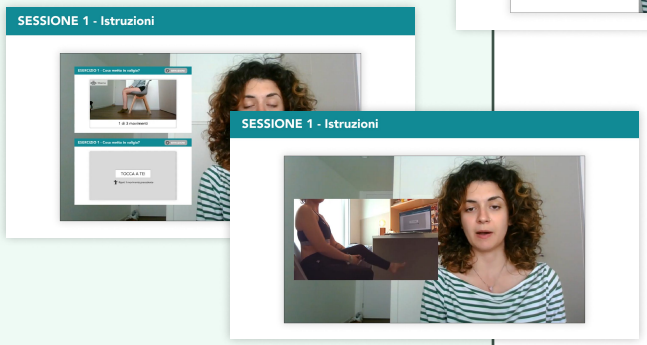
Session overview

Before starting the session, there is an introduction outlining what will be done: the exercises and their duration, the necessary materials, the body and cognitive areas that will be trained, and the benefits for health and daily life. A video of a physiotherapist explains each step of the exercises. As the physiotherapist speaks, texts, images, and animations appear to accompany the explanation.



Exercise instructions

Each exercise begins with a video where the physiotherapist provides instructions on how to perform the task. The explanation is accompanied by visualizations of the screens that will appear during the exercise and an example of how to perform it using a specific case.



Exercise performance

The exercise "Remember the Sequence", involves an initial screen where the user observes the movements through videos, followed by a screen displaying the words ‘it’s your turn’ where the user must repeat all the previously observed movements from memory and then click "I'm done" after completing the sequence. These two screens alternate until the exercise is completed, depending on the number of movements to be repeated. During the movements video, instructions on how to correctly perform the exercises and the number of repetitions are provided.

Figure 57. Prototype screens and descriptions

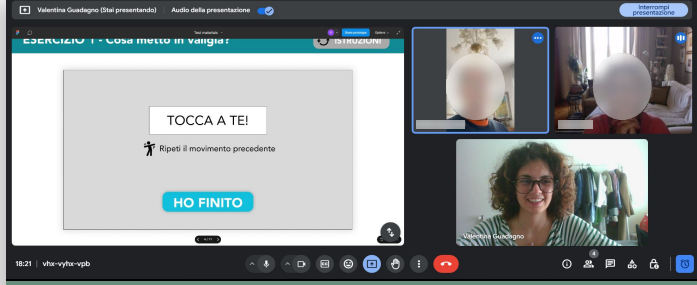


Figure 58. Screenshot from online test with P2, P3 and P4.

“I like the idea of playing with physical exercises but these ones are too easy. I’d like more challenging exercises.” - P3

“At the beginning I hadn’t understood I had to perform the sequence, but only the latter exercise.” - P2

“The instructions were clear to me only when the example was provided. I understood that moment what I had to do.” - P1

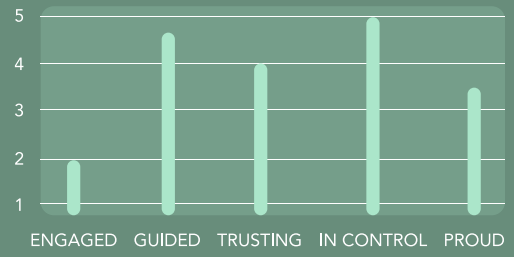


Table 17. Bar chart representing the average scores given by participants for each question

7.5 Summary and conclusions

The iterative testing process aimed to refine a concept that best reflected the design goal and interaction qualities through three distinct phases. Each phase built upon the insights from the previous one, ultimately guiding the development of the final design.

The first iteration focused on how to provide clear and structured guidance, revealing that participants preferred instructions delivered by a real physiotherapist, supported by multimedia formats like video, text, and voice. These insights highlighted the need for concise, straightforward instructions and linear navigation to enhance user guidance.

The second iteration shifted focus to engagement, exploring different PE combined with cognitive challenges. Participants favored activities that were interactive and combined physical tasks with cognitive elements, such as playing games while exercising.

The third iteration aimed to merge these insights, testing a prototype that combined the most effective guidance methods with the most engaging activities. This iteration underscored the importance of tailoring the difficulty of exercises to individual abilities and providing clear instructions to ensure both physical and cognitive demands were met effectively.

The findings from these three iterations suggest that the final design should incorporate clear, multi-media instructions, a variety of engaging exercises, and customizable difficulty levels to accommodate different user needs. By addressing these factors, the final concept can ensure both effective guidance and sustained engagement, making it well-suited to the target user group.

DELIVER

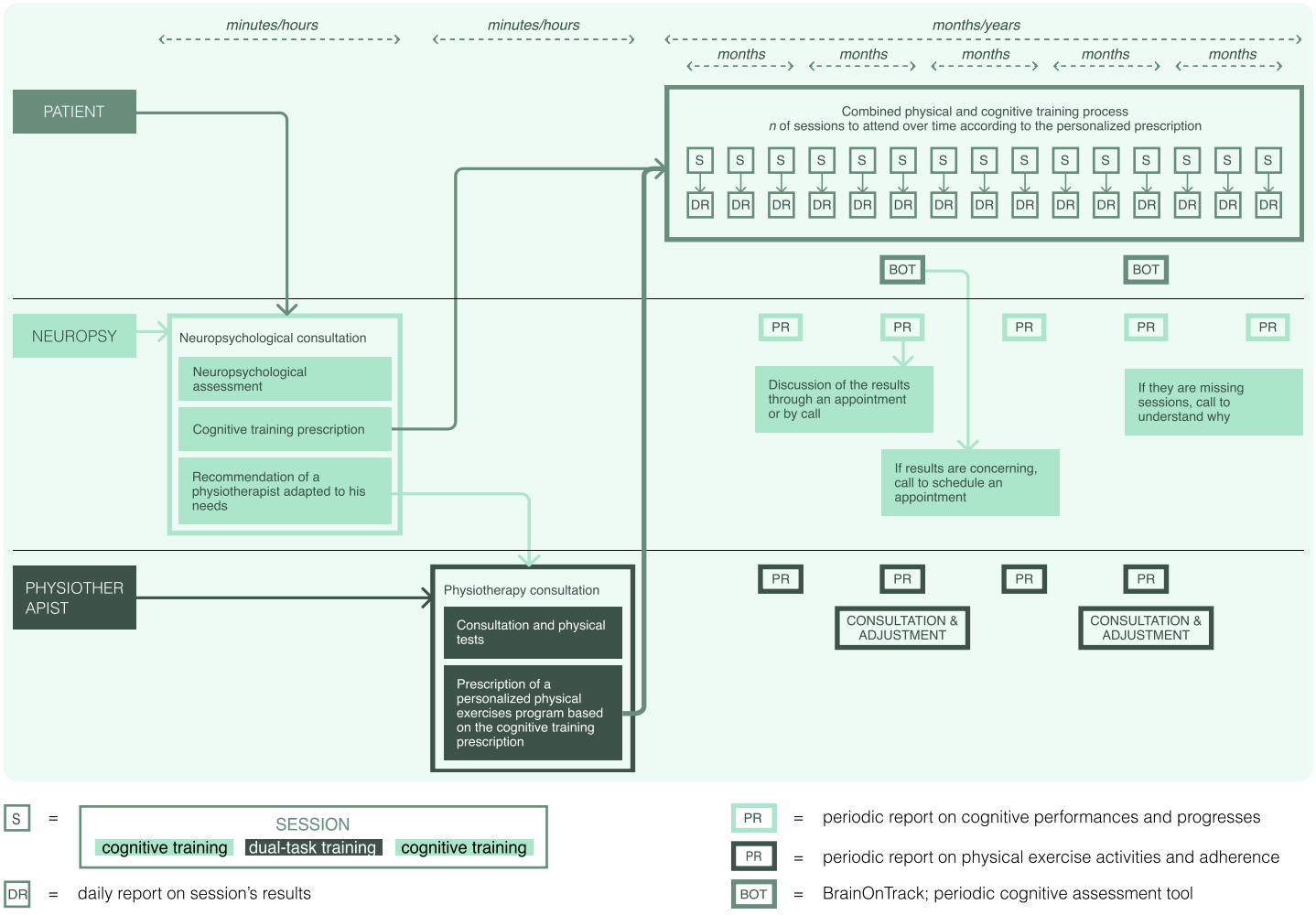
CONTENT	RESEARCH QUESTIONS
8. Final design	What does the final concept look like and how does it work? How is it integrated into the patient journey of a COGWEB user and in the real-world context? Which games are designed and how? Does it reflect the design goal and interaction vision? What should Neuroinova consider to actually implement it into COGWEB?
9. Discussion	What are the author's reflections on the final design and on the research and design process? What can be recommended for the future of this project? What is the author's overall personal reflection?

8. Final design

This chapter details the final concept of the dual-task component, Consigo, derived from insights gained in previous iterations. It presents its integration in the COGWEB® patient journey, considering aspects such as long term guidance and personalization, and how it would work in a real-world scenario. The chapter eventually presents the final test and evaluation conducted and gives some recommendations about Neuroinova's market implementation.

8.1 Consigo: a dual-task component

Figure 59. Patient journey in the final design's context



The final concept, *Consigo*, is a dual-task component that combines cognitive and physical exercises, integrated in the COGWEB® session. It features a series of cognitive tasks in the form of exergaming (see Chapter 2.6.2), which require physical responses from the user. The primary goal of *Consigo* is to motivate older adults participating in the COGWEB® training to engage in PE sessions by offering clear and structured guidance with engaging and enjoyable activities.

In Portuguese, "Consigo" means both "with you" and "I manage," reflecting the close relationship that the concept fosters between patient and physiotherapist, as well as the sense of pride patients experience as they successfully complete exercise sessions tailored to their individual situation.

This component is integrated into the patient journey within the COGWEB® system, as shown in Figure 59. It is part of a program that originates from a personalized prescription and includes long-term guidance provided by a supervising physiotherapist. Although these last two aspects fall outside the primary focus of the final design, guidelines and frameworks have been developed for the professionals overseeing the program. These guidelines, aimed at making the program potentially more effective and engaging over the long term, are detailed in Chapter 8.3.

8.2 Exercise sessions

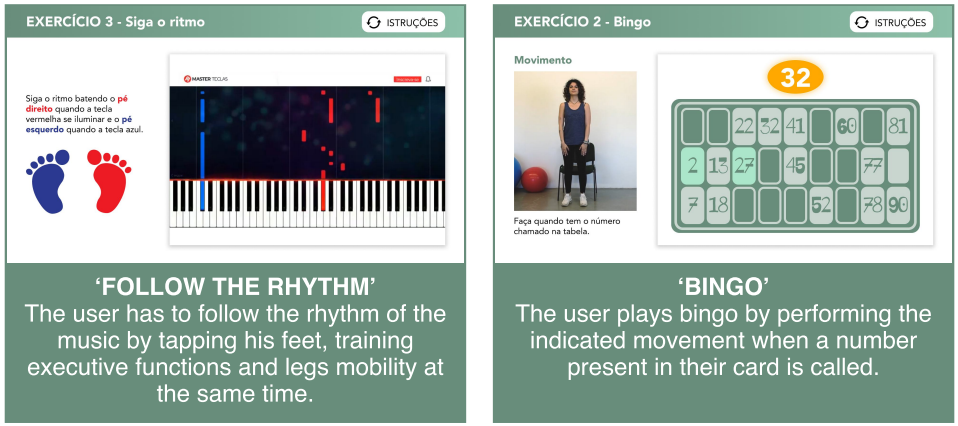
Consigo features a session of a series of cognitive tasks similar to those in COGWEB®, but with responses made through physical movements and exercises instead of keyboard and mouse interactions. This way, patients combine cognitive and physical training in a dual-task format. Figure 60 show examples of these exercises.

8.2.1 Combination modality

According to the distinction proposed by Gavelin et al. (2021), the session is designed as a sequential intervention, where in the cognitive training sessions other exercises with also a physical component are integrated. These exercises fall under the category of exergaming, involving entertaining games with cognitively challenging tasks that require physical movements. Test iterations identified this modality as the most promising approach to ensure clear guidance and high engagement at the same time.

8.2.2 Flow theory

Exergaming combines the motivational aspects of gaming with PE. Factors from theoretical models like the Flow Theory (Csíkszent-mihályi, 1975), Gameflow (Sweetser & Wyeth, 2005), and the Dual Flow Model (Sinclair, Hingston, Masek, 2007) were considered. 'Flow' is a psychological state where people are fully immersed in an activity that they enjoy (Csíkszent-mihályi, 1975). It occurs when a task is challenging but not too difficult, allowing users to feel in control while pushing slightly beyond their skills. Flow theory has been applied in various domains, including exercising and gaming. For gaming, Sweetser and Wyeth (2005) adapted flow theory into 'game-flow,' where games should focus users to control their skills in response to challenges. Game flow also supports players in developing skills and mastery. Sinclair, Hingston, and Masek (2007) propose a dual flow model for exergaming, aiming for flow both physiologically (effectiveness) and psychologically (attractiveness), as shown in Figure 61. Physical flow is achieved by adjusting exercise intensity to the user's fitness level, while psychological flow is achieved by setting cognitive challenges appropriate to cognitive skills. Proper adjustments aimed at progression allow users to enjoy the game while performing effective PA. If the challenge exceeds skills or fitness, anxiety and failure occur; if too low, boredom and deterioration set in.

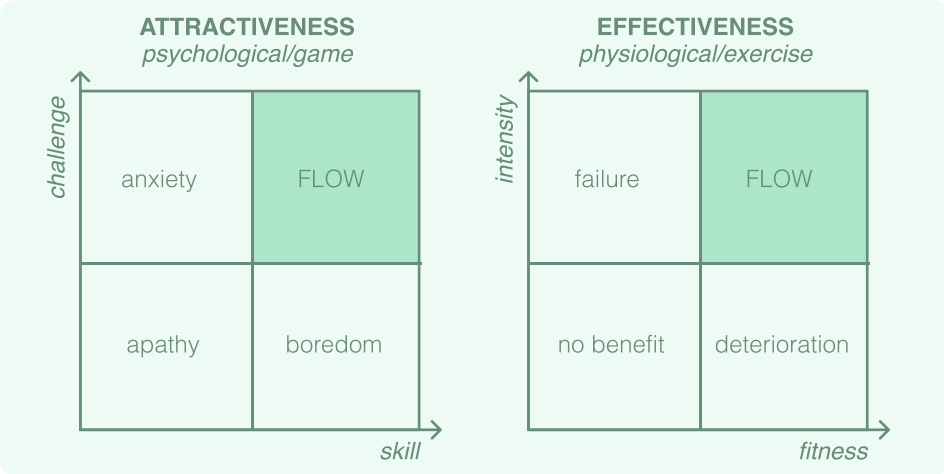


'FOLLOW THE RHYTHM'
The user has to follow the rhythm of the music by tapping his feet, training executive functions and legs mobility at the same time.

'BINGO'
The user plays bingo by performing the indicated movement when a number present in their card is called.

Figure 60. Examples of dual-task exercises designed

Figure 61. Dual-flow model (Sinclair, Hingston & Masek, 2007)



8.2.3 Levels & Progression

Difficulty levels for both physical and cognitive exercises are adjusted based on the patient's initial level to achieve the state of flow and for ensuring skill progression. An effective cognitive and physical training should be progressive to aim for continuous health benefits. In this case, since the adaptment should affect symoultaneously both cognitive and physical training, the exercises are first chosen according to the cognitive task involved, adapted to the patient's cognitive level. Since the design involves games with physical responses, the physical exercises are chosen subsequently.

Chapter 8.6.5 will show practical examples of difficulty variation in the final prototype, while Table 18 shows an example of different levels of PE designed by the research team for the development of ACTIVAS.

8.2.4 Technology

The technology used is the same as for COGWEB®, as the program did envision PE as an implementation that all COGWEB®'s patients can perform without needing extra materials or devices. Therefore, the user interacts with the digital platform via the device they have access to (computer, tablet, television). There are no sensors or devices that track the user's performance or how they physically respond to the tasks. Consequently, it is currently not possible to have a record of their performance, but only of their adherence and the areas they would improve assuming they actually perform the exercises. Cognitive performances are already tracked through COGWEB®, so their inclusion in dual-task training does not require additional evaluation.
The user provides feedback through body movements following the questions posed in the exercises, which continue automatically at a speed determined by the difficulty level, where faster = more difficult and slower = easier. Only when the exercise ends, the patient is asked to proceed by clicking a button.

8.2.5 Session structure

The dual-task training session structure is shown in Figure 62. It begins with an overview video explaining the exercises, followed by instructional videos and the exercise interface. After the session, users provide feedback and see a report of their progress and results.

	EASY	EASY-MODERATE	MODERATE-DIFFICULT	DIFFICULT
 *walking*	Walking slowly (flat surface)	Walking at a speed of 6,43 km/h (flat surface)	Walking at a moderate pace with a light weight (inclined surface)	Running with a weight between 4,5-19 kg (inclined surface)
 *side hip strenght*	Isotonic contraction, own body, with support and no coordination element	Isotonic contraction, external resistance, with support and no coordination element	Isotonic contraction, external resistance, no support and no coordination element	Isotonic contraction, external resistance, no support and coordination element
 *calf raises*	Feet hip width apart, hands supported and no element of coordination	Feet together, one hand free and no element of coordination	Feet together, hands free, with element of coordination and heels elevated	Perform the movement with just one leg

Table 18. Example of different levels of physical exercises adaptation (Baptista et al., 2023)

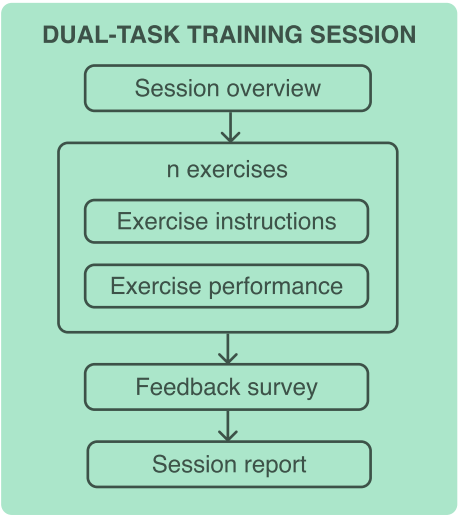


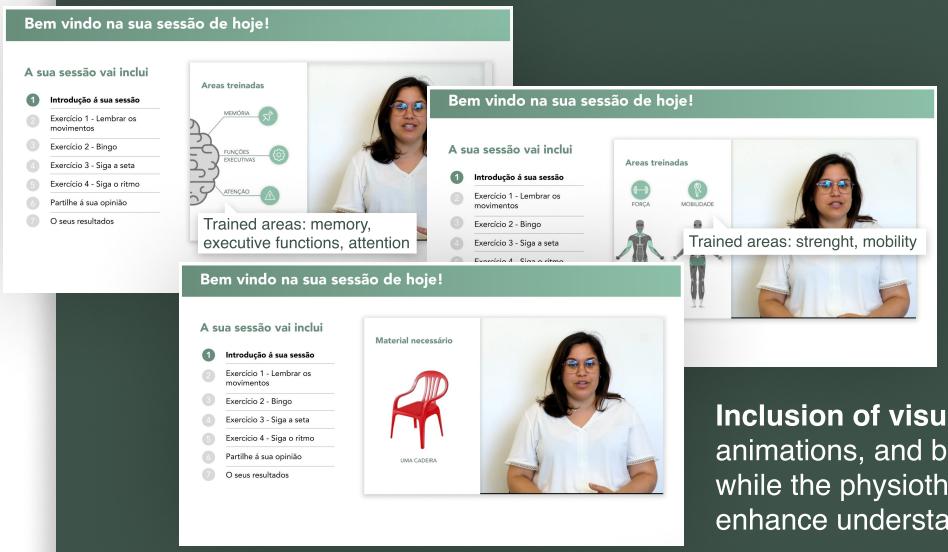
Figure 62. Dual-task training structure

Session overview
At the beginning of the session, an overview video provides patients with all necessary information about the upcoming exercises: exercises, duration, targeted physical and cognitive areas, benefits, and required materials. Figure 63 show screens from the final prototype of the introduction screen with the video.
In Appendix I the full prototype and script of the videos are available.

“This will help you to better manage your daily activities, such as remembering appointments or solving practical problems on your own, and will help you to feel more energised and less tired during the day.”

Quote from the video script

The person speaking is the patient’s **physiotherapist**: their presence helps build trust and professional credibility, making patients feel more comfortable and connected. This approach emphasizes the importance of the patient-professional relationship in motivating adherence.



Clear and straightforward language to ensure comprehension for every cognitive impairment levels.

Inclusion of visuals like images, animations, and brief texts that appear while the physiotherapist is speaking to enhance understanding.

Users at the end of the video can choose to **replay the video or proceed**.

Figure 63. Screens from the overview section from the final prototype.

"In this exercise, you're going to play bingo. On your screen, you'll have a table with numbers. The numbers that appear at the top and centre of the table will be called. If you have the called number, do first a squat and then jump. " - 'Bingo' script

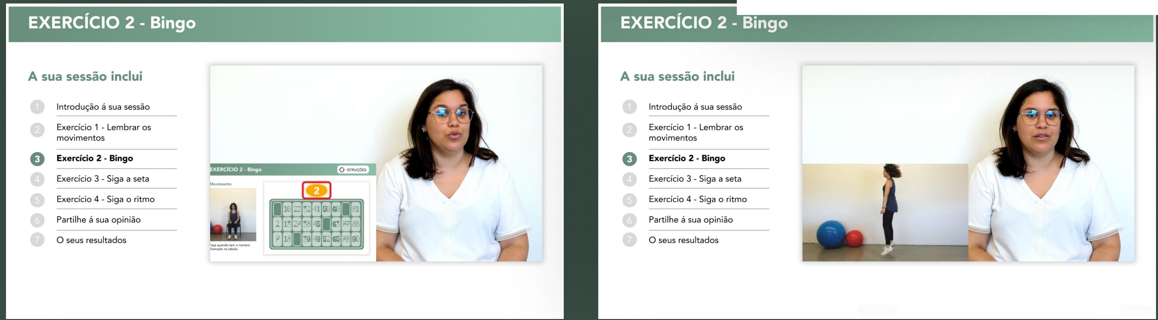


Figure 64. Screens fromt the instructional video of the exercise 'Bingo'.

"We repeat the first movement with the knees. Right leg, five seconds raised. Left leg, one, two, three, four, five. Then, with our arms relaxed at our sides, we make circular movements with our neck. Once clockwise and once anti-clockwise.
Repeat the previous movements. Press 'I'm done' when you finished."
- 'Remember the sequence' script

Figure 65. Screens fromt the interface of the exercise 'Remember the sequence'

Exercises
Following the introduction, the session begins with a series of exercises tailored to the patient's prescribed plan. Each exercise includes:

1. Instructional video: a video where the physiotherapist provides clear and concise instructions, demonstrating the screens the patient will see and the movements they need to perform. Each exercise has specific instructions detailed in the final evaluation chapter. Figure 64 shows examples of this video in the exercise 'Bingo'.
2. Exercise interface: an interface displaying a brief description of the task and the game console. The game progresses automatically, and patients can replay the instruction video by clicking the 'instructions' button. Figure 65 shows examples of the interface in the exercise 'Remember the sequence'.

Feedback survey
At the end of the session, patients are asked to provide feedback by clicking on emojis representing

their level of satisfaction (Figure 66). A video of the physiotherapist asks three questions:

1. How much did you enjoy the PE?
2. How much did you enjoy the cognitive games?
3. How easy was the session to complete?

This feedback method, resulting effective from iteration #1, is easy for patients to understand and helps gather information on adherence and exercise satisfaction for professionals. The collected feedback will assist professionals in adjusting the prescription.

Progress report

At the end of each session, patients see a page with their weekly results related to the activities performed and their adherence (Figure 67). This report updates automatically with each completed session and consists of three parts:

1. Adherence data: the patient's activity compared to their prescribed goal
2. Trained areas and exercise modalities: displays the areas trained and types of physical exercises performed.
3. Physiotherapist comment: includes a personal comment left by the physiotherapist including patient's strenghts and weaknesses

This report does not include performance data, as there is no system to track and gather such feedback. It relies only on the number of exercises completed.

8.2.6 Games

This section presents the four games designed and tested in the final evaluation. Each game includes a possible progression for both physical and cognitive levels. To stimulate motivation, engagement, and prevent boredom, the concept includes a variety of exercises, similar to how COGWEB is designed.

Remember the Sequence ('Lembrar a sequência')

In this game, users watch videos showing a sequence of movements, one at a time. Each subsequent video includes an additional movement from the previous one. After each video,

Figure 66. Screen fromt the feedback survey section from the final prototype.

"The session is over, we've made incredible progress today! Please share your opinion with us by clicking on the face that most represents how you felt. " - Feedback survey script

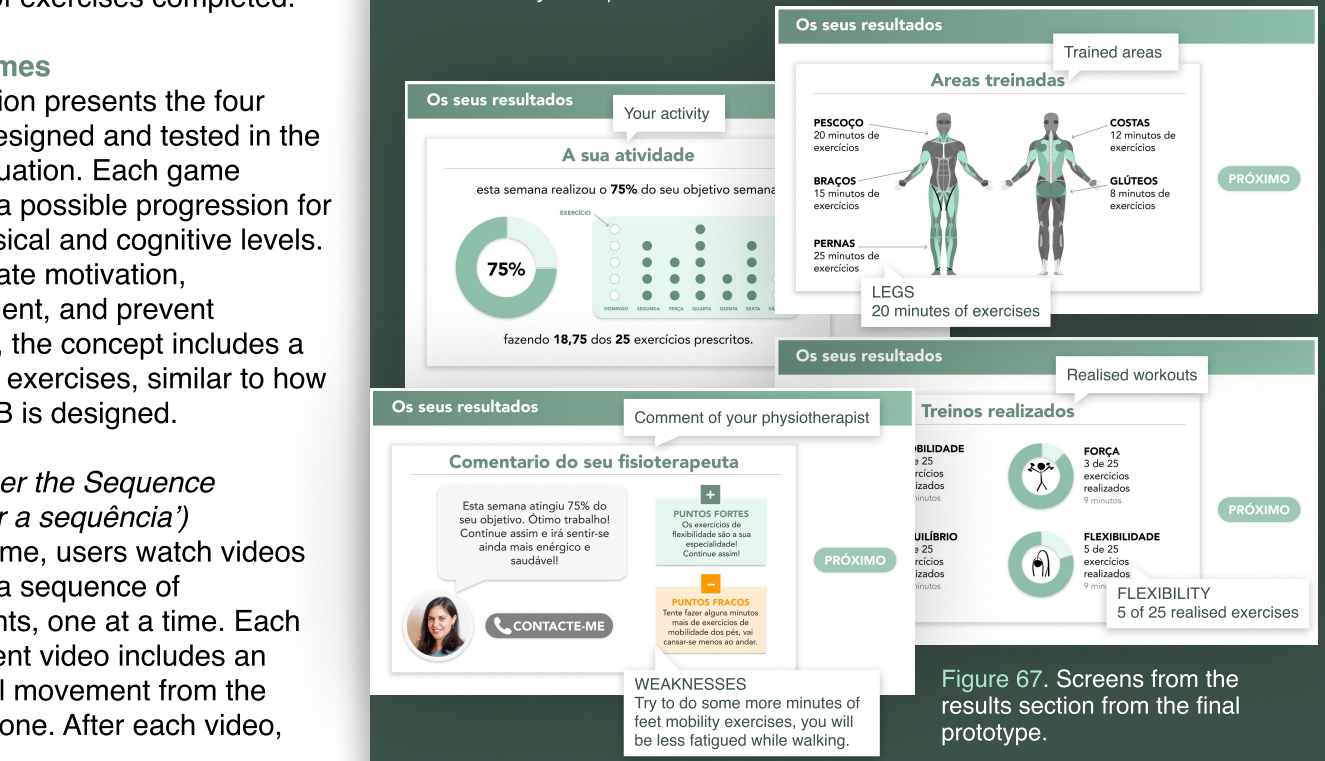


Figure 67. Screens from the results section from the final prototype.

Figure 68. Screens from the interface of the exercise ‘Remember the sequence’.

“First movement: let’s stand up. Raise your right knee to 90° and extend your leg as high as possible, keeping it straight. Hold for five seconds and lower it down. Let’s repeat it with the left leg.” - ‘Remember the sequence’ script

Each movement is explained with instructions on posture, movements, pace, and repetitions. On the 'it's your turn' (*'è a sua vez'*) screen, the user is prompted to repeat the previous movements. These two screens alternate as the number of movements to repeat increases.

Figure 69. Screens from the interface of the exercise ‘Bingo’.

“Two. Number two. Eighteen. One, eight.”
- ‘Bingo’ script

The movement is displayed through an animation on the left side of the table and repeats each time a new number is called. When the called number appears on the table, it is highlighted. This way, the user can see if their response was correct.

the user is asked to repeat the movements from memory. As the number of movements increases, it becomes more challenging to remember and perform them all.
Cognitive functions trained: memory.
Physical exercises: defined based on the prescription.
Example of progression and variation in difficulty:

- Increasing the number of movements to remember and repeat.
- Using movements related to the same body part, harder to remember.

Figure 68 shows screens from the game interface.

Bingo
In this game, the user plays bingo with a table displayed on the screen. At preset intervals, a number is called and shown at the top center of the table. If the user sees the called number in their table, they must perform the movement shown on the left side of the screen, as explained in the instruction video.
Cognitive functions trained: attention, processing speed, executive functions.
Physical exercises: a specific movement to be performed each time a number is called, based on the prescription.
Example of progression and variation in difficulty:

- Increasing the quantity of numbers in the table.
- Increasing the speed at which numbers are called.

Figure 69 shows screens from the game interface.

Follow the arrow
(‘Siga a seta’)
In this exercise, the user sees four arrows on the screen, each indicating a different movement. As the game progresses, one arrow lights up, and the user must perform the corresponding movement (Figure 70).
After the initial explanation, there is an additional video that demonstrates and explains each movement one by one (Figure 71).
Cognitive functions trained: attention, executive functions, processing speed.
Physical exercises: the four movements are repeated based on how often each arrow lights up, and they are adjusted according to the prescription.

Example of progression and variation in difficulty:

- Increasing the speed at which the arrows change.
- Associating non-intuitive movements with the arrows. For example, in an easier level, the right arrow may correspond to raising the right arm, and the left arrow to raising the left arm. As difficulty increases, these movements may be swapped or unrelated to the arrow's direction (e.g., right arrow, squat).
- Introducing a Go/NoGo task (Helmers, Young, & Pihl, 1995; Newman, Widom, & Nathan, 1985): a response inhibition exercise where the objective is to identify and respond to the "Go" stimuli as quickly as possible, while withdrawing from responding to the "NoGo" stimuli. In this case, if the arrow lights up green (NoGo) instead of yellow (Go), the user should not perform any movement (Figure 72).

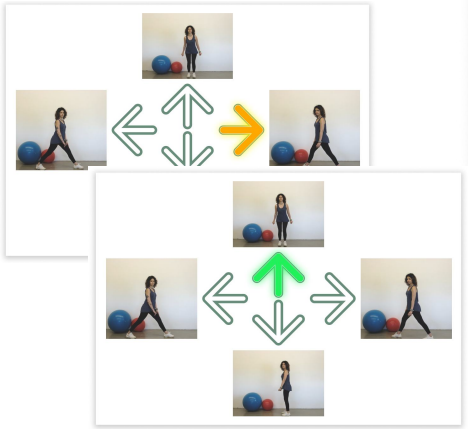
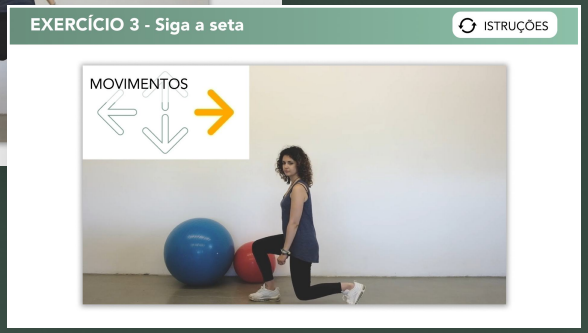


Figure 72. Example of progression introducing a Go/NoGo task (yellow=go; green=no go)

Follow the rhythm
('Siga o ritmo')
In this exercise, a piano plays a melody, and the keys light up in rhythm with the music. (Figure 73) The user has to follow the rhythm by tapping their feet: the right one when the keys on the right turn green, and the left one when the keys on the left turn red.
Cognitive functions trained: executive functions, processing speed.
Physical exercises: mobility, strength, and aerobic exercises targeting the leg muscles. They can be adjusted on the prescription and may include other movements, like clapping hands, as long as they can be performed

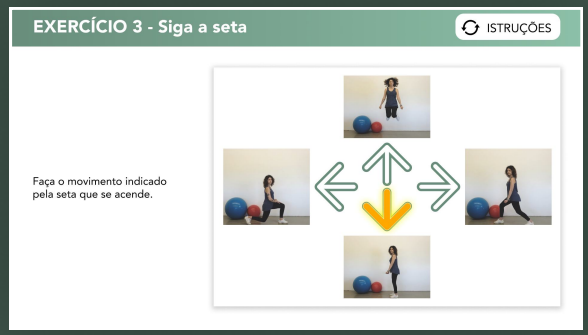
Figure 70. Screens from the interface of the exercise 'Follow the arrow'.



Before starting the exercise, there's an additional video that explains each movement associated with the arrows one by one, providing instructions on correct posture and execution.

"Let's stand up straight. When the arrow on the right lights up, step forwards with your right leg: bend both knees to 90 degrees, lightly touching the ground with your back knee and ensuring that your front knee is at ankle height. " - 'Follow the arrow' script

Figure 71. Screen from the interface of the exercise 'Follow the arrow'.



In each screen the movements are kept visible.

quickly in response to the rhythm. Example of progression and variation in difficulty:

- Using a faster, more challenging song.
- Introducing a Go/NoGo task, such as tapping feet when hearing the piano (Go) and clapping hands or doing nothing when hearing the drums (NoGo).

8.2.7 Additional possible exercises

The exercises presented were designed for the final evaluation, but the concept includes a continually expanding variety of exercises to be created and updated regularly. Examples of other possible games could be:

- *Equal or different* (attention): two images are displayed on the screen. If they are the same, the user performs Movement A; if different, Movement B. (Figure 74)
- *Story* (attention, language): a simple story is told. Each time a predetermined word is mentioned, the user performs a specific movement. (Figure 75)
- *Complete the figure* (attention, construction skills): a simple figure gradually appears on the screen. The user is asked to simulate drawing its outline by moving their arm in the air. (Figure 76)
- *Repeat the result* (calculus): math problems are shown. The user repeats a specified movement as many times as the result of the operation. For example, if the problem is 7 + 14, the user performs the movement 21 times. (Figure 77)

Another way to create exercises is to take those from COGWEB and modify them by adding a PE as an alternative response to clicking with the mouse and keyboard.

Figure 73. Screens from the interface of the exercise ‘Follow the rhythm.

The piano plays a well-known song to increase the user’s engagement, as resulting from iteration #2. The instructions with visual aids are kept visible during the whole exercise duration.

Figure 74. Example of how the exercise ‘Equal or different’ could appear.

Figure 75. Example of how the exercise ‘Story’ could appear.

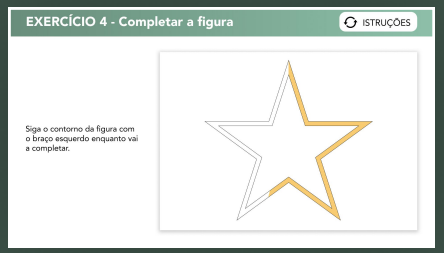


Figure 76. Example of how the exercise ‘Complete the figure’ could appear.

Figure 77. Example of how the exercise ‘Repeat the result’ could appear.

8.3 Personalization and long-term guidance

8.3.1 Personalization

Consigo is included in the context of COGWEB® as part of a program that involves a personalized prescription. This aspect surrounds the concept as a framework useful for professionals to structure the exercises program (Figure 78), and it is based on individual and environmental patient characteristics, taking inspiration from the Multi-component Approach (Lachman et al., 2018) and insights from the ideation activity of Chapter 6.1. Personalization is crucial for adherence and to allow patients to follow a journey that evolves from their initial abilities and needs, and aims for progressive improvement over time. In this framework, personalization applies to:

- Selection of the physiotherapist: the professional should be chosen according to the patient's preferences and needs. It is important that the physiotherapist's personality and approach are aligned with the patient to ensure a positive, trust-based relationship where the patient feels comfortable.
- Exercise program prescription: during the initial consultation, the physiotherapist must inquire about the patient's individual characteristics and needs, physical abilities, goals, routine, living environment, doing also appropriate measurements. Based on these, the physiotherapist should formulate a customized exercise plan to be periodically adjusted to ensure progression.

This framework serves as a guideline for professionals to adapt their medical decisions based on their expertise.

8.3.2 Long-term guidance

Another important aspect to consider when looking at Consigo in the context of the COGWEB® program is long-term guidance. This is a fundamental motivator for increasing PE adherence. The relationship with the physiotherapist is a key facilitator of adherence, relying on continuous and long-term support. Guidelines for professionals for ensuring long-term guidance are listed as follows.

- Periodic consultations: regular checks with the patient are essential. Patients should always feel supported and never alone. This can be achieved through periodic contacts or feedback forms to gather patient opinions on the program.
- Accessible physiotherapist contact: ensuring multiple, easily visible contact methods on the platform to reach their physiotherapist anytime.
- Regular progress feedback: informing patients about their progress and performance is fundamental for motivation. Providing cumulative periodic reports helps keeping track of progress.
- Periodic adjustments on the prescription: regular in-person consultations and program updates based on patients' progress are necessary for continuous improvements.

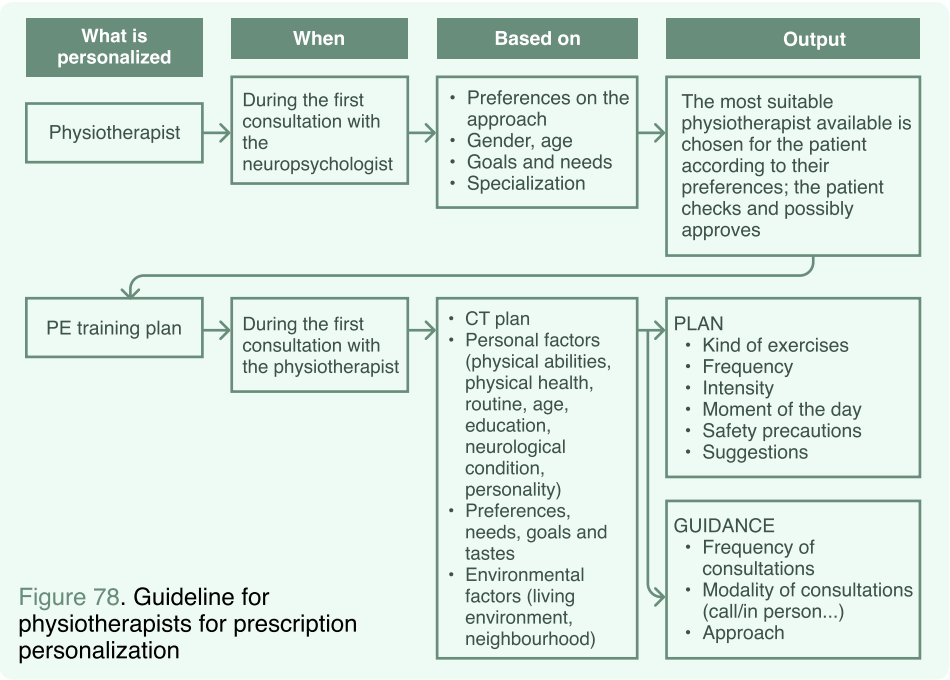


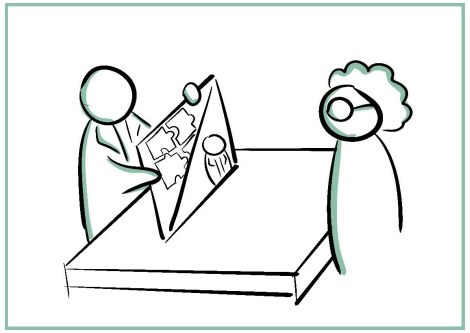
Figure 78. Guideline for physiotherapists for prescription personalization

8.4 Context of use

Figure 79 shows a storyboard describing a possible scenario where the concept is used the real-world context.

Figure 79. Storyboard of context of use scenario

1. The patient goes to a neuropsychological consultation after being adviced from her GP, as she starts suffering from some memory issues.

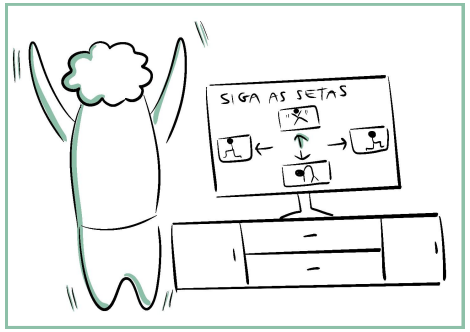


2. The neuropsychologist assess her and prescribes her some cognitive exercises targeted for her problems to do on a daily basis with COGWEB®. As the physiotherapy consultation is included in the plan, the neuropsychologist schedules an appointment with the professional that matches mostly with the preferences she expressed.

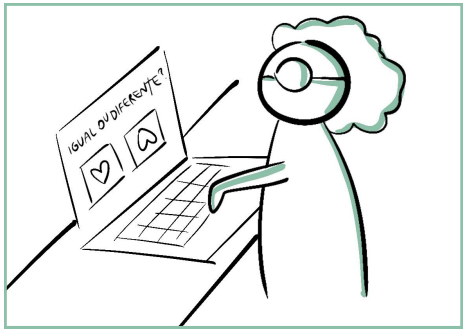
3. The patient goes to the appointment with the physiotherapist, who investigates on her routine, habits, needs, goals and preferences and do some physical assessment to determine her level of PA and any physical issue or pain. Then, he prescribes her some PE targeted to her situation, applying them to the cognitive exercises she has to do.

4. The combination with the PE prescribed by the physiotherapist and the cognitive exercises from the neurological prescription is done, and a personalized session is available.

5. Every day, after lunch time she starts her session, doing ten minutes of cognitive training with exercises for memory, executive functions and attention.



6. After ten minutes, the dual-task training session starts. To have more space available and read better, she connects her laptop to the television and performs the exercises.



7. After other ten minutes, she places the computer again on the desk and continues the final part of her cognitive training for other ten minutes.

8.5 Final evaluation

8.5.1 Goal

This test aims to evaluate the final concept offering a variety of exercises at two different difficulty levels, focusing on the two main elements of the intended interaction: engagement and guidance. The goal was to assess how engaging and understandable the exercises are. The research questions investigated in this final test were:

- Does the final concept reflect the envisioned interaction qualities (engaged, guided, trusting, in control, proud)?
- Does the final concept achieve the design goal (guidance and engagement)?
- Are the exercises clear to understand?
- Are the exercises fun and challenging enough to keep the user in the flow?
- Would a sedentary person be motivated to do these exercises at home?

8.5.2 Improvements from previous iteration

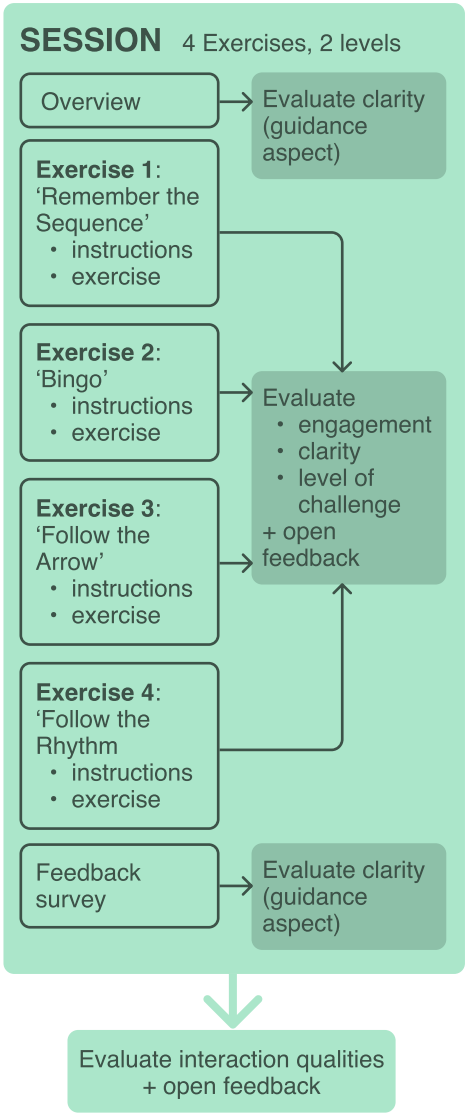
Based on the latest iteration, the final test integrated the following improvements:

- A prototype with a variety of dual-task exercises (cognitive challenges with physical responses) and four different games designed for the final design.
- Two levels of PE and cognitive challenges that participants could choose according to their skills and preferences, to provide a state of flow physiologically (effectiveness) and psychologically (attractiveness).
- Improved clarity of instructions:
  - Providing examples
  - Highlighting elements on the screen during explanations
  - Simplifying syntax and language
  - Simplifying tasks
  - Reminding users of tasks during exercise execution
- In the 'Remember the Sequence' exercise, the presentation of movements was simplified. Instead of showing one movement per video and requiring the user to remember the entire sequence, each video progressively increases the number of movements. The user only needs to repeat the movements shown in the most recent video. While the memory challenge remains the same, the task becomes easier to understand.

8.5.3 Set-Up

Participants tested the prototype described in Chapter 8.2, evaluating for each exercise the clarity, engagement, and level of challenge of each exercise, giving open feedback as well.
Specifically for the purpose of this test, the prorotype was adapted with two levels of cognitive and physical difficulties that participants could choose. The PE associated with the games were also designed for the test.
At the end of the test, they provided overall open feedback on the concept and assessed the interaction qualities.
Participants were also asked to think out loud while testing, and their actions were observed to get further insights on possible errors and behaviours.
Figure 80 shows the final evaluation set-up and Figure 81 shows images of participants performing the test.

Figure 80. Final evaluation set-up



8.5.4 Participants

Four participants from the Portuguese community, ranging from 51 and 74 years old, with moderate or low levels of PA tested the final prototype. One of them was a COGWEB® user affected by brain injury. Their demographics are shown in Table 19.

8.5.5 Levels

For the study, two levels of difficulty were designed: cognitively and physically medium-low, or medium-high. This allowed participants to select the appropriate level of challenge for their skills to be in a state of flow. The approach was to give them the possibility of choosing between two combined level as assessing each participant's cognitive and physical levels in advance was not possible, and asking them to choose separate difficulty levels for physical and cognitive tasks would have been too complex, particularly for those with cognitive impairments. Table 20 shows how the levels were applied for each exercise.

8.5.6 Quantitative results

The quantitative results were obtained from assessments using a Likert scale ranging from 1 to 5 for the following factors:

- Interaction qualities of the concept as experienced by participants

Participant	Age	Gender	Nationality	Physical health condition	Cognitive impairment	PA level
P1	74	F	Portuguese	Healthy	Healthy	Moderate PA
P2	51	M	Portuguese	Healthy	Healthy	No/little PA
P3 COGWEB® user	63	F	Portuguese	Healthy	Brain injury	Moderate PA
P4	58	F	Portuguese	Back pain	Healthy	Moderate PA

Table 19. Generative session participants' demographic overview

*The exercises are decided together with the physiotherapists in the research team.

		Physical exercise	Cognitive task
EXERCISE 1 Remember the Sequence	Medium-low difficulty	• Mobility and strenght exercise of low intensity to perform on a chair • Three movements to perform *	Three movements to remember
	Medium-high difficulty	• Mobility, strenght and aerobic exercises of medium-high intensity to perform standing up • Five movements to perform *	Five movements to remember
EXERCISE 2 Bingo	Medium-low difficulty	Stand up and then sit on a chair	• Fewer numbers on the table • Slower pace
	Medium-high difficulty	Squat and jump	• More numbers on the table • Faster pace
EXERCISE 3 Follow the arrow	Medium-low difficulty	Mobility exercises of low intensity	Slower pace
	Medium-high difficulty	Strenght and aerobic exercises of medium-high intensity *	Faster pace
EXERCISE 4 Follow the rhythm	Medium-low difficulty	Tapping the feet, slower movements to a slower rhythm	Song with slower rhythm ('Bella Ciao')
	Medium-high difficulty	Tapping the feet, rapid movements to a rapid rhythm *	Song with rapid rhythm ('YMCA')

Table 20. Difficulty levels applied for each exercise

- For each exercise, engagement, challenge and clarity

Table 21 explains the meanings attributed to the scores.
Figure 82 and 83 show the average scores given by participants to the aforementioned factors.

8.6.7 Insights and conclusions

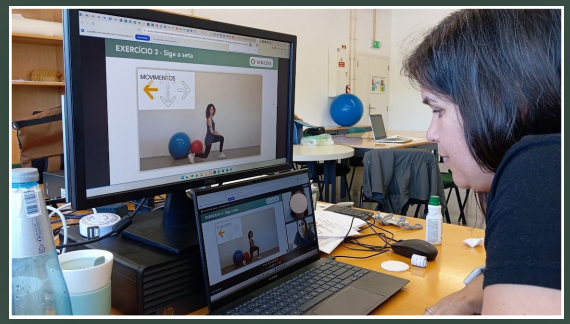
The final test revealed that participants had a generally positive experience with the Consigo concept, which successfully combined physical exercises with cognitive tasks. The instructions, both before and during the exercises, were clear enough to guide users effectively, although some initial confusion led to mistakes. However, participants were able to correct these errors by reviewing the instructions or during the exercise itself. The integration of physical and cognitive challenges was particularly well-received, as it engaged participants in a 'flow' state where the difficulty level

	I.Q.	Engagement	Challenge	Clarity
1	The feeling was not experienced at all	The exercise was perceived as boring and not engaging at all	The exercise was too easy for their cognitive and/or physical skills, resulting in boredom (according to the 'flow' theory)	The instructions were confusing, and participants did not know what to do during the exercise
5	The feeling was not experienced a lot	The exercise was found to be very engaging, entertaining, and enjoyable.	The exercise was too difficult for their cognitive and/or physical skills, causing anxiety (according to the 'flow' theory).	The instructions were perfectly understood, and participants were confident about what to do

Table 21. Meanings attributed to the scores of the Likert scale

Figure 81. Pictures from the final evaluation test

"At the beginning I didn't understand that I had to stand up only when I have the called number, but I wasn't paying attention. After listening to the instructions for the second time, it was completely clear." - P4, talking about 'Bingo'



"I think it is more entertaining to have the possibility to answer with a movement rather than clicking with the mouse." - P3

"It's challenging because the level of difficulty increase while the exercise progress, adding more and more movements." - P1, talking about 'Remember the Sequence'

matched their skills, making them eager to continue. The presence of a physiotherapist in the video further enhanced the sense of guidance, trust, and credibility. Some usability issues were identified, such as unclear animations and repetitive movements in specific exercises, but these did not significantly detract from the overall positive feedback. The concept showed promise, especially for sedentary users who might be motivated by the cognitive tasks, and for COGWEB® users who could find the physical responses an engaging alternative to traditional methods. These insights suggest that the final design effectively reflects the intended interaction qualities and provides a dual challenge that could make PE more appealing to a broader audience.

The evaluation form, insights and full results from each participants can be found in Appendix L. Chapter 9 will provide deeper reflections and conclusions related to the final design.

"I hate doing physical exercises. But I like this ones because I don't think about them as I am focused on the games." - P2

"I'd love if this was implemented into COGWEB®. I'd feel even prouder to complete the sessions if I am also improving my physical abilities besides the cognitive ones." - P3

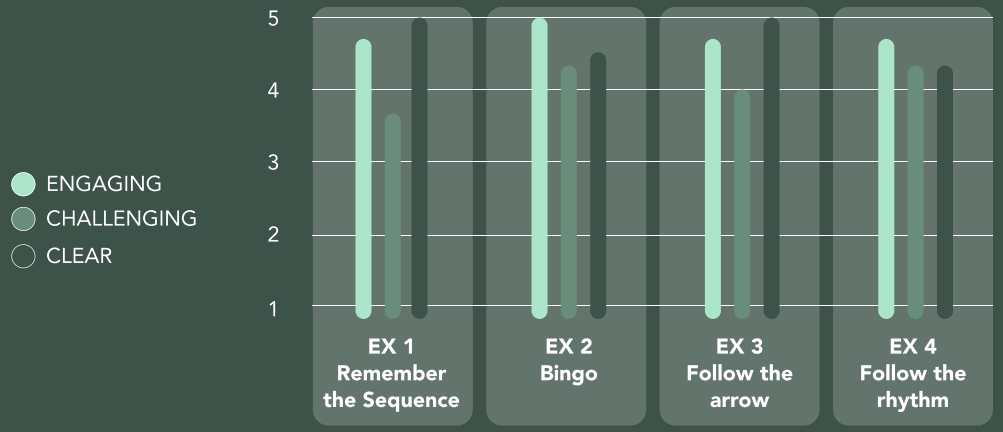


FIgure 82. Bar chart representing the average participants' score for each exercise considering engagement, challenge and clarity factors.

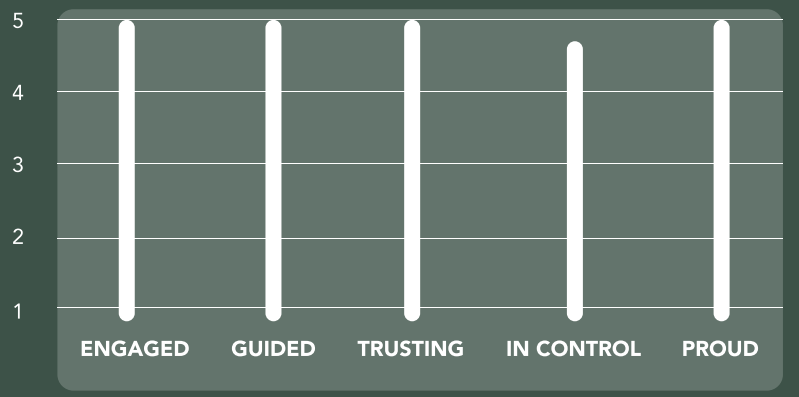


Figure 83. Bar chart representing the average participants' score given to the interaction qualities.

8.6 Implementation

If Neuroinova chooses to integrate Consigo into their COGWEB® product, here are some considerations the company should take into account to develop it and make it available to users.

1. Establish a network of physiotherapists who collaborate with Neuroinova who can supervise the PE program within COGWEB®. Create a comprehensive database detailing their characteristics, expertise, and availability. This ensures that users receive personalized and professional guidance aligned with their specific needs and conditions.
2. Develop a protocol or algorithm that matches each physiotherapist with a patient's needs based on personalization criteria outlined in Chapter 8.3, to ensure a guidance tailored for every patient with an automated system.
3. Record instructional videos for each exercise from the physiotherapists. Since the instructions for games and those for movements are separate and combinations may vary according to the prescription, record these videos separately. This modular approach allows for flexible and personalized exercise plans that can be easily adapted and updated as needed.
4. Automatize the combination of PE and CT: implement an automated system that combines PE with cognitive exercises according to the prescription. This integration should consider the combination of the cognitive training prescription with the dual task prescription, and the combination of PE with the cognitive tasks within the dual-task training.
5. Refinement in design and video production: assign a dedicated person or team to refine the design and produce the videos.
6. Design progress reports and automatize the data storage: design progress reports of users' activity and progress over time. Implement a system that automatize the generation of these data for each patient.
7. Conduct tests with users to evaluate the effectiveness, usability, and engagement of the dual-task component. Gather feedback to identify any issues or areas for improvement, and make necessary adjustments based on this input.
8. Design and provide a variety of exercises to address different user preferences, abilities and goals, as well as tailored for each cognitive function to train. This variety helps maintain user interest and motivation, ensuring they remain engaged in the long-term.

9. Discussion

In this final chapter, the project outcome and process are discussed and reflected upon, and recommendations for future improvements and research are provided.

9.1 Reflection on final design

9.1.1 Design goal

The design goal of the project was to motivate older adults following the COGWEB® training to adhere to a prescribed PE session tailored to individual and environmental factors, providing clear and structured guidance along with engaging and enjoyable activities.

Guidance and engagement

According to the tests' results and feedback, the goal of providing clear guidance and engaging activities was successfully achieved. Participants responded positively to the activities, finding them engaging and the instructions easy to follow. This suggests that, within the confines of the session, the design was effective in meeting its objectives. However, it is important to note that these observations were made over a short period. To fully assess whether the design goal is sustained over the long term, further observation and testing over an extended period are necessary. Long-term adherence and engagement are critical factors that can only be validated through continued monitoring.

Personalization of the prescription

The aspect of the design goal related to personalization was not fully testable in this initial phase. While participants could choose between different levels of difficulty, the full customization potential of the program was not evaluated. This aspect relies heavily on the developed guidelines and how professionals choose to apply them. Since the approach is based on existing models and aligns with current professional practices, there is a reasonable assumption that it will work effectively.

9.1.2 Intended interaction

In this chapter, the interaction vision (Chapter 5.5) was defined as a complement to the design goal, specifying the qualities the concept should embody in its interaction with users. These qualities were assessed throughout the iterative testing process and the final evaluation, bringing to the following reflections:

- Guided: this quality, one of the main goals, was pursued by ensuring clarity in presenting information and instructions through language, multimedia, step-by-step guides, and examples. The presence of a physiotherapist in the videos and the personalized approach aimed to provide a sense of proximity and trustworthy guidance. This quality received very high ratings in the final evaluation, indicating it was successfully achieved.
- Engaged: the design focused on creating various exercise games and evaluating how engaging and challenging participants found them relative to their cognitive and physical abilities. Feedback was promising, with positive results, though further improvements could be made by adding more games and ensuring that difficulty levels are better personalized to individual needs.
- Proud: this quality involved users feeling satisfied with their progress and confident in completing the exercises. However, it was difficult to assess since participants didn't have real progress or results to base their feedback on, as the exercises were designed primarily to evaluate the concept. The progress report from Iteration #1 was well-received, with participants indicating it would motivate them to continue and serve as positive reinforcement.
- In control: this quality referred to users feeling they could manage the exercises with the right level of challenge. While participants generally felt confident, the exercises were often too easy for their skill levels. However, when two levels of difficulty were provided in the final test, this quality was positively evaluated.
- Trusting: this quality was cultivated by making the physiotherapist appear reliable and credible through clear and comprehensive information about the exercises and their benefits. The presence of a familiar person in the videos, who participants had worked with before, contributed to a positive sense of trust.

Overall, participants rated the interaction qualities very highly in

the final evaluation, with all scores above 4.75. It can be concluded that the design goal was likely achieved within the scope of the exercise session, though some variables may need to be adjusted to ensure more reliable results.

9.1.3 Link to initial brief and research gap

The ACTIVAS Project aimed to enhance PA levels among older adults by integrating a remote, personalized PE program with Neuroinova's COGWEB® cognitive training. To achieve this, the project needed to explore factors affecting adherence to the program and develop a concept that utilizes motivational factors. Existing theoretical models and practical interventions were analysed, providing useful insights, but were often too broad for the specific context of older adults with cognitive impairments in Portugal, or demonstrated positive health outcomes, but lacked information on user adherence.
To address this gap, on-field research involved participants with characteristics matching the target group, although not all phases included this specific sample. The research underscored the importance of professional guidance and engaging exercises to boost participation. Due to project constraints, the focus shifted from ensuring long-term adherence to motivating users for individual sessions. Despite promising final evaluation results, further research is needed to determine if long-term adherence can be achieved in real-world settings, with actual prescriptions and ongoing monitoring, to fully meet the overall ACTIVAS' objectives.

9.1.4 Considerations on the impact of the project

The engagement and guidance provided by the platform are key factors in motivating users to complete the sessions. While the long-term effects were not tested, the positive user experience has the potential to impact their PA levels and encourage continued participation in the program. Designing a program that ensures this positive experience and fosters a desire to keep following it, is crucial for achieving the desired improvements in cognitive and physical health. This could lead to significant benefits, reduced healthcare costs and greater independence for older adults, contributing to healthier and active ageing.

9.1.5 Considerations of the impact on the company

Neuroinova, a company already recognized for its significant achievements in scientific research and in delaying cognitive decline among its users, has the potential to further contribute to the healthcare system. The Consigo component offers an advantage by incorporating cognitive tasks in a format similar to COGWEB®, leveraging the company's expertise in designing effective exercises. This familiarity not only strengthens their position in the market but also allows them to continue innovating in this area. Moreover, their collaboration with physiotherapists and researchers presents opportunities to extend medical benefits beyond their current focus.
Additionally, incorporating a dual-task component, as suggested by a COGWEB user, would enhance engagement by providing a more dynamic and interesting way to respond to tasks, further increasing their involvement in the training. Finally, Neuroinova aims to act on risk factors for cognitive health, and physical inactivity is one of the most common yet changeable risk factor. This work was a contribution towards that big goal.

9.1.6 Considerations on technology and digital literacy

Despite the promising results and the potentialities this concept offers, its usability is limited to a segment of users with sufficient digital literacy to navigate the platform independently. Other users may require constant support from caregivers to participate in the sessions, which compromises their independence. Those without access to such support may be excluded entirely. This project leveraged Neuroinova's existing technologies and expertise, as well as the significant advantages of ICT in terms of accessibility and flexibility, but the exclusion of this user

segment remains a limitation in making the project's potential benefits universally accessible.

9.1.7 Considerations on cognitive impairments

As discussed in Chapter 2.3, a combined approach of physical and cognitive exercises shows promising results for cognitive health, offering greater benefits than cognitive training alone. For the target group, this approach may help prevent, delay, and reduce symptoms of cognitive decline. However, individuals with more severe conditions may not be able to use the platform independently. They would require external assistance from caregivers or further adaptations to the program, possibly necessitating in-person sessions with a professional.

9.1.8 Considerations on feasibility, desirability and viability

Feasibility

The project demonstrates its feasibility given Neuroinova's existing resources, expertise, and technology. Collaborating with a network of physiotherapists to oversee the PE program within COGWEB® is a realistic goal, leveraging the company's established professional connections. While the technical aspects, such as developing a modular system for exercise videos and cognitive games, as well as an algorithm for matching patients with physiotherapists, are challenging, they are achievable with a dedicated team. Video production, in particular, will require considerable time and effort; however, this effort will be concentrated mainly in the initial stages, after which the videos can be combined according to personalized prescriptions through automation. Addressing this aspect is crucial for introducing a novel approach to therapy that could significantly impact the field of digital health. More practical recommendations for a feasible implementation into Neuroinova's products are detailed in Chapter 8.7.

Desirability

The project addresses a clear need for personalized, engaging physical and cognitive training for older adults, particularly those at risk of cognitive decline. The design's focus on user engagement, personalized guidance, and a variety of exercises aligns well with the desires of the target demographic, as reflected in positive user feedback during testing. However, ensuring long-term desirability will depend on the project's ability to keep users motivated through continued adaptation and the integration of user feedback, crucial for promoting active and healthy aging.

Viability

The project shows potential for long-term viability by leveraging Neuroinova's established reputation. Expanding COGWEB® to include dual-task training not only expands the company's products but also positions it to attract a broader user audience. The involvement of physiotherapists adds value and credibility, likely increasing user adoption. However, challenges such as the manual adjustments in prescriptions and video production could raise operational costs, potentially affecting profitability. To ensure sustained success, streamlining these processes will be essential. The project aligns well with ethical and social standards, emphasizing personalized care and user engagement, and its adaptable design is poised to meet the evolving needs of its audience. While further exploration is needed for long-term effects, the project could potentially become a sustainable and impactful solution in the digital health field.

9.1.9 Design strenghts & weaknesses

Strenghts

- Users are familiar with the cognitive task feature integrated into the PE as it is the same present in COGWEB®. This reduces the initial motivation needed and seamlessly incorporates the activity into their existing routines.
- User engagement: the concept resulted being engaging and keeps the user in the flow providing them the right level of

- challenge to motivate them keep using it, an important motivational factor.
- Guidance: significant effort and testing have gone into optimizing the instructions, ensuring users receive clear and effective guidance.
- Simultaneous cognitive and physical training: the combined cognitive and physical exercises resulted more engaging in the exergaming format compared with the sequential format that was initially expected for ACTIVAS.
- Sedentary individuals might be encouraged to start PE as they are entertained by the games and less focused on the physical effort.
- COGWEB® users can enjoy the PE as they introduce novelty and variety to their usual interaction with the platform, thereby increasing engagement.

Weaknesses

- There is no current method to track user performance, which limits the ability to provide adequate immediate feedback and track their real progress.
- Manual adjustment of prescriptions: without automated tracking, exercise prescriptions must be manually adjusted during consultations with physiotherapists. This might limit the effectiveness of the program, as there is no way to actually observe and assess how they perform each exercise and if they regularly follow the plan. Moreover, this increases the amount of work needed by the professionals and time spent to adapt the prescription over time, requiring continuous and constant appointments and manual readaptations.
- Video production challenges: the concept requires to record a wide variety of videos, including the ones for games instructions, and those for each movement. Recording and producing them requires significant work to spend on it.
- Automatization and combination challenges: each personalized prescription involves a unique combination of cognitive exercises from COGWEB® and dual-task training exercises from ACTIVAS. The dual-task exercises themselves are a blend of cognitive task games and physical exercises. Although these exercises are recorded and designed in a modular way to facilitate effective combinations based on individual prescriptions, it remains a challenge to minimize the manual effort required and to incorporate automation efficiently.

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9.2 Reflection on research and design process

9.2.1 Considerations on study settings

Collaborating with the University of Aveiro provided a valuable environment for organizing research activities and accessing participants. The university's resources and the familiarity of participants with the location and research team created a comfortable and relaxed atmosphere, which encouraged open feedback. However, this familiarity might have biased the participants' responses, as they could have been inclined to provide positive feedback to please the researchers. Additionally, the study faced challenges in recruiting sedentary participants, as those more active and interested in new activities were more likely to participate. This limitation suggests that studying the adherence of COGWEB® sedentary users, if this component was implemented, could yield further insights.

9.2.2 Considerations on working along with the research team

Collaborating with the research team was crucial for the project's success. Their expertise provided essential resources and knowledge, particularly in designing appropriate and feasible PE and applying their insights throughout the project. Working closely with Ana, a gerontologist and usability studies expert, was an invaluable learning experience. Observing her interactions with participants and benefiting from her guidance significantly impacted my development. The research team's support allowed me to learn and apply their expertise on physiotherapy to the project more effectively.

9.2.3 Considerations on the company

Working with a company offered access to resources that would have been difficult to obtain autonomously. The ability to consult with experts, frequently interact with them, and utilize their products allowed for the development of realistic solutions. Collaborating with an established company enriched the project's complexity and depth, providing a professional growth opportunity that would have been challenging to achieve otherwise.

9.2.4 Considerations on the language

Language barriers posed a significant challenge throughout the project. Since most participants spoke only Portuguese, Ana's assistance was needed to moderate research activities. My ability to conduct sessions independently was limited to interactions with English-speaking or Italian participants. Although this situation restricted my autonomy, it was also a learning opportunity. Over the four months in Portugal, I made substantial progress in learning Portuguese, eventually understanding almost everything in conversation and engaging in simple and basic dialogues. This progress meant that I became completely aware of what the participants were saying and could intervene or ask questions when I felt it was needed. This language challenge, though difficult, was one of the most stimulating aspects of the project.

9.2.5 Considerations on technological constraints

The project faced technological limitations, particularly the inability to integrate sensors or webcams for real-time movement tracking and feedback. This constraint was a challenge, as real-time feedback is a significant motivator for long-term engagement. To overcome this, a system was developed that still provided guidance and interaction in an engaging way, despite the lack of direct feedback on progress. A feedback survey system was also implemented to gather participants' opinions, along with a progress report based on adherence, which, while not ideal, was better than having no feedback at all.

9.2.6 Tests limitations

The study presented some limitations that affected the overall assessment of the concept. First, the concept was not tested with a real prescription, making it difficult to determine the appropriate level of challenge for participants' skills. Additionally, the concept was not evaluated in actual COGWEB® sessions, which limited the assessment of its true applicability and effectiveness in a real-world setting. Finally, the testing was conducted over a short term, preventing the evaluation of long

9.3 Future recommendations

term effects and the role of the physiotherapist in ongoing guidance and personalization, leaving these aspects open for future investigation.

9.3.1 For the design improvement

Some recommendations for future design improvement could be:

- Integrate real-time feedback: incorporate sensors or webcams to track user movements and performances during exercises. Real-time feedback based on user input can help them to perform the exercises correctly and stay motivated. This addition could significantly improve both accuracy and engagement.
- Automatize videos-cognitive games-PE combination: simplify the process of adapting and randomizing exercise videos based on personalized prescriptions. Automation will reduce the time and effort required for manual adjustments. This efficiency will allow for more seamless and tailored user experiences.
- Provide a wider variety of exercises: continue developing new exercises to cater to different user preferences and abilities. A varied selection ensures user motivation and engagement over time.
- Explore gamification: consider integrating gamification elements like rewards, challenges, or levels into the exercises. This approach might make them more fun and engaging, increasing long-term participation and satisfaction.

9.3.2 For future research

- Test the long-term effect: compare long-term adherence and outcomes between COGWEB® users with and without the dual-task component. This study would provide insights into the component's effectiveness.
- Test the effectiveness of user adherence in a real-world setting: test the efficacy of user adherence in a real-world setting when personalized prescriptions and long-term guidance are involved. The design should be tested in a setting where a real prescription is made based on individual assessment and where the user has a continuous relationship with their physiotherapist. To assess those effects, it would be necessary to get periodic feedback from COGWEB® patients and monitor their adherence, if Neuroinova decides to adopt this system.
- Compare with other interventions: compare Consigo with other cognitive and physical intervention programs to identify the most effective strategies for user adherence and health outcomes. Understanding these differences can guide future development efforts.
- Assess impact on prevention or cognitive decline delay: investigate whether Consigo can help delay cognitive decline and maintain physical function. A randomized controlled trial (RCT) comparing different user groups (with Consigo, without PE component, without CT component) could reveal the most promising strategy to get those health outcomes.

9.4 Personal reflection and conclusion

Before starting my academic journey in design, I enrolled in a Psychology faculty but quit the studies after one semester, thinking I had made the wrong choice and bringing me to choose what I thought it was ‘the right path’: a bachelor in Industrial Design. However, during my bachelor, I realized how much I enjoyed user research and the concept of putting the user at the center of the design process, considering with particular regard their psychological, cognitive and emotional aspects when shaping solutions. This inclination led me to pursue a master’s degree in Design for Interaction.

As I progressed through my master’s program, I saw how psychology and design are closely connected. This helped me combine my interests in psychology, the human mind and cognition with my design approach, realizing that I didn’t make a mistake by studying psychology and that I was connecting different little pieces left behind of who I am and what I like, shaping my personal approach to design.

I’ve always felt that design perfectly reflects the way I am. On one side, I’m drawn to the logical and systematic aspects of research, where I enjoy analyzing and understanding situations to find answers. On the other side, I embrace the fuzziness of the ideation part where I can use my intuition and my chaotic creativity to turn ideas into solutions that can make sense of what I found during research.

I chose to specialize in Medisign because I find purpose in designing to improve disadvantaged conditions where help is truly needed to create some impact, and healthcare is for sure a field where progresses of this kind are necessary.

Working on this project with a company that values research and puts medical progress over profit has been incredibly fulfilling. It has given me a sense of purpose and pride as I contributed to something I truly believe and admire. Working with such a respected company was a great learning experience. I gained a lot from their expertise, and the collaboration kept me excited and enthusiastic every day.

There were also challenges and moments of doubt throughout this project. At times, I struggled to find direction or bring order to my work, but thanks to the positive and insightful guidance from my supervisors and the research team, I managed these difficulties with confidence, never loosing my enthusiasm. I am extremely grateful for their guidance, which remained unwavering throughout the whole project and allowed me to follow my work style in a free and relaxed way.

I’m fully aware of the luck to have found a field I’m passionate about and to have worked on a project with such engagement. The months of research for a graduation project and outreach, although exhausting, were definitely worth it, and I’m thankful for the opportunity to work on a project that matched my goals so well.

Overall, I’m proud of the results achieved and I will always treasure the time spent working on this project.

While there’s always room for improvement and this is just the beginning, I hope that my contribution will be a step to help improve someone’s life and bring benefits.

If you’ve made it this far, thank you for reading my thesis, it is really meaningful for me.

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11. Appendices

A. Generative sessions materials

Generative sessions – Elderlies from Portuguese community (never used CogWeb)

Introduction

- Introduce myself
- Introduce the project
- Explain the activity:
  - Duration (around 1h)
  - I'm going to ask you to do some activities that I'll explain step-by-step. Each activity will be followed by some questions about your routine, your preferences and your opinions.
  - Goal
- If you want you can take a break anytime
- Your participation is voluntary, if you want to leave you can do it
- The session will be recorded with audio and some pictures will be taken (they won't show your face), the data will be used for..., the names anonimized, faces blurred, everything destroyed at the end
- Give / read consent form
- Do you have any question?

PART I

Goal: have insights on routines, tastes and preferences, attitude and opinions towards physical activity and technology

Creating a routine timeline

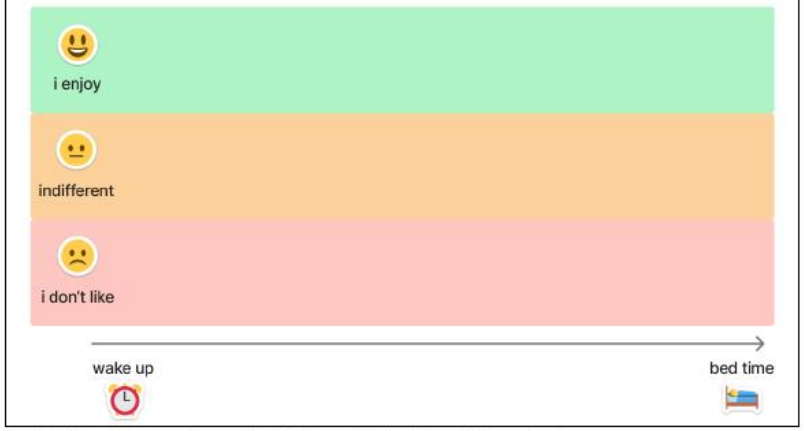
15 min

Hand in the paper with the activity, the pre-cut set of images and the other materials.

The first activity consists of representing your daily routine in this timeline, from the moment when you wake up to when you go to bed. You have a set of images with different activities from which you can choose and place them in the timeline (*show them and name some of them*). You have also to place them in these three different stripes according to how much you like those activities: if you enjoy them, place them in the green stripe. If you have no opinions, they are indifferent to you, place them in the orange stripe. If you don't like to do them, place them in the red stripe. If you have questions in any moment, I'm here to help and explain.
Describe how is your routine while you make it.

a) Paper that they have to fill in

1. How is my **daily routine**? Show us your actions placing the pictures in the timeline.



b) Set of images (pre-cut) with the activities they will have to place

Follow-up questions:

10 min

Pointing at the interesting images in the pictures, also while talking about point 1. Referring particularly to images representing physical activity and technology.

1. Why do you do this activity?
2. What do you like/don't like about this activity?
3. Looking at the **pictures you didn't choose**, is there something that you like?
   a. How often do you do it?
      i. 'never' -> why?

ii. ‘sometimes/more than never’ -> what do you like about this activity?

Physical activity

10 min

Now we are going to talk about physical activity, always starting with your daily routine.

Looking at the timeline they created in the previous activity

- If there are images representing physical activity:

1. Why do you do this activity?
2. What do you like/don’t like about it?
3. Do you do some other physical activity?
    a. ‘no’ -> why?
        i. would you like to do more?
        ii. what is your goal?
    b. ‘yes’ -> can you describe what you do and when?
        i. would you like to do more?
        ii. what is your goal?

- If there are no images representing physical activity; and we didn’t discuss about it in the follow-up questions:

1. Do you do physical activity?
    a. ‘no’ -> why?
        i. would you like to do more?
        ii. what is your goal?
    b. ‘yes’ -> can you describe what you do and when?
        i. would you like to do more?
        ii. what is your goal?

Remote physical activity

5 min

Show them on a laptop a video of a person doing physical exercises in front of a computer.

Can you look at this video and describe it?

1. What do you think about it?
2. Would you do it?
    a. ‘yes’ -> why?
    b. ‘no’ -> why?
        i. What would convince you to do it?

a) Video

Video of myself doing a physical exercise in front of a laptop, following a video

PART II

Goal: understanding how they envision the ideal relationship with their health practitioners: if they are followed by a physical therapist, specifically with them.

Creating a collage

10 min

Now, I’ll give you a white paper, and another set of images, words and smileys. What I ask you is to represent how you envision your ideal relationship with your *doctor/physical therapist*, making a collage. (*Think about a specific doctor that follows you, if it’s easier for you*). How would you like it to be? You are free to use the materials in any way you want, no rules. Follow just the thoughts you have, there’s not a right way to do it. You can also draw, write, make arrows and connections.

Hand in the white paper (a), the set of images (b), and the materials to make the collage.

a) White paper

My ideal relationship with my doctor

b) Set of images

Follow-up questions

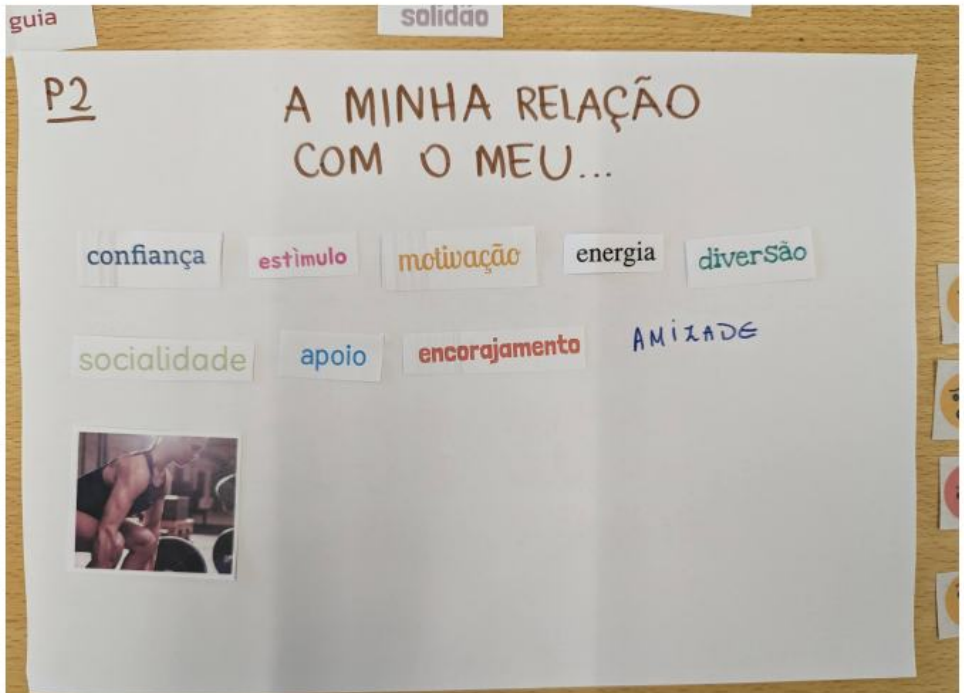
10 min

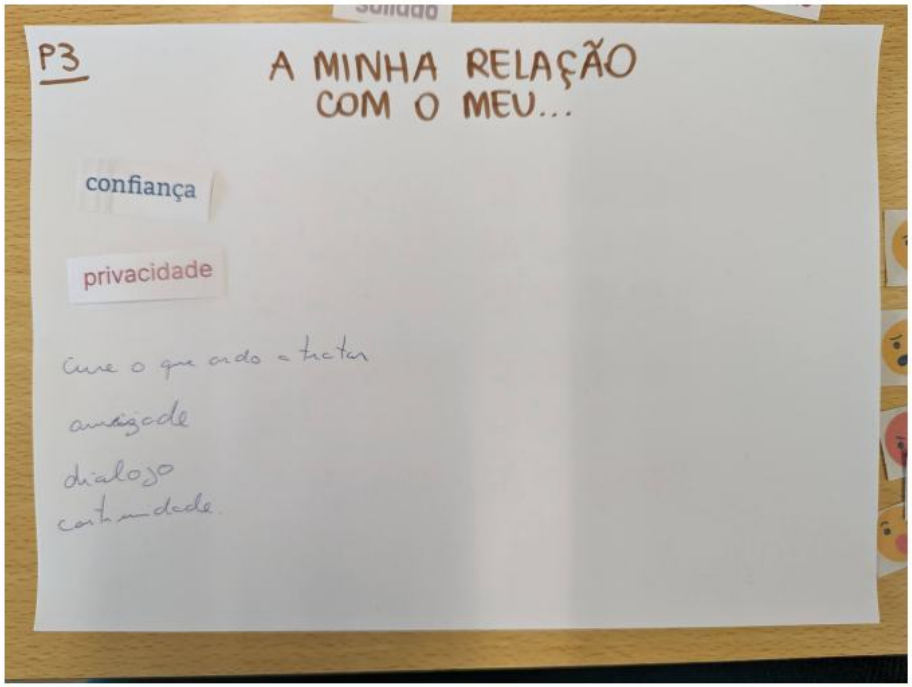
1. Can you describe what you created, explaining your process of thoughts? // *Possibly ask to think out loud while making the collage*

The next questions will be based on the participant's answers. Try to understand their deeper needs and expectations towards their ideal relationship, their fears and concerns. Try also to understand how this relationship could be obtained if the case of a remote platform.

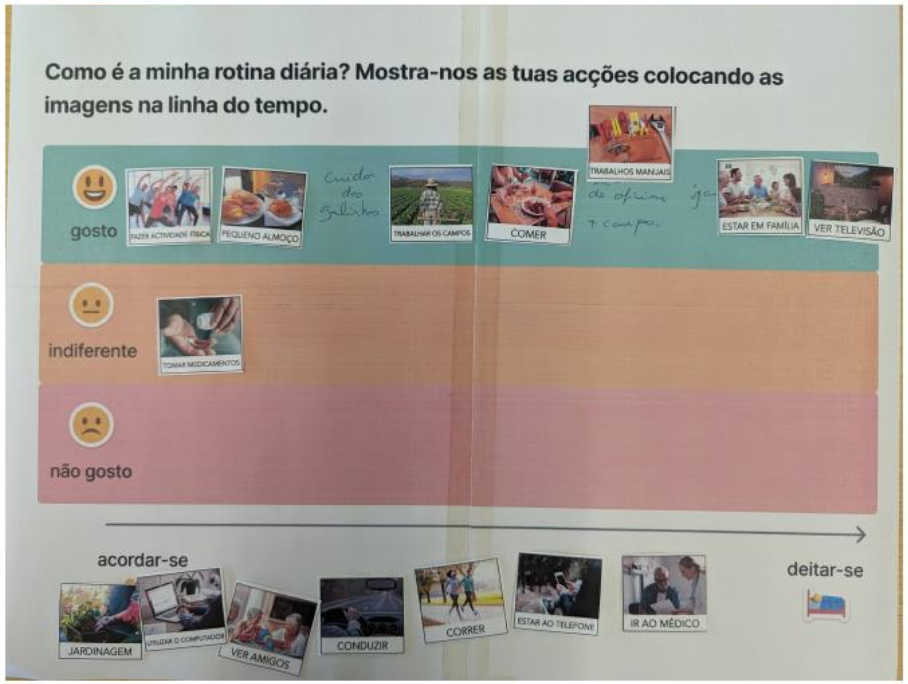
Materials:

- ☐ Papers to fill in
- ☐ Set of images
- ☐ Video
- ☐ Consent forms
- ☐ Script
- ☐ Phone to record audio
- ☐ Pens and markers
- ☐ Scissors
- ☐ Glue
- ☐ Tape




P3
A MINHA RELAÇÃO COM O MEU...
confiança
privacidade
Cuire o que ando a fazer
amizade
diálogo
confiança


Como é a minha rotina diária? Mostra-nos as tuas acções colocando as imagens na linha do tempo.
gosto
indiferente
não gosto
PEQUENO ALMOÇO
TOMAR MEDICAMENTOS
ANDAR
VER AMIGOS
IR ÀS COMPRAS
COZINHAR
COMER
DESCANSAR
LIMPAR
LAVAR A ROUPA
PASSAR A FERRO
JARDINAGEM
VER TELEVISÃO
LER
JOGAR ÀS CARTAS
OUVIR MÚSICA


Como é a minha rotina diária? Mostra-nos as tuas acções colocando as imagens na linha do tempo.
gosto
indiferente
não gosto
acordar-se
deitar-se
TRABALHOS MANUAIS
FAZER ACTIVIDADE FÍSICA
PEQUENO ALMOÇO
TRABALHAR OS CAMPOS
COMER
ESTAR EM FAMÍLIA
VER TELEVISÃO
TOMAR MEDICAMENTOS
JARDINAGEM
UTILIZAR O COMPUTADOR
VER AMIGOS
CONDUZIR
CORRER
ESTAR AO TELEFONE
IR AO MÉDICO

Como é a minha rotina diária? Mostra-nos as tuas acções colocando as imagens na linha do tempo.
gosto
indiferente
não gosto
acordar-se
deitar-se
PEQUENO ALMOÇO
COMER
VER AMIGOS
LER
IR ÀS COMPRAS
ANDAR
JARDINAGEM
DESCANSAR
VER TELEVISÃO
ESTAR EM FAMÍLIA
IR AO MÉDICO
LIMPAR
PASSAR A FERRO
COZINHAR
TOMAR MEDICAMENTOS
LAVAR A ROUPA
OUVIR MÚSICA
DANÇAR
JOGAR ÀS CARTAS

P1 - Santana

Demographic info
65 years old, female, Brazilian, married, two children, lives with her son, 7 years of education, married, no diseases, healthy, no pain, autonomous with technology. Uses phone, laptop.

Daily routine
P1 starts her day with breakfast before taking her grandson to school. She then runs errands, like driving long distances and doing prayers at church, where she is active in volunteering. Afterward, she prepares lunch and cleans the house, though she doesn't enjoy it much. She also cooks for the family and engage in various activities with her grandson, like taking him to padel. Despite being busy, she finds time for a short break to use her cell phone and engage in physical activity. In the evening, she picks up her grandson, prepares dinner, and spends time with her family before sleeping early. Before bed, she prays again and spends some time on the computer, staying updated on the news and watching things from Brazil, her home country. She cherish the moments when she can relax with her husband and her son at home.

Occasional activities
1. Going to the doctor for checkups
2. Reading
3. Walking (when going to the mall or for gymnastics)
4. Playing cards (occasionally with her grandson)
5. Traveling on Sundays and going out to eat

Physical activity habits
She goes to the gym twice a week for one-hour sessions. She also walks in her routine, doing some laps around the gym before her session and walking to the mall.

Physical activity motivators
- Enjoyment: She engages in physical activity because she enjoys it, because she has nothing else to do and expresses pleasure in participating.
- Health benefits: She recognizes the importance of physical activity for maintaining vitality and energy. She sees it as essential for preventing atrophy and staying active.

Physical activity barriers
- Time constraints: She expresses a desire to attend the gym more frequently but family responsibilities are a limiting factor. Physiotherapy sessions, which she views as less engaging, also occupy some of her time.

Physical activity needs & preferences
- Social interaction: She values the social aspect of group exercise, indicating a preference for exercising in a group rather than alone. She mentions enjoying the complicity, laughter, and conversations during sessions.
- Variety: While she enjoys her current gym routine, she expresses a desire for more activities or additional days at the gym to further enhance her physical well-being.
- Fun and engagement: She expresses preferences for activities that involve dance, music and rhythm as more fun and engaging.

Ideal relationship with PA guide
- Trust and Confidence
- Motivation and Encouragement: feeling inspired when pushed to achieve her best. Positive reinforcement and support drive her to put effort and stay committed to her fitness routine.
- Social Engagement, Fun, Enjoyment
- Feedback and Goal Setting: appreciates receiving guidance and direction to help her improve her performance and track her progress effectively.
- Energy and Novelty: values the teacher's energy and enthusiasm, finding it contagious and motivating. Additionally, she appreciates the introduction of new exercises or techniques to keep her workouts fresh and exciting.
- Preventive Approach: attending gym sessions regularly to maintain her well-being rather than addressing issues when they arise.
- Autonomy and Respect: while she values guidance and support, she also wants to feel empowered to make decisions about her workout routine and avoid feeling pressured or controlled when she doesn't feel like.
- Clear Communication: she expects clear instructions and explanations during exercises to ensure proper technique and minimize the risk of injury.

Tastes and preferences
1. Driving: She enjoys driving, even for long distances, as evidenced by her mentioning a nine-hour round trip to Portimão.
2. Praying: She mentions spending a significant amount of time praying, both in the church and at home. It's something she likes to do and finds meaningful.
3. Physical activity: She enjoys physical activity, such as gymnastics, which she attends regularly.
4. Reading: Although she doesn't read much, she expresses enjoyment in reading occasionally.
5. Spending time with family: She values spending time with her family, particularly her husband. Despite her busy schedule, she makes time to care for him and cherishes the moments they have together.
6. Playing cards: She enjoys playing cards, although she hasn't found a regular partner yet. However, she engages in the activity with her grandson from time to time.
7. Using the computer: While she doesn't use the computer extensively, she expresses enjoyment in watching the news and content from Brazil, her home country, to stay informed and connected.

connection with family and loved ones

active lifestyle (regular physical activity, long distance driving, travelling during the weekend, taking care of her husband)

enjoys relax (playing cards, reading, drinking beer while listening to music)

Remote PA opportunities > her motivators
- Convenience: She sees remote physical activity as innovative and convenient, appreciating the flexibility it offers in terms of time and space. It eliminates the need to travel to a gym and allows for adaptation to personal schedules.
- Cost-saving: She acknowledges the financial advantage of remote physical activity, particularly for those who would otherwise need to pay for gym memberships. This aspect makes it more accessible and appealing to a broader audience.

Remote PA challenges > her barriers
- Lack of professional guidance: Not having a professional instructor present to provide guidance and corrections could lead to improper form or technique if individuals are not paying close attention.
- Distractions: She mentions the challenge of maintaining focus during remote workouts, potential for distractions and parallel conversations that could detract from the quality of the exercise experience.

Remote PA overall opinion
She finds remote physical activity appealing for its convenience and cost-saving benefits, she also acknowledges the importance of professional guidance and the need for self-discipline to overcome potential distractions and ensure proper execution of exercises.

P2 - Sonia

Demographic info
sonia, 74, brazilian, 17 years of education, master degree, divorced, arthrosis on her knee, autonomy with technology (orders food, computer, calls bolt etc), 2.8 velocity test for physical ability

Daily routine
P2 starts her day with a cup of coffee every morning, something she really enjoys and cannot give up on. Then, she goes to the gym where she meets her friends and tidies up her house. She takes medications regularly. Even though she's not a big fan of taking medicine, she knows it's important, so she does it anyway and never forgets about it. Besides her regular chores, she likes to draw and take walks, especially during lunchtime. These things make her happy and help her relax. She gives online private classes of Maths to some students in Brasil. She enjoys playing games on her phone and watching Netflix on the laptop when she wants to unwind. Even though she's not a big fan of resting, she knows it's necessary sometimes. She's lucky to do what she enjoys and avoids things she doesn't like.

Tastes and preferences
1. Drawing
2. Running and physical activity: her biggest passion
3. Traveling
4. Taking walks
5. Spending time with friends

Occasional activities
1. Playing cards on the phone
2. Watching netflix
3. Reading
4. Gardening

Physical activity habits
Her commitment to physical activity shines through in her daily routine, where she frequents the gym with enthusiasm, often attending classes like spinning, Pilates, and swimming. Despite her age of 74, she maintains a consistent regimen, sometimes even going seven days a week. However, occasional health procedures like colonoscopies can disrupt her routine temporarily. Nonetheless, she adapts, finding alternative exercises like biking to strengthen her knees post-surgery. Her dedication to staying active stems from a genuine love for it, rooted in her history as a former marathon runner. Physical activity isn't just a habit for her; it's a source of fulfillment and vitality, offering a sense of fullness and well-being that she values deeply.

independent and active (moved from brazil two years ago to start a new life in portugal)

active lifestyle and passion for gymnastic and running

physical injuries that mine her adherence to pa, but she finds alternative ways

Physical activity motivators
- Staying active: she explores and finds different ways to stay active.
- Passion and sense of fullness: her motivation isn't merely about staying fit; it's about preserving her mental and emotional well-being that she feels when she does physical activity. She feels depressed when she is not able to do it.

Physical activity barriers
- Health problems and physical pain: she had a knee surgery that made her impossible to perform some physical activities, such as running, her biggest passion.

Physical activity needs & preferences
- Social interaction: She values the social aspect of group exercise, indicating a preference for exercising in a group rather than alone.
- Running: she is an ex runner, therefore this activity is what she prefers the most.

Experience with physiotherapy
She underwent physiotherapy for a knee injury, both in Brazil and separately for each knee. The therapy was essential in alleviating the pain and discomfort caused by her injury.

Remote PA opportunities > her motivators
1. Convenience of doing it without limitations of times and costs.
2. Willingness to adapt and participate in remote workouts when the gym is inaccessible or when it's the only option available.
3. Personalization and adapted plans and exercises for her needs and preferences.

Remote PA challenges > her barriers
1. Lack of equipment at home for replicating gym workouts.
2. Difficulty in achieving the same intensity and variety of exercises as experienced at the gym.
3. Absence of social interaction.
4. Lack of engagement, boredom.

Remote PA overall opinion
She views remote physical activity as a practical alternative but misses the social interaction and variety offered by the gym. Despite its limitations, she remains open to remote exercise, acknowledging its importance in maintaining her fitness routine.

Ideal relationship with PA guide
She envisions an ideal relationship based on factors such as:
- confidence and trust
- stimulation, motivation, energy
- sociability
- encouragement
- friendship: a close bond with her instructor fosters trust and enables effective communication and collaboration in achieving fitness goals
- customization: she values instructors who understand her needs and provide support and guidance tailored to her preferences
- respect and comprehension: she prefers instructors who are not overly forceful or critical and who respect her boundaries and individual pace during workouts
- professionality and credibility: she highlights the importance of instructors being technically proficient and understanding her specific needs, contributing to a positive and rewarding fitness experience


P3 - Joao
Demographic info
joao, 73, 9 years of education, married, hypertention, no physical problem or pain, medium autonomy with computer (uses when he has to to pay taxes but not very proficient, uses smartphone but just the minimum)
Daily routine
P3 each morning starts his day by washing his face and engaging in gymnastics for approximately 30 minutes before breakfast. His physical activities include squats, rolls, investments, collections, and turbines. Following his morning exercise routine, he takes a leisurely stroll and he finally has breakfast. Subsequently, he attends to his responsibilities in the field, caring for animals and attending to various agricultural tasks. Despite his busy schedule, he finds joy in these activities, which form a significant part of his daily routine. He takes care in the tasks outside the kitchen, while his wife of the tasks inside the kitchen, but they offer mutual help. They take a rest together during the evening while watching television.
Tastes and preferences
He enjoys engaging in physical activities and working in the field, finding fulfillment in caring for animals and tending to agricultural tasks. He appreciates the structured nature of his routine, which includes exercise, agricultural work, and household responsibilities. Additionally, he values his partnership with his wife, sharing household duties and collaborating effectively to manage their daily lives.
Physical activity habits
His physical activity routine consists of exercises he learned during his previous gym visits, dating back to previous decades. Drawing from his past experiences, he has developed a personalized exercise plan that includes various exercises targeting different muscle groups. He follows a flexible approach, alternating between different exercises such as abdominals and pressure exercises, depending on his preferences and goals. Additionally, he has been involved in running since 2008, indicating a long-standing commitment to maintaining an active lifestyle.
physically active, structured exercises routine
works in the fields
Physical activity motivators
• Passion and personal goals: having been involved in training since the 1980s, he seems to have developed a passion for physical fitness and exercise
• Personal goals and self-challenge: his engagement in running since 2008 reflects a desire to challenge himself and continue pursuing physical fitness goals even as he ages
• Staying active: strong intrinsic motivation to stay active and maintain his physical well-being, increased by looking at his peers who are extremely sedentary and lack of vital energy
Remote PA opportunities > her motivators
1. Convenience and flexibility of exercising at home
2. It still allows for connection with others in different locations
3. Personal goals, self-challenge and intrinsic motivation that persist even when faced with the challenges of remote exercise
Remote PA challenges > her barriers
1. Lack of social interaction typically found in group settings like gyms
2. Lack of motivation that comes from working out alongside others
3. Lack of motivation and consistency given from the lack of an in-person instructor
Physical activity barriers
• Need to adapt his exercise plan from previous experience in the gym: possible disruption in his regular exercise routine, possibly due to factors such as changes in his environment or lifestyle
Ideal relationship with PA guide
• trust and privacy: he desires a therapeutic alliance built on confidence and a sense of partnership, where he feels comfortable sharing his concerns and expectations
• dialogue and communication: desire for open and transparent communication between himself and the therapist
• customization: his experience also suggests a degree of skepticism and dissatisfaction with certain aspects of physiotherapy, indicating a need for clearer expectations and a more tailored approach to treatment
• mutual respect
• collaboration
• clear goals and approach towards clear results
Experience with physiotherapy
His experience with physiotherapy involves a combination of massage, exercises, and consultations with a physiatrist. He recalls a period of intense physical activity that led to overexertion and subsequent visits to physiotherapy. Despite undergoing treatment, he expresses a sense of frustration with the process, mentioning his inability to fully heal and engage in certain activities. His experience highlights the complex nature of rehabilitation, where expectations may not always align with outcomes, and the road to recovery can be challenging and uncertain.


P4
Demographic info
alcina, 68, 16 years of education, married, doesnt have any illness or pain, good digital literacy and autonomy (computer and phone)
Daily routine
P4 in her daily routine demonstrates a balance between familial obligations, personal interests, and leisure activities. She starts her day by attending to household chores. She prioritizes spending time with her mother, who lives with her, and appreciates the companionship during activities like breakfast and shopping. She daily goes to the coffee shop where she relaxs by reading the newspaper and the news on the phone. She daily goes for a walk or with her bike in a park close to her house with her husband or a friend.
Her interactions with her children and grandchildren are central to her routine, as she frequently gathers with them for meals and family gatherings, or to fetch her grandchildren from school to bring them to other activities.
Tastes and preferences
While she doesn't particularly enjoy cooking, she takes on the responsibility of meal preparation, by purchasing food for her family. She values her family and friendships but mentions that her focus has shifted more towards family since the onset of COVID-19.
She likes riding the bike, swimming and doing open-air activities.
While she doesn't currently engage in musical activities, she expresses a desire to learn the guitar, reflecting a interest in exploring new hobbies.
Despite not being musically inclined, she fondly recalls singing in school groups and expresses a willingness to participate in singing groups in the future.
Physical activity habits
She maintains a fairly active lifestyle, engaging in physical activities such as biking and walking almost every day. While she enjoys both activities, she expresses a preference for biking due to its lower impact on her bones compared to walking. Her motivation for engaging in physical activity revolves around maintaining her health and enjoying the fresh air, highlighting a personal commitment to her well-being. Despite not participating in structured exercise programs, her consistent engagement in daily physical activities reflects a proactive approach to staying active.
active lifestyle
Physical activity barriers
• Physical limitations
• Tastes and preferences more towards outdoor activities that she enjoys rather than structured exercises
Remote PA opportunities > her motivators
1. Convenience and flexibility in scheduling of exercising at home
2. Customization to her physical needs and limitations
3. Trust in her doctor's opinion if they recommend a structured plan
Remote PA challenges > her barriers
1. Strict schedules if the plan has predetermined exercises sessions with a day and a time to respect
Physical activity motivators
• Social engagement: she likes sharing the time spent in physical activities with other people, but she also does it on her own
• Leisure and enjoyment for the activities itself, expressing a preference for outdoor activities and being surrounded by nature
• Community/social influence: in the place she lives is very common to ride a bike, reason why for her was obvious to choose such an activity
• Mantaining her health and well-being
Ideal relationship with PA guide
• proximity, trust, and confidence: close relationship with the terapist to feal at ease
• firm approach to treatment: prioritizing effectiveness over comfort. She perceived quicker results with a therapist who was more assertive in her methods, rather than another one who was softer but slower in achieving results
• listens to her needs, customized approach tailored to her needs and physical capabilities
• encouragement
• support
• social interaction, preference for shared experiences with others
Experience with physiotherapy
During her physiotherapy sessions, she primarily received treatment for physical discomfort resulting from a fall. This intervention occurred over the span of several months, involving massage and exercises targeting specific areas of discomfort, notably her back. While she did not receive prescribed exercises to continue at home, the sessions contributed to her recovery. Her rapport with the physiotherapist was notably positive, facilitated by a pre-existing knowledge with the therapist, who also happened to be a childhood friend of her older son. This familiarity fostered a comfortable atmosphere where they engaged in conversations about personal lives.

B. Experts interview guides

Interview guide - ACTIVAS, physiotherapists

Introduction

- Nice to meet you, thank you for taking the time to have a chat with me today.
- I am Valentina, I am currently doing my master thesis in The Netherlands. I am here to work on Activas project, and in particular my goal is to redesign the platform from both the practitioners' and users' side, in order to guarantee users' adherence. In particular, I am going to work on the relationship between practitioners and users and on how this can be redesigned to ensure user engagement, motivation and support.
- The goal of this interview is to get a better understanding of the background theory from your professional point of view about physical activity, Activas, and your perception as practitioners of users and your relation/interaction with them.
- The interview will be split into two parts, it could take around one hour, but there's the possibility to do it in two different sessions. I will follow a guide to keep it on track, but feel free to share whatever you like.
- If you want to take a break at some point or leave earlier, it is completely possible, just let me know.
- I am curious about your experience, and anything you will want to share will be extremely valuable.
- Since I am going to interview you at the same time, whoever wants to answer the questions I'll make can do it, or you can also share both your perspectives at the same time for the same question.
- I will conduct the interview in English, but if you feel more comfortable with expressing some concepts in Portuguese, feel totally free to do it. I will use a software for transcriptions and I'll record the session as well, so it will be possible for me to translate it later if I don't understand.
- Do you have any questions before starting?

About you

- This is a question for all of you. Can you tell me a bit about yourself, your work and your role within Neuroinova?
- What is your professional background?

Relationship with users

Let's talk about your relationship with users. In this case, I'll ask you to think about specifically older adults. First, I'm going to ask you about your usual experience, and then how it would be applied in Activas.

- What is your role with your patients in general? What do you usually do with them?
- Can you describe to me the entire sequence of events that begins when the patient first gets in touch with you, until the last contact you have with them?
- What are the main reasons why they reach out?
- Can you make a description of who are the Activas target users?
- How would it be when applied to Activas? How would the patient journey change and what's the role of the physiotherapist?
- In Activas, is there an interface or a section on the platform where users and practitioners interact? Which are the points of contact within the platform?
- How would you manage the patient's care together with the other professionals, such as the neuropsychologists?
- How do you feel about your relationship with them, from your point of view?
- What are the main challenges that you face in working with them?
- What do they complain about the most?
- Do you follow a specific communication style or approach with them? Can you describe it and tell me the reasons behind it?
- Which strategies do you follow to build trust and support them?
- What are your goals regarding your users?

Perception about users

Now, I'm going to ask you about your personal opinion on users' perceptions.

- What do you think is users' attitude on physical activity, in terms of adherence or their opinion about it?
- What do you think are the main barriers and challenges towards their adherence?
- What do you think motivates them to continue the training or could motivate them?
- What do you think their main goals are?
- What do you think their main fears or concerns are?
- How do you usually address their challenges?
- What do you know about their daily routine?

Other questions about users

- What do you think are the external or environmental factors that influence their adherence?
- What's the role of family members or caregivers?
- What is the situation of physical activity among elderly people in Portugal?

ACTIVAS

- Can you describe to me how the ACTIVAS system works? Who are the actors and stakeholders involved and how are they connected?
- How does a prescription for a treatment work in this case?
- Will the users first come with a clinical need for cognitive health, or for physical activity as well?
  - if cognitive health: how is the physical activity plan prescribed, since the first need is for cognitive reasons?
  - if physical activity: how is the cognitive training plan prescribed?
- How the performance of users is checked?
- Are there two different sections where users can keep track of their results? One for cognitive training and one for physical activity?
- Would they refer to two different practitioners or just one for everything?
- Is the physical activity program also automatically adjusted like CogWeb based on users' performance? Or are regular in-person assessments needed?
- Why deciding to put p.a. breaks in the cog training instead of doing them together? (Compared to CogniVitra) / Example of MEMORY (doing cog. exercises while walking); understand if this specific structure is necessary and has a specific reason or if it can be rethought.
- Compared to other combined programs, what is the advantage of Activas?
- What is the gap in the literature regarding the integration of p.a. and cog training? How is Activas trying to fill it?

Wrap-Up & Conclusion

I don't have any other questions, but if you have anything else you want to add that you think might be important, feel free to do it.
Thank you again for your time and the valuable information you shared.

INTERVIEWS

PROFESSIONALS & EXPERTS

Interview guide - Neuroinova, Cognitive training and CogWeb

Introduction

- Nice to meet you, thank you for taking the time to have a chat with me today.
- I am Valentina, I am currently doing my master thesis in The Netherlands. I am here to work on Activas project, and in particular my goal is to redesign the platform from both the practitioners' and users' side, in order to guarantee users adherence. In particular, I am going to work on the relation between practitioner and users and on how this can be redesigned to ensure user engagement, motivation and support.
- The goal of this interview is to get a better understanding of the background theory from your professional point of view about cognitive training, of Neuroinova's expertise and know-how, and on your perception as practitioners of users and your relation/interaction with them.
- The interview will take around one hour, I will follow a guide to keep it on track, but feel free to share whatever you like. I am curious about your experience, and anything you will want to share will be extremely valuable. Since I am going to interview you at the same time, whoever wants to answer the questions I'll make can do it, or you can also share both your perspective at the same time for the same question.
- If you want to take a break at some point or leave earlier, it is completely possible, just let me know.
- I will conduct the interview in English, but if you feel more comfortable with expressing some concepts in Portuguese, feel totally free to do it. I will use a software for transcriptions and I'll record the session as well, so it will be possible for me to translate it later if I don't understand.
- Do you have any question before starting?

About you

- This is a question for all of you. Can you tell me a bit about yourself, your work and your role within Neuroinova?
- How long have you been working here? What is your background?

About Neuroinova

- Can you introduce me the company and talk about the main areas of expertise?
- On a market positioning point of view, which are the factors that distinguish Neuroinova from other companies? Which is their competitive advantage?

About Cognitive Training

- In terms of cognitive training and theoretical knowledge, I already did some research about, so I am going to ask you only the things that to me are still a bit unclear and where I'd specifically like to know how it works in Neuroinova.
  If you could give me a definition, what is cognitive training and how does it improve cognitive functions?
- Who does cognitive training? In which cases is it applied?
- Are there any guidelines or standards to follow related to the program prescription?
- I have read a lot about cognitive training, cognitive rehabilitation, cognitive stimulation… There is a lot of terminology, can you clarify to me the difference between these wordings?
- Are there other relevant differences in wording?
- How does the system work? Who are the actors involved and how are they connected?
- How is the situation in Portugal related to cognitive health?
- Before developing CogWeb, how were you providing cognitive training?
- How does an in-person cognitive training session work? Which are the pros and cons of web-based CT and in-person?
- Can you share examples of successful outcomes you've observed from cognitive training interventions with older adult patients?

About CogWeb

- If a person makes a mistake for distraction reasons, poor internet connection, reasons besides his actual cognitive performance, how does the system take it into account? How does it differ from in-person training?
- How do the exercises change according to the cognitive impairment of the user? Is there a difference between traumatic events (like stroke) and chronic/neurodegenerative conditions? Are there any standards to follow?
- Is there a classification of all the cognitive deficits?
- Which are the factors that determine the customization of exercises?

About BrainOnTrack

- What are the risk factors for cognitive decline? Ana showed me the graph of BrainOnTrack: according to that, the trend is calculated based on the errors made in the test and the age. Does it take into account other relevant factors?
- BrainOnTrack: how often do different users have to checkup according to their age or other factors?

Relationship with users

Let's talk about your relationship with users. In this case I'll ask you to think about specifically older adults.

- Can you describe me how is your relationship with the patients in terms of patient journey? With 'patient journey' I mean the entire sequence of events that begins when the patient first develops a need for clinical care and engages with the organization, until the last contact you have with them.
- How often do you meet?
- How do you keep in touch with each other?
- Do you have regular meetings or appointments?
- Is there an interface or a section on the platform where users and practitioners interact? Which are the points of contact within the platform?
- Do they ever call you or try to put in touch without appointment?
- Which are the main reasons why they reach out?
- What do you talk about?
- Can you describe a typical assessment process?

- How would you describe the relationship with them, from your point of view? How does it change from patient to patient?
- Do you follow a specific communication style or approach with them? Can you describe it and tell me the reasons behind?
- Which strategies do you follow to build trust and support them?
- Can you share any challenges you've encountered in working with them?

Perception about users

Now, I'm going to ask you about your personal opinion on users' perception.

- What do you think is users' attitude on cognitive training, in terms of adherence or their opinion about it?
- What do you think are the main barriers and challenges towards their adherence?
- What do you think they need to effectively adhere to the program?
- What do you think their main goals are?
- What do you think motivates them to continue the training?

Other questions about users

- What do you think are the external barriers from their adherence? This time I'm not asking what do you think they think, but your opinion.
- What do you think could be the motivators for an increased adherence?
- How are family members or caregivers involved in the cognitive training?

Wrap-up and conclusion

I don't have any other question, but if you have anything else you want to add that you think might be important, feel free to do it.

Thank you again for your time and the valuable information you shared.

C. Personas from research phase

José Carvalho

Physically Active lifestyle

- 74 years old
- Retired, farmer
- Lives in the countryside near Braga
- widow

Bio

José is a retired marathon runner with a passion for physical activity and staying active. Despite facing challenges like back pain, he remains dedicated to his fitness routine, attending the gym regularly and participating in various classes like spinning and pilates. When he's not able to attend, he does 30 minutes of weights lifting at home. He lives in the countryside near Braga, where he regularly takes case of his fields and his animals. Every Sunday his sons visit him from Porto to spend some time together.

Daily routine

Feed the animals in the fields → Does some house chores → Takes care of the fields → Prepares and eat lunch at home → Goes to gym classes by car → Grabs a coffee in a coffee shop in the city centre → Prepares and eats dinner → Calls his sons → Watches some Netflix

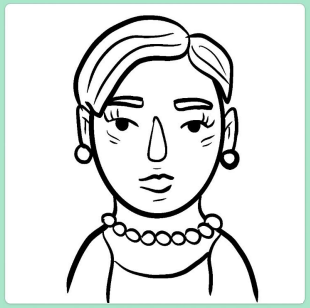
Physical Activity

He loves doing regular physical activity, he would feel depressed without

He's scared of getting older and sees physical activity as the antidote to stay healthy and alive

Even if he's not able to attend classes, he finds an alternative way to do his daily workout

Digital Devices



Mariana da Silva

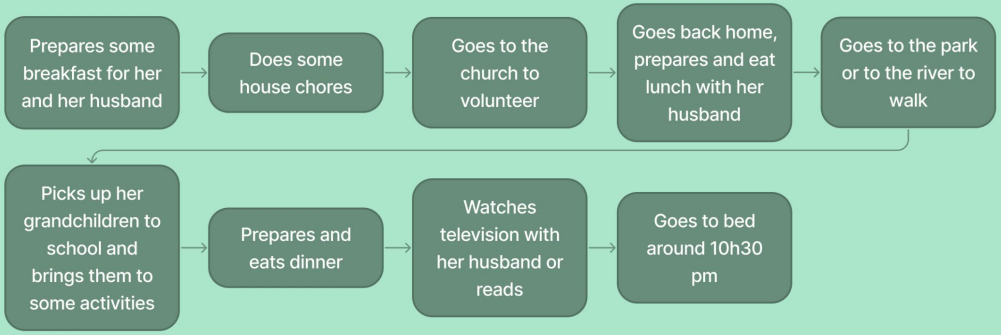
Busy Active lifestyle

- 67 years old
- Retired
- Lives in Aveiro
- married

Bio

Maria is an active woman who leads a busy lifestyle volunteering in her community church and taking care of her grandchildren. Originally from Brazil, she moved to Portugal many years ago and is now an active figure in the local community. She always finds some time to spend with her family travelling together in the weekends or having meals together, or for going to the park or to the river to take a walk or ride her bike with her husband or a friend.

Daily routine



Physical Activity

She does it to feel active, energetic and healthy

She enjoys spending some quality time in outdoor activities with her peers

She gets bored doing indoor physical structured exercises, she prefers doing something she finds pleasing and at the same time keeps her active

She has some physical limitations due to knee surgery that limit her choice of physical activites

She is fine with the level of physical activity that she does, she belives that her active lifestyle keeps her healthy

Digital Devices

Ana Clara Oliveira

Sedentary lifestyle

- 81 years old
- Retired school teacher
- Lives in Porto
- widow

Bio

Ana Clara an 81-year-old retired schoolteacher, lives alone in Porto, Portugal. After her husband passed away ten years ago, she found comfort in a quiet, routine life. Maria enjoys watching TV, reading, and knitting, spending most of her day in the comfort of her home. She has two adult children who visit occasionally, and she cherishes the time she spends with her grandchildren.

Daily routine

Wakes up and prepares some breakfast → Reads the morning newspaper → Watches her favourite talk show on the TV → Prepares and eat lunch at home while watching the news → Takes a short nap → Calls her daughter in Lisbon or her sister who lives nearby → Sometimes meets her peers at the church → Knits, reads or watches some TV shows → Prepare a light dinner → Reads a book and takes a nap

Physical Activity

She has pain or her back and her legs and struggles in doing even simple movements. She is scared that PA could get it worse.

She feels often tired, prefers to watch tv and reading rather than doing something more physically active.

She feels that her house chores are already challenging and tiring enough to do something even tiring.

Digital Devices

D. Personas for role-playing activity

Inès Ferreira

Age: 70
Location: Lives in Marquês, an urban neighbourhood in Porto
Occupation: Retired architect for 5 years; occasionally takes on small jobs for former clients.

Health
- Generally healthy, with occasional back pain.
- Smoker
- Occasionally drinks wine

Cognitive Health
- Exhibits mild symptoms of preclinical dementia (e.g., forgetfulness, difficulty finding words, slight confusion with time or place).
- Consulted a neurologist; no diagnosis but advised to start cognitive training to delay cognitive decline and improve her cognitive functions.

Behavior
- Sedentary lifestyle; prefers staying at home.
- Spends a lot of time watching TV.
- Rarely goes out, mainly for necessities or occasional social gatherings at the bar.
- Dislikes physical activity, prefers resting and relaxing activities.

Hobbies
- Crochet
- Watching TV
- Listening to music
- Occasionally painting

Teresa Franco

Age: 72
Location: Lives in Matosinhos, a neighbourhood in Porto near the beach
Occupation: Retired teacher for 7 years; no longer engaged in professional work but occasionally tutors neighborhood children.

Health
- Diabetic
- Experiences frequent leg pain and general physical frailty
- Doesn't drink nor smoke

Cognitive Health
- Displays symptoms of cognitive impairment slightly less severe than mild dementia (occasional memory lapses, trouble concentrating, difficulty following conversations).
- Has visited a neurologist who recommended cognitive training and physical therapy to manage her condition and improve her mental and physical health.

Behavior
- Leads a sedentary lifestyle, mostly confined to her home.
- Spends a lot of time watching TV and reading.
- Rarely goes out, mainly for medical appointments or essential shopping.
- Dislikes physical activity due to physical discomfort, prefers resting and engaging in calm activities.

Hobbies
- Reading novels
- Watching TV dramas
- Knitting
- Listening to audiobooks

Pedro Neves

Age: 68
Location: Lives in Monsanto countryside
Occupation: Retired civil engineer; enjoys helping friends and neighbors with small projects and repairs.

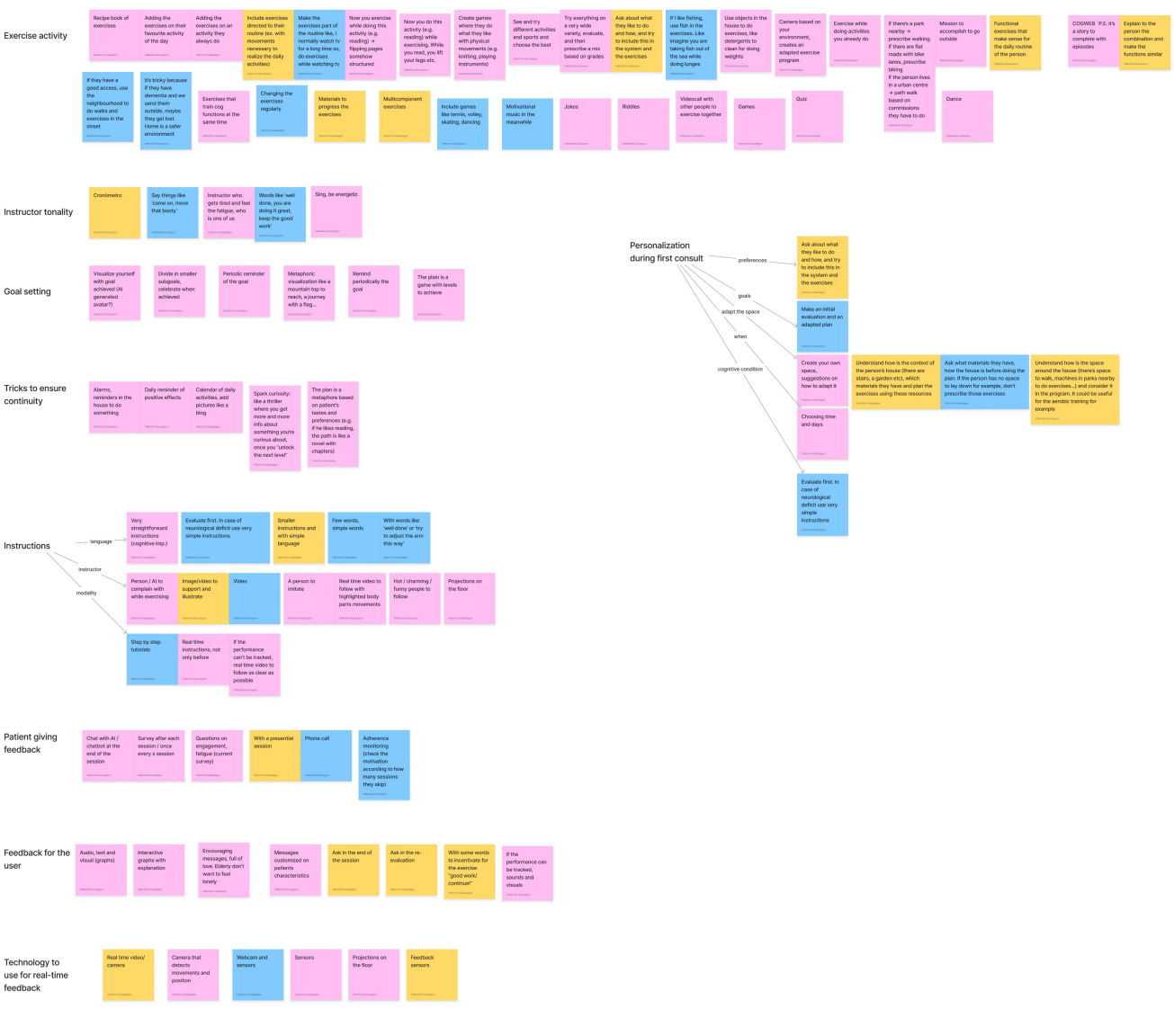
Health
- Manages high blood pressure with medication
- Takes medication for thyroid issues
- Generally healthy and energetic despite the health conditions

Cognitive Health
- Displays signs of cognitive impairment, such as occasional memory lapses, difficulty focusing, and sometimes struggling with complex tasks.
- Has consulted a neurologist who recommended cognitive exercises and maintaining social and mental activities to manage and delay further decline.

Behavior
- Leads a busy and active lifestyle.
- Regularly engages in house chores and maintenance of his fields.
- Volunteers at the neighborhood church.
- Takes care of his grandchildren frequently.
- Sometimes goes for walks or rides his bike in the nearby park but does not engage in structured physical exercise.

Hobbies
- Gardening and taking care of the vegetable garden
- Biking and walks in the nature
- Playing chess

E. Idea generation analysis process


Exercise activity
Instructor tonality
Goal setting
Tricks to ensure continuity
Instructions
language
instructor
modality
Patient giving feedback
Feedback for the user
Technology to use for real-time feedback
Personalization during first consult
preferences
goals
adapt the space
when
cognitive condition
Exercise activity
Other features to motivate
Goal setting
Plan representation
Instructions
medium
instructor
modality
Patient giving feedback
End of the session
During presential consultations
Anytime
Feedback for the user
when
modality
Tonality

F. Test iteration 1 materials

Script – Test Iteration 1

Introduction

- Introduce ourself
- Thank you
- Present the research goal
- Present the activity:
  - What we are going to do (two parts: simulation of a consult with a physiotherapist, trying a session of three short and mild exercises)
  - Time: 15-20 minutes
  - Each part is followed by a few questions about your opinion on what you did
- Consent form + need to record audio & take pictures if consent it
- Do you feel comfortable? Do you have any questions before starting?

Part 1: trying a session made by three physical exercises *7-10 minutes*

- Now, you will do a session of three very simple, short and mild exercises. These exercises are not crafted according to the consultation you just had and the plan that was just prescribed. We only wanted to test if it is possible to tailor a plan at the moment considering all those aspects. In this second part we want to understand and test three different ways of interactions related to how the exercise is presented, how the instructions are given, and how feedback is given to you, and how you give it to the system. You will see what we mean in a moment. In the end we will ask you some questions about your opinion.
- We are going to show you some screens of a digital platform for physical exercises. These are just sketches to understand in the very first stage which aspects to include. You have to navigate it and follow the instructions. We ask you to think out loud while you do it and tell us your impressions and opinions in real time.
- *The user does the test*
- Thank you very much, now we are going to ask you some questions as well. As before, don't be afraid of being honest, whatever thing you will say, will be very valuable for us.

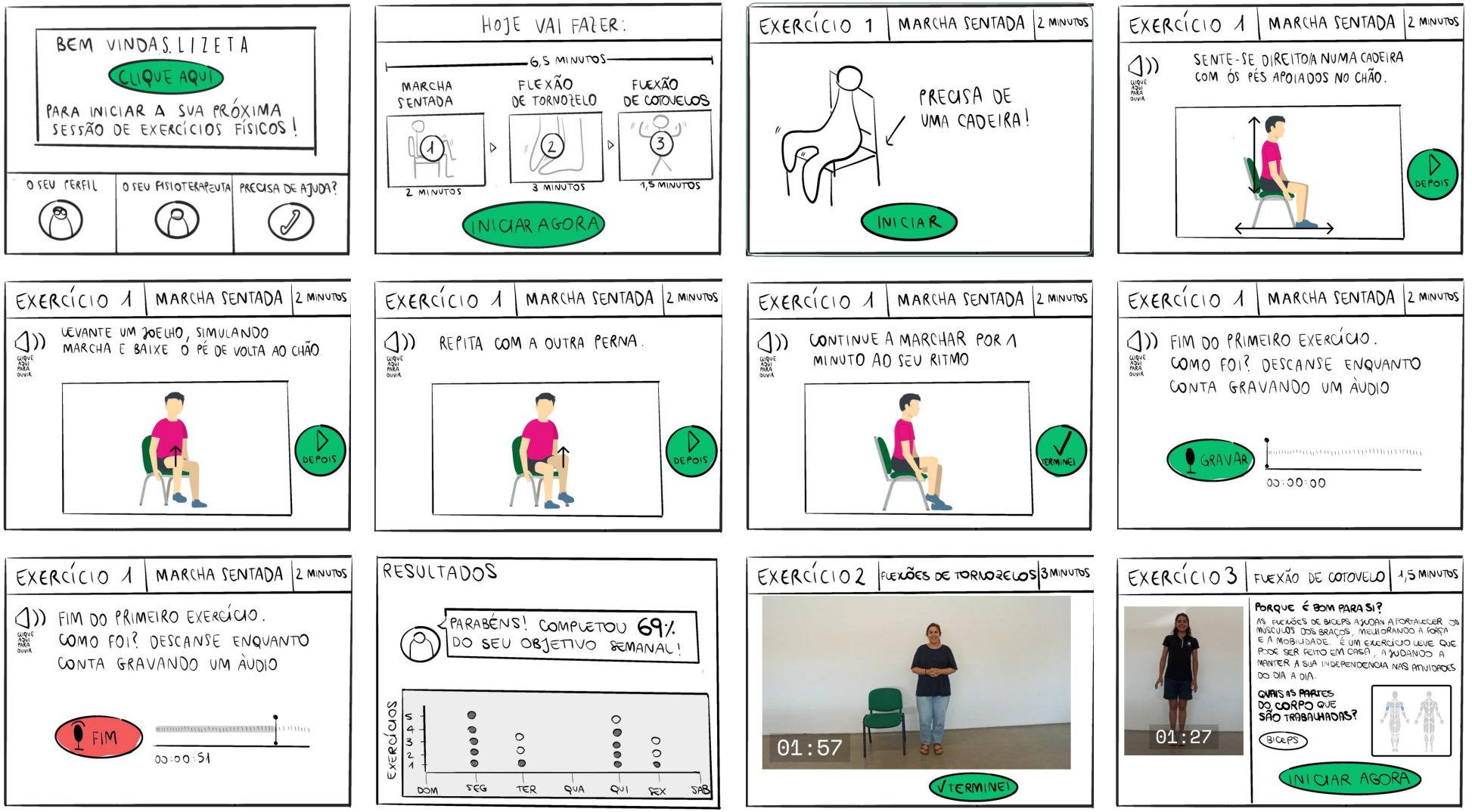
Part 2 – Evaluation

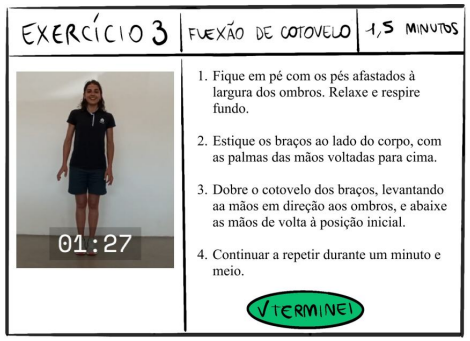
Show participants an image with the three exercises overview together. In the meanwhile, a person selects the answers on a Google forms survey.

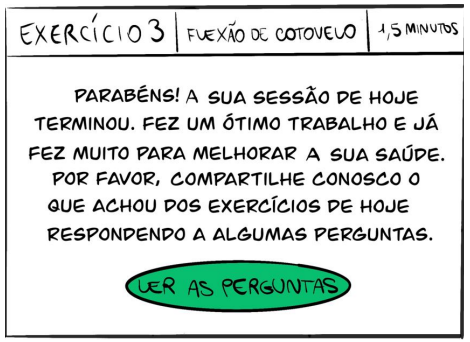
- Think separately about the three exercises you just did. Don't think about the exercise itself, but about how it was presented. If you don't remember it, you can look at the screens again. We are going to say some affirmations, such as 'I felt confident while doing it' and you just have to tell, which one of the three exercises, you think the affirmation is more appropriate. So, if you felt most confident with exercise number 3, you will answer 'exercise 3'.
  - In which exercise did you trust more the instructor?
    - Ex. 1
    - Ex. 2
    - Ex. 3
  - In which exercise felt motivated and encouraged
    - Ex. 1
    - Ex. 2
    - Ex. 3
  - I felt proud of what I could do
    - Ex. 1
    - Ex. 2
    - Ex. 3
  - I felt in control of my movements
    - Ex. 1
    - Ex. 2
    - Ex. 3
  - I felt energetic
    - Ex. 1
    - Ex. 2
    - Ex. 3
  - I felt I could follow the instructions
    - Ex. 1
    - Ex. 2
    - Ex. 3
  - I felt a closer relationship with my physiotherapist
    - Ex. 1
    - Ex. 2
    - Ex. 3
  - I felt I could freely give my opinion and feedback on the exercise
    - Ex. 1
    - Ex. 2
    - Ex. 3
- Now, we ask you which one of the three exercises you preferred for each characteristic:
  - Instructor (animation/random person/physiotherapist)
  - Personality (no personality but as clear as possible / fun and energetic / sweet and kind)
  - Way of instructions (step by step instructions / just a video / written instructions + video)
  - Way to give feedback (recording your opinion at the end / don't do it at all or just during presential meetings / survey at the end)
  - Way of representing your results (graphs, qualitative descriptions, levels...)
- And to conclude, which one of the three modalities did you prefer in general and why?
- Which aspects did you like about the three modalities?
- Which aspects didn't you like?

Conclusion

- Is there any other feedback you would like to give us or something you want to ask?
- Muito obrigada e beijinhos


BEM VINDA S. LIZETA
CLIQUE AQUI
PARA INICIAR A SUA PRÓXIMA SESSÃO DE EXERCÍCIOS FÍSICOS!
O SEU PERFIL
O SEU FISIOTERAPEUTA
PRECISA DE AJUDA?
HOJE VAI FAZER:
6,5 MINUTOS
MARCHA SENTADA
FLEXÃO DE TORNOZELO
FLEXÃO DE COTOVELOS
2 MINUTOS
3 MINUTOS
1,5 MINUTOS
INICIAR AGORA
EXERCÍCIO 1
MARCHA SENTADA
2 MINUTOS
PRECISA DE UMA CADEIRA!
INICIAR
SENTE-SE DIREITO/A NUMA CADEIRA COM OS PÉS APOIADOS NO CHÃO.
DEPOIS
LEVANTE UM JOELHO, SIMULANDO MARCHA E BAIXE O PÉ DE VOLTA AO CHÃO
REPITA COM A OUTRA PERNA.
CONTINUE A MARCHAR POR 1 MINUTO AO SEU RITMO
TERMINEI
FIM DO PRIMEIRO EXERCÍCIO. COMO FOI? DESCANSE ENQUANTO CONTA GRAVANDO UM ÁUDIO
GRAVAR
00:00:00
FIM
00:00:51
RESULTADOS
PARABÉNS! COMPLETOU 69% DO SEU OBJETIVO SEMANAL!
EXERCÍCIOS
DOM
SEG
TER
QUA
QUI
SEX
SAB
EXERCÍCIO 2
FLEXÕES DE TORNOZELOS
3 MINUTOS
01:57
TERMINEI
EXERCÍCIO 3
FLEXÃO DE COTOVELO
1,5 MINUTOS
01:27
PORQUE É BOM PARA SI?
AS FLEXÕES DE BÍCEPS AJUDAM A FORTALECER OS MÚSCULOS DOS BRAÇOS, MELHORANDO A FORÇA E A MOBILIDADE. É UM EXERCÍCIO LEVE QUE PODE SER FEITO EM CASA, AJUDANDO A MANTER A SUA INDEPENDÊNCIA NAS ATIVIDADES DO DIA A DIA.
QUAIS AS PARTES DO CORPO QUE SÃO TRABALHADAS?
BÍCEPS
INICIAR AGORA

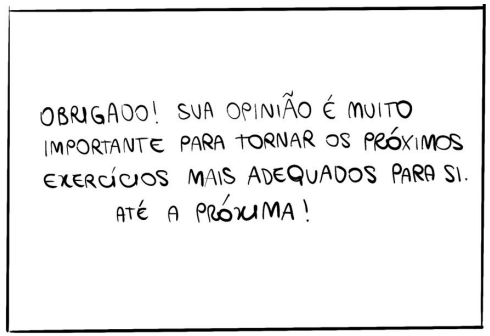

EXERCÍCIO 3
FLEXÃO DE COTOVELO
1,5 MINUTOS
01:27
1. Fique em pé com os pés afastados à largura dos ombros. Relaxe e respire fundo.
2. Estique os braços ao lado do corpo, com as palmas das mãos voltadas para cima.
3. Dobre o cotovelo dos braços, levantando aa mãos em direção aos ombros, e abaixe as mãos de volta à posição inicial.
4. Continuar a repetir durante um minuto e meio.
V TERMINEI

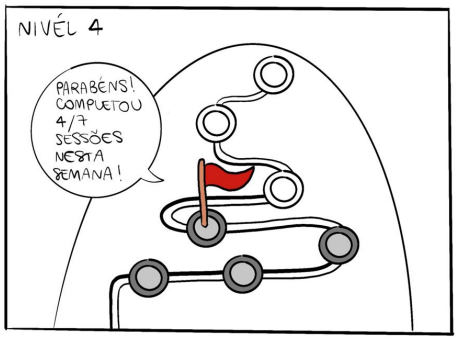

EXERCÍCIO 3
FLEXÃO DE COTOVELO
1,5 MINUTOS
PARABÉNS! A SUA SESSÃO DE HOJE TERMINOU. FEZ UM ÓTIMO TRABALHO E JÁ FEZ MUITO PARA MELHORAR A SUA SAÚDE. POR FAVOR, COMPARTILHE CONOSCO O QUE ACHOU DOS EXERCÍCIOS DE HOJE RESPONDENDO A ALGUMAS PERGUNTAS.
LER AS PERGUNTAS

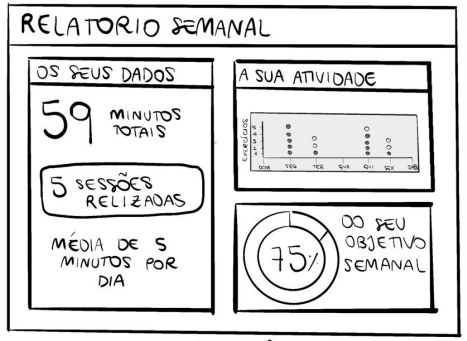

EXERCÍCIO 3
FLEXÃO DE COTOVELO
1,5 MINUTOS
QUANTO SE SENTIU CONFORTÁVEL A FAZER OS EXERCÍCIOS DE HOJE?


EXERCÍCIO 3
FLEXÃO DE COTOVELO
1,5 MINUTOS
ACHOU OS EXERCÍCIOS FÁCEIS DE SEGUIR?


EXERCÍCIO 3
FLEXÃO DE COTOVELO
1,5 MINUTOS
GOSTOU DE FAZER OS EXERCÍCIOS DE HOJE?


OBRIGADO! SUA OPINIÃO É MUITO IMPORTANTE PARA TORNAR OS PRÓXIMOS EXERCÍCIOS MAIS ADEQUADOS PARA SI.
ATÉ A PRÓXIMA!

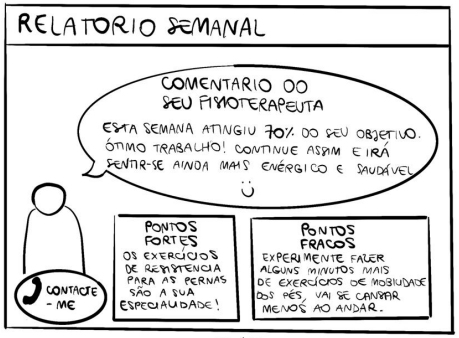

NIVÉL 4
PARABÉNS! COMPLETOU 4/7 SESSÕES NESTA SEMANA!


RELATORIO SEMANAL
OS SEUS DADOS
59 MINUTOS TOTAIS
5 SESSÕES RELIZADAS
MÉDIA DE 5 MINUTOS POR DIA
A SUA ATIVIDADE
75%
DO SEU OBJETIVO SEMANAL

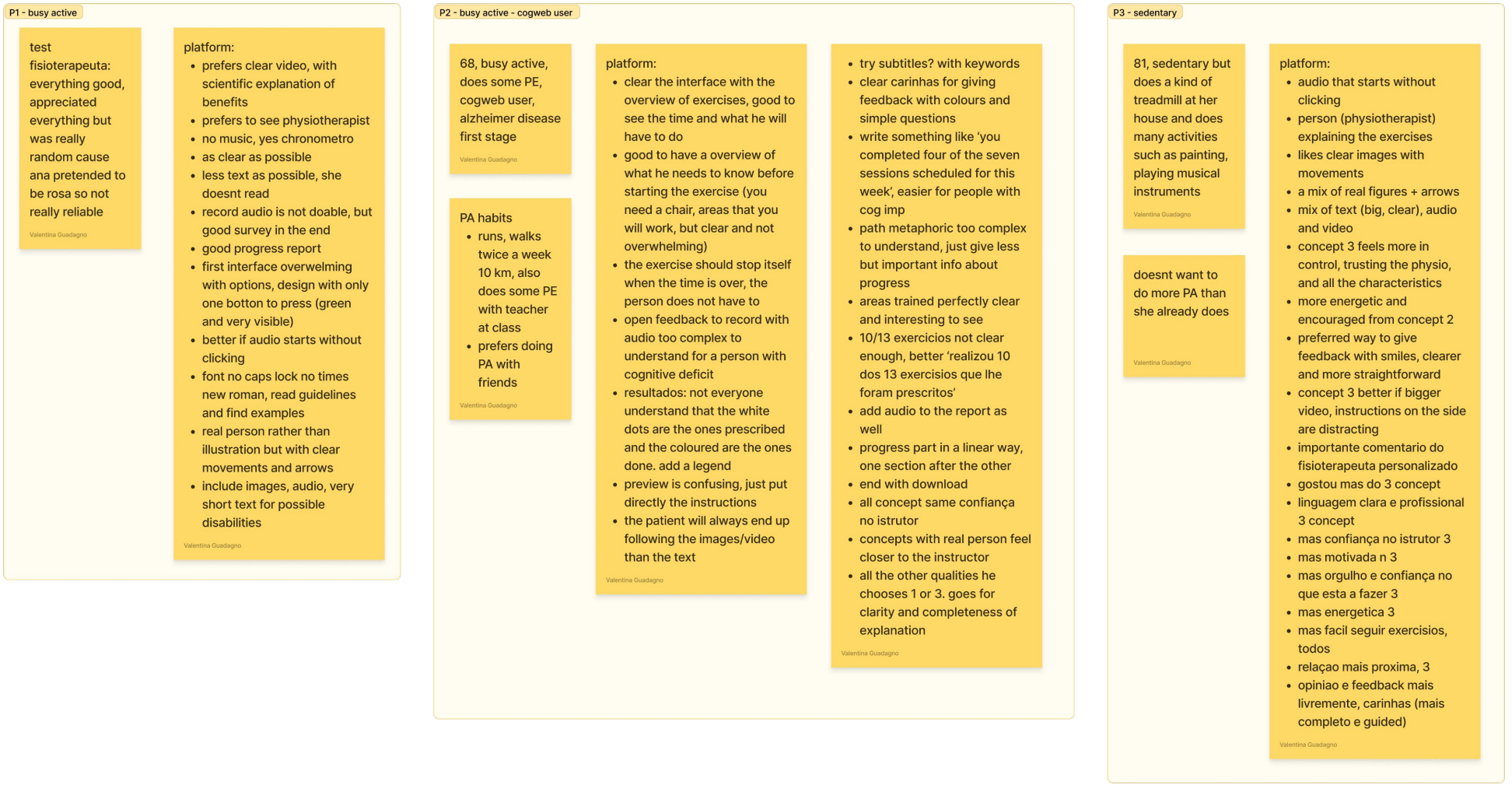
1/3


RELATORIO SEMANAL
AREAS TREINADAS
PESCOÇO 20 MINUTOS
BRAÇOS 15 MINUTOS
ABDÔMEN SUPERIOR 10 MINUTOS
ABDÔMEN INFERIOR 13 MINUTOS
PERNAS 30 MINUTOS
TREINOS REALIZADOS
RESISTENCIA 10/13 EXERCÍCIOS
MOBILIDADE 8/9 EXERCÍCIO
AERÓBICA 6/11 EXERCÍCIOS

2/3


RELATORIO SEMANAL
COMENTARIO DO SEU FISIOTERAPEUTA
ESTA SEMANA ATINGIU 70% DO SEU OBJETIVO. ÓTIMO TRABALHO! CONTINUE ASSIM E IRÁ SENTIR-SE AINDA MAIS ENÉRGICO E SAUDÁVEL
CONTACTE - ME
PONTOS FORTES
OS EXERCÍCIOS DE RESISTENCIA PARA AS PERNAS SÃO A SUA ESPECIALIDADE!
PONTOS FRACOS
EXPERIMENTE FAZER ALGUNS MINUTOS MAIS DE EXERCÍCIOS DE MOBILIDADE DOS PÉS, VAI SE CANSAR MENOS AO ANDAR.

3/3


P1 - busy active
test fisioterapeuta: everything good, appreciated everything but was really random cause ana pretended to be rosa so not really reliable
Valentina Guadagno
platform:
• prefers clear video, with scientific explanation of benefits
• prefers to see physiotherapist
• no music, yes chronometro
• as clear as possible
• less text as possible, she doesnt read
• record audio is not doable, but good survey in the end
• good progress report
• first interface overwelming with options, design with only one botton to press (green and very visible)
• better if audio starts without clicking
• font no caps lock no times new roman, read guidelines and find examples
• real person rather than illustration but with clear movements and arrows
• include images, audio, very short text for possible disabilities
Valentina Guadagno
P2 - busy active - cogweb user
68, busy active, does some PE, cogweb user, alzheimer disease first stage
Valentina Guadagno
PA habits
• runs, walks twice a week 10 km, also does some PE with teacher at class
• prefers doing PA with friends
Valentina Guadagno
platform:
• clear the interface with the overview of exercises, good to see the time and what he will have to do
• good to have a overview of what he needs to know before starting the exercise (you need a chair, areas that you will work, but clear and not overwhelming)
• the exercise should stop itself when the time is over, the person does not have to
• open feedback to record with audio too complex to understand for a person with cognitive deficit
• resultados: not everyone understand that the white dots are the ones prescribed and the coloured are the ones done. add a legend
• preview is confusing, just put directly the instructions
• the patient will always end up following the images/video than the text
Valentina Guadagno
• try subtitles? with keywords
• clear carinhas for giving feedback with colours and simple questions
• write something like 'you completed four of the seven sessions scheduled for this week', easier for people with cog imp
• path metaphoric too complex to understand, just give less but important info about progress
• areas trained perfectly clear and interesting to see
• 10/13 exercicios not clear enough, better 'realizou 10 dos 13 exercisios que lhe foram prescritos'
• add audio to the report as well
• progress part in a linear way, one section after the other
• end with download
• all concept same confiança no istrutor
• concepts with real person feel closer to the instructor
• all the other qualities he chooses 1 or 3. goes for clarity and completeness of explanation
Valentina Guadagno
P3 - sedentary
81, sedentary but does a kind of treadmill at her house and does many activities such as painting, playing musical instruments
Valentina Guadagno
doesnt want to do more PA than she already does
Valentina Guadagno
platform:
• audio that starts without clicking
• person (physiotherapist) explaining the exercises
• likes clear images with movements
• a mix of real figures + arrows
• mix of text (big, clear), audio and video
• concept 3 feels more in control, trusting the physio, and all the characteristics
• more energetic and encouraged from concept 2
• preferred way to give feedback with smiles, clearer and more straightforward
• concept 3 better if bigger video, instructions on the side are distracting
• importante comentario do fisioterapeuta personalizado
• gostou mas do 3 concept
• linguagem clara e profissional 3 concept
• mas confiança no istrutor 3
• mas motivada n 3
• mas orgulho e confiança no que esta a fazer 3
• mas energetica 3
• mas facil seguir exercisios, todos
• relaçao mais proxima, 3
• opiniao e feedback mais livremente, carinhas (mais completo e guided)
Valentina Guadagno

G. Test iteration 2 materials

EXERCISE 1
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 2
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 3
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 4
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 5
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 6
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 7
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 8
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 9
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 10
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 11
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

EXERCISE 12
- How much was it fun?
  1 (not at all) 2 3 4 5 (a lot)
- How much was it easy to understand?
  1 (not at all) 2 3 4 5 (a lot)
- How much likely would you do it again?
  1 (not at all) 2 3 4 5 (a lot)

Test 2 – Script

Introduction
- Introduce ourselves
- Introduce the research goal
- Explain the activity: vai simular uma sessão de exercícios físicos em diferentes tarefas. Estas tarefas podem ser jogos (como quiz e adivinhas), desportos, atividades baseadas em passatempos como leitura, musica ou desenho, o simples exercicios fisicos a seguir uma instrutora. Após cada exercício vou-lhe perguntar quanto achou que foram divertidos e quanto foi simples seguir as istruções. Vou-lhe perguntar as suas opiniões em geral também.
- It should last around 20 minutes

Test
- Open the powerpoint and follow the instructions (the file has some bugs so it needs the coordination of valentina for moving the slides)
- After each exercise ask the questions from the evaluation form (evaluate from 1 to 5 how much the exercise is fun, how much is easy to understand, how much likely they would do it again); and their qualitative considerations
- Perguntar se preferem jogos, desportos, passatempos ou só exercícios

Conclusion
- Any recommendations, suggestions or anything you want to say?
- Obrigada e beijinhos

Exercício 1
DESPORTO
Dança

Exercício 1

Neste exercício, vai dançar.
Siga os passos de dança da instrutora que verá no vídeo no próximo ecrã.

INICIAR

Exercício 1 | DESPORTO: DANÇA INSTRUÇÃO

Exercício 2
DESPORTO
Ténis

Exercício 2

Neste exercício, vai jogar ténis.
Siga o jogador, deslocando-se para a esquerda e para a direita para bater na bola.

INICIAR

Exercício 2 | DESPORTO: TÉNIS INSTRUÇÃO

Exercício 3
DESPORTO
Futebal

Exercício 3

Neste exercício, vai marcar penaltis. Remate como o jogador para marcar golos.

INICIAR

Exercício 3 | DESPORTO: FUTEBOL INSTRUÇÃO

Exercício 4
ADIVINHA

Exercício 4

Responda as adivinhas que verá nos próximos ecrãs. Verá também uma **pessoa que lhe dá pistas** através de movimentos. **Siga os movimentos** da pessoa e depois dê a resposta oralmente.

INICIAR

Exercício 4 ADIVINHA | 1/2 INSTRUÇÃO

Sou verde, mas fico amarelo ou vermelho quando estou maduro. Quem sou eu?

Exercício 4 ADIVINHA | 1/2 INSTRUÇÃO

Sou verde, mas fico amarelo ou vermelho quando estou maduro. Quem sou eu?

Exercício 5
QUIZ

Exercício 5

Responda as perguntas de um quiz com duas opções.
Se escolher a **opção A**, faça o **movimento A**.
Se escolher a **opção B**, faça o **movimento B**.

A 
B 

INICIAR

Exercício 5 QUIZ | 1/2 INSTRUÇÃO

Qual é a capital da Hungria?

A BUDAPEST
B SOFIA

00:20

Exercício 5 QUIZ | 1/2 INSTRUÇÃO

Qual é a capital da Hungria?

A BUDAPEST
B SOFIA

Exercício 6
BINGO

Exercício 6

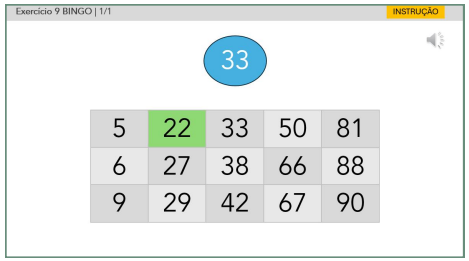
Neste jogo, vai jogar bingo. No próximo ecrã, verá uma **tabela com números**. Será chamado um número, que aparecerá na parte superior e central do ecrã.
Se tiver o número chamado, faça o **movimento seguinte**.

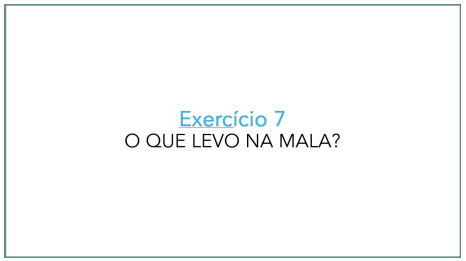
INICIAR

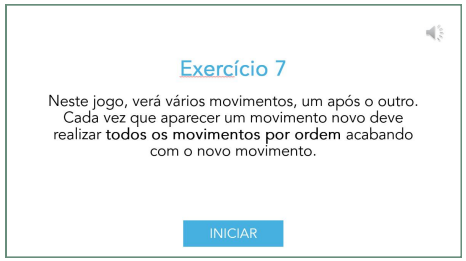
Exercício 9 BINGO | 1/1 INSTRUÇÃO

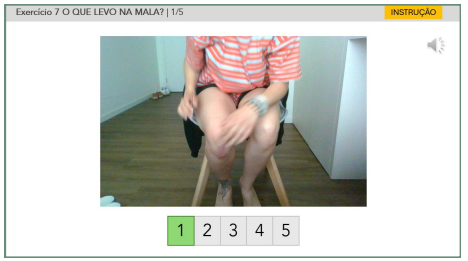
54

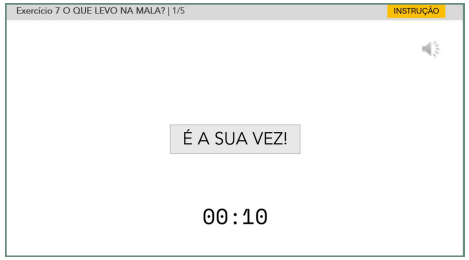
5	22	33	50	81
6	27	38	66	88
9	29	42	67	90

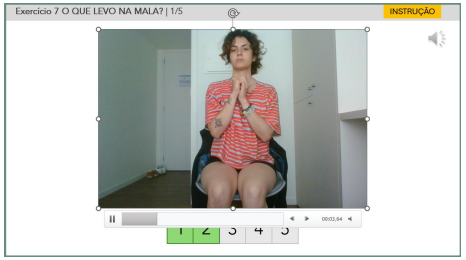

Exercício 9 BINGO | 1/1
INSTRUÇÃO
33
5 22 33 50 81
6 27 38 66 88
9 29 42 67 90

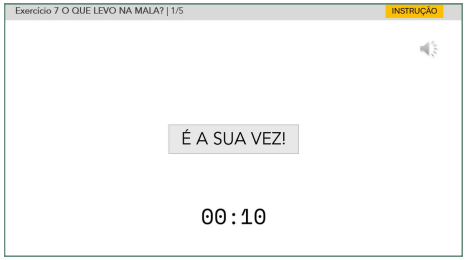

Exercício 7
O QUE LEVO NA MALA?

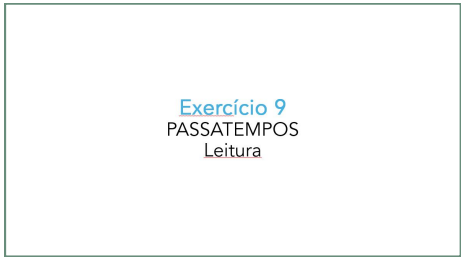

Exercício 7
Neste jogo, verá vários movimentos, um após o outro. Cada vez que aparecer um movimento novo deve realizar todos os movimentos por ordem acabando com o novo movimento.
INICIAR

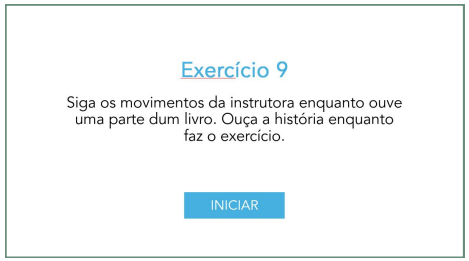

Exercício 7 O QUE LEVO NA MALA? | 1/5
INSTRUÇÃO
1 2 3 4 5

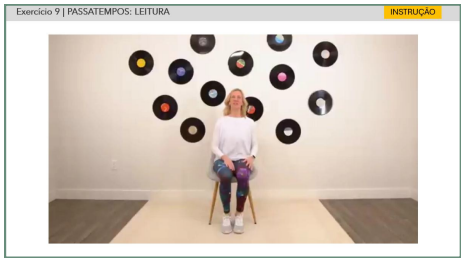

Exercício 7 O QUE LEVO NA MALA? | 1/5
INSTRUÇÃO
É A SUA VEZ!
00:10


Exercício 7 O QUE LEVO NA MALA? | 1/5
INSTRUÇÃO

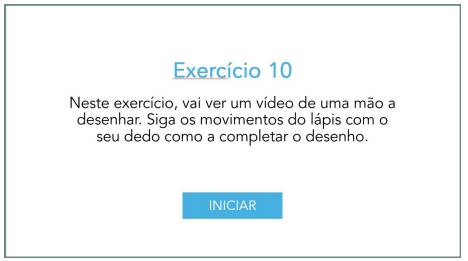

Exercício 7 O QUE LEVO NA MALA? | 1/5
INSTRUÇÃO
É A SUA VEZ!
00:10

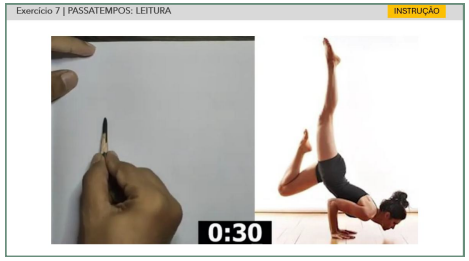

Exercício 9
PASSATEMPOS
Leitura

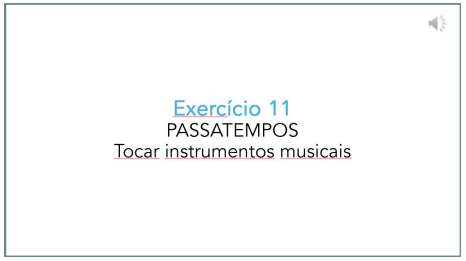

Exercício 9
Siga os movimentos da instrutora enquanto ouve uma parte dum livro. Ouça a história enquanto faz o exercício.
INICIAR

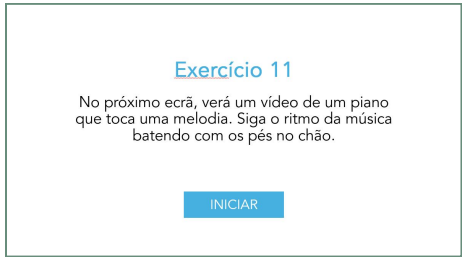

Exercício 9 | PASSATEMPOS: LEITURA
INSTRUÇÃO


Exercício 10
PASSATEMPOS
Desenho


Exercício 10
Neste exercício, vai ver um vídeo de uma mão a desenhar. Siga os movimentos do lápis com o seu dedo como a completar o desenho.
INICIAR

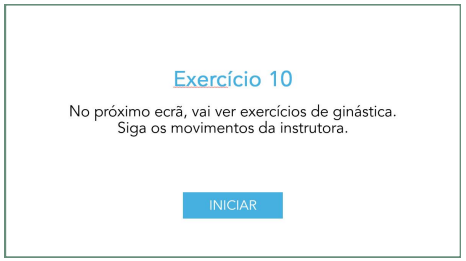

Exercício 7 | PASSATEMPOS: LEITURA
INSTRUÇÃO
0:30


Exercício 11
PASSATEMPOS
Tocar instrumentos musicais

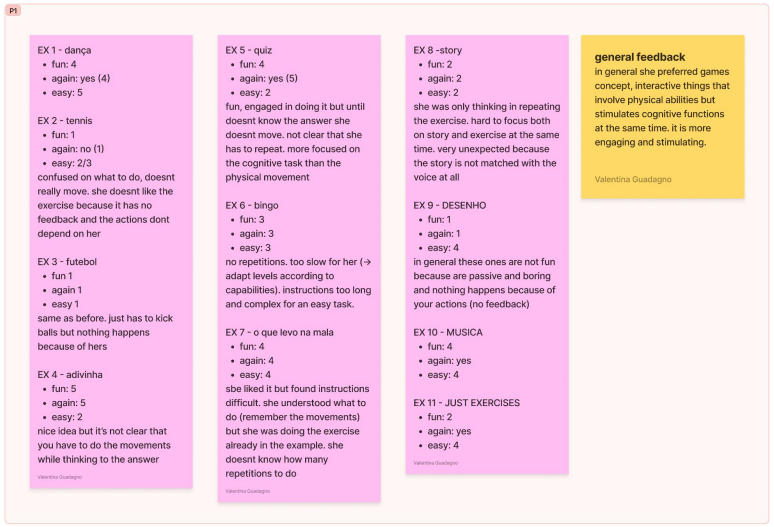

Exercício 11
No próximo ecrã, verá um vídeo de um piano que toca uma melodia. Siga o ritmo da música batendo com os pés no chão.
INICIAR


Exercício 9 | PASSATEMPOS: TOCAR INSTRUMENTOS MUSICAIS
INSTRUÇÃO
Credits in the description

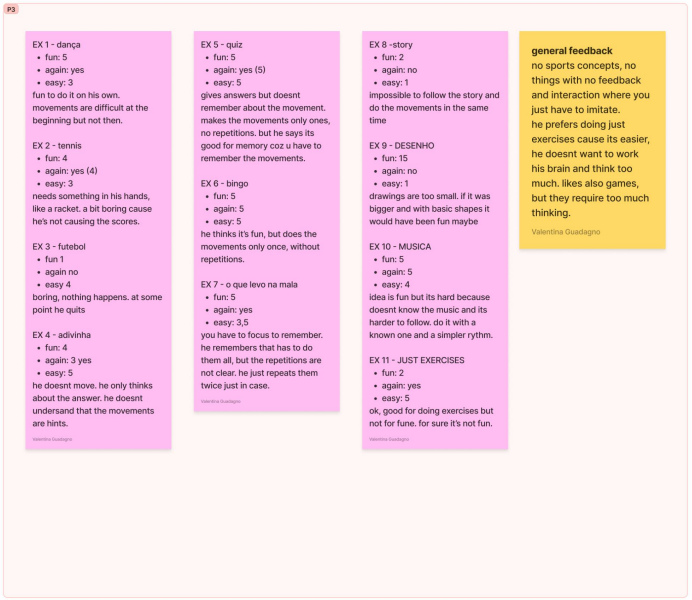

Exercício 10
GINÁSTICA
Exercícios com uma cadeira


Exercício 10
No próximo ecrã, vai ver exercícios de ginástica. Siga os movimentos da instrutora.
INICIAR


Exercício 10 | GINÁSTICA: EXERCÍCIOS COM UMA CADEIRA
INSTRUÇÃO
REPETIÇÕES


P1
EX 1 - dança
• fun: 4
• again: yes (4)
• easy: 5
EX 2 - tennis
• fun: 1
• again: no (1)
• easy: 2/3
confused on what to do, doesnt really move. she doesnt like the exercise because it has no feedback and the actions dont depend on her
EX 3 - futebol
• fun 1
• again 1
• easy 1
same as before. just has to kick balls but nothing happens because of hers
EX 4 - adivinha
• fun: 5
• again: 5
• easy: 2
nice idea but it's not clear that you have to do the movements while thinking to the answer
Valentina Guadagno
EX 5 - quiz
• fun: 4
• again: yes (5)
• easy: 2
fun, engaged in doing it but until doesnt know the answer she doesnt move. not clear that she has to repeat. more focused on the cognitive task than the physical movement
EX 6 - bingo
• fun: 3
• again: 3
• easy: 3
no repetitions. too slow for her (→ adapt levels according to capabilities). instructions too long and complex for an easy task.
EX 7 - o que levo na mala
• fun: 4
• again: 4
• easy: 4
sbe liked it but found instructions difficult. she understood what to do (remember the movements) but she was doing the exercise already in the example. she doesnt know how many repetitions to do
Valentina Guadagno
EX 8 -story
• fun: 2
• again: 2
• easy: 2
she was only thinking in repeating the exercise. hard to focus both on story and exercise at the same time. very unexpected because the story is not matched with the voice at all
EX 9 - DESENHO
• fun: 1
• again: 1
• easy: 4
in general these ones are not fun because are passive and boring and nothing happens because of your actions (no feedback)
EX 10 - MUSICA
• fun: 4
• again: yes
• easy: 4
EX 11 - JUST EXERCISES
• fun: 2
• again: yes
• easy: 4
Valentina Guadagno
general feedback
in general she preferred games concept, interactive things that involve physical abilities but stimulates cognitive functions at the same time. it is more engaging and stimulating.
Valentina Guadagno


P2
EX 1 - dança
• fun: 3
• again: yes (3)
• easy: 5
likes it because she likes dancing but believe doesnt make sense to put it in the system because if she wanted she would just have to search for dancing videos to imitate.
EX 2 - tennis
• fun: 3
• again: yes (4)
• easy: 5
if she does it at the same time she feels she's doing it. otherwise she feels stupid. if it was interactive (you are actually hitting the ball, it would be really fun)
EX 3 - futebol
• fun 2
• again no
• easy 5
boring, she only has to kick the ball with one foot. not even moving.
EX 4 - adivinha
• fun: 1
• again: no
• easy: 3
didnt really like it because she doesnt understand when to repeat the movement and feels stupid in doing it.
Valentina Guadagno
EX 5 - quiz
• fun: 5
• again: yes (5)
• easy: 2
she likes it but she doesnt remember the movement. it would help to see the movements while looking at the questions
EX 6 - bingo
• fun: 3,5
• again: yes
• easy: 4
easier with shorter instructions (for everything). makes sense introducing levels of difficulty (more/less numbers, slower or faster)
EX 7 - o que levo na mala
• fun: 3
• again: 3
• easy: 3
long and hard instructions. when they see the movements they already do it (and not when its their turn). do it only with one repetition, or specifying that the movement should be repeated. otherwise difficult to understand.
Valentina Guadagno
EX 8 -story
• fun: 2
• again: no
• easy: 1
idea good but if u first see the movement and then listen to the story while repeating the movement. helps you to distract from the fatigue. that specific combination was schizophrenic because was not at all coordinated video and story. maybe better if it's the same person who tells the story.
EX 9 - DESENHO
• fun: 1
• again: 1
• easy: 4
feels stupid coz movements too slow. better with a bigger and simpler movement.
EX 10 - MUSICA
• fun: 5
• again: 5
• easy: 1,5
idea is fun but its hard because she doesnt know the music and its harder to follow. do it with a known one.
EX 11 - JUST EXERCISES
• fun: 2
• again: 2,5 (halfway)
• easy: 4
ok but she doesnt like doing gymnastic so she would feel bored and would need something else.
Valentina Guadagno
general feedback
in general she preferred games and dual task training. like songs, tennis, answering. doing something else while exercising.
the games should be designed in a way where you could just answer with movements and not focusing on something else (for example quiz and riddles are difficult because it could happen that you only think about the question and not do the exercise) because it feels the goal is another one (just the cognitive task), which is different from levo na mala and bingo because it's directly required to perform the exercise.
Valentina Guadagno


P3
EX 1 - dança
• fun: 5
• again: yes
• easy: 3
fun to do it on his own. movements are difficult at the beginning but not then.
EX 2 - tennis
• fun: 4
• again: yes (4)
• easy: 3
needs something in his hands, like a racket. a bit boring cause he's not causing the scores.
EX 3 - futebol
• fun 1
• again no
• easy 4
boring, nothing happens. at some point he quits
EX 4 - adivinha
• fun: 4
• again: 3 yes
• easy: 5
he doesnt move. he only thinks about the answer. he doesnt undersand that the movements are hints.
Valentina Guadagno
EX 5 - quiz
• fun: 5
• again: yes (5)
• easy: 5
gives answers but doesnt remember about the movement. makes the movements only ones, no repetitions. but he says its good for memory coz u have to remember the movements.
EX 6 - bingo
• fun: 5
• again: 5
• easy: 5
he thinks it's fun, but does the movements only once, without repetitions.
EX 7 - o que levo na mala
• fun: 5
• again: yes
• easy: 3,5
you have to focus to remember. he remembers that has to do them all, but the repetitions are not clear. he just repeats them twice just in case.
Valentina Guadagno
EX 8 -story
• fun: 2
• again: no
• easy: 1
impossible to follow the story and do the movements in the same time
EX 9 - DESENHO
• fun: 15
• again: no
• easy: 1
drawings are too small. if it was bigger and with basic shapes it would have been fun maybe
EX 10 - MUSICA
• fun: 5
• again: 5
• easy: 4
idea is fun but its hard because doesnt know the music and its harder to follow. do it with a known one and a simpler rythm.
EX 11 - JUST EXERCISES
• fun: 2
• again: yes
• easy: 5
ok, good for doing exercises but not for fune. for sure it's not fun.
Valentina Guadagno
general feedback
no sports concepts, no things with no feedback and interaction where you just have to imitate.
he prefers doing just exercises cause its easier, he doesnt want to work his brain and think too much. likes also games, but they require too much thinking.
Valentina Guadagno


P4 & P5
EX 1 - dança
• fun: 3, 4
• again: yes
• easy: 3, 3
nice
EX 2 - tennis
• fun: 2, 2
• again: no, yes
• easy: 5, 5
it's not interactive so it is a bit boring just to follow the movements
EX 3 - futebol
• fun 1, 1
• again: no
• easy: 5,5
same as before. nothing happens, it is boring
EX 4 - adivinha
• fun: 4, 4
• again: yes
• easy: 5,5
maria wasnt imitating the movements. she did it only in the end after she thought about the answer.
it could be useful for who has a low level of cognition, otherwise too easy (talking about the riddle itself). maria wasnt understanding that the movement was a hint, luciano was focusing only on the movement
Valentina Guadagno
EX 5 - quiz
• fun: 5, 5
• again: yes
• easy: 5,5 (1 remembering about his past condition after having a stroke)
they were remembering the movements to answer. they did as many repetions as long as the screen was showing the question. they didn't get the timer was the time for repeating the exercise, but the necessary time to guess. difficult to remember the movements to answer the questions, expecially for who has cognitive problems.
luciano suggests this sequence: movements to answer > question > right movement with right answer
EX 6 - bingo
• fun: 5, 5
• again: yes
• easy: 5, 5
generally, if the cognitive level is low it could be problematic. but the difficulty level raises with the cognitive performance. easier than the other ones because you just have to do one movement while searching for the number.
EX 7 - o que levo na mala
• fun: 5, 5
• again: yes
• easy: 5, 5
very fun and engaging. the right level of difficulty could be very challenging and engaging. (concept of FLOW)
Valentina Guadagno
EX 8 -story
• fun: 3, 4
• again: yes
• easy: 5, 4
maria was both performing the exercises and listening to the story (she repeated the story to me). however, it is difficult because it requires to focus on the movements and the story at the same time. if it was just a movement repeated, with the story in the background to distract you, it would be better and easier.
EX 9 - DESENHO
• fun: 1
• again: no
• easy: 5, 5
boring, stupid. it would be better to draw easier and basic shapes, like circles, stars, etc. this specific drawing just doesnt make sense but the idea is nice.
EX 10 - MUSIC
• fun: 5, 5
• again: yes
• easy: 5, 5
idea its good and nice, but with simpler songs to follow and probably known. like the wedding march. or the italian national anthem (lol). rythm should be slower and allow the feet moving
EX 11 - JUST EXERCISES
• fun: 4, 3
• again: yes
• easy: 5, 5
here you just focus on physical aspect. luciano would do it because he would like to do PE in general, but maria finds it a bit boring and prefers to do the cognitive exercises in the meantime
Valentina Guadagno
general feedback
P1 prefers games concept.
luciano prefers both games and exercise concepts.
they both prefer interactive games and not just seeing movements to imitate. it's more engaging if you actively have to do something, unless it's directly exercises. but maria thinks that in general if you are not already into exercises and you dont like to do them you need something more because otherwise you would just skip them. and to play at the same time would be a fun way to do it without getting bored. if you get bored and tired for the exercise you have something else that entertains you (the games).
everything should be adjust on the cognitive and physical capability. they think that basically all the concepts could be interesting if integrated in a system that alternates them and adjust them according to their level.
Valentina Guadagno

H. Test iteration 3 materials

OVERVIEW

Welcome back! I am Valentina, your physical therapist, and I am going to introduce you to the exercise session we are going to do today.
We are going to do four exercises, with a total duration of X minutes.
In this exercise, we will at the same time train both your cognitive functions, such as memory, attention and executive functions; and your body, especially *naming what you will train, like leg mobility*.
It will help you better manage your daily activities, such as remembering appointments or solving practical problems independently. At the same time, it will help you feel more energetic and feel less fatigue during the day.
For these activities, all you need is a stable chair, which we will use only in some exercises.
If you are ready to watch the first exercise, press the "Start Session" button. If you want to watch the video again instead, press "Watch video again."

INSTRUCTIONS´

1) Remember the movements
Video 1
The first exercise is "Remember the movements."
In this exercise, several movements will be presented, one at a time.
Following each movement, a screen with the words 'your turn' will appear. At that time, you will have to repeat the movements shown on the previous screen. Pay attention because there will be more and more movements to remember and repeat. This exercise is great for your body, but also for your memory!
Click on "See Example" to see a demonstration example.

Video 2
video example
If you are ready to start, press "Start Session." If you want to watch the video again, press on "Watch video again."

Exercise
Comment: *exercise description 1.*
Repeat: Repeat the previous movement.
Observe: *Exercise description 1+2.*
Repeat: Repeat the previous movements.
Observe: *Exercise description 1+2+3.*
Repeat: Repeat the previous movements.

OVERVIEW

Bentornati! Sono Valentina, la vostra fisioterapista e vi presenterò la sessione di esercizi che faremo oggi.
Andremo a fare quattro esercizi, con una durata totale di X minuti.
In questo esercizio, alleneremo allo stesso tempo sia le vostre funzioni cognitive, come la memoria, l'attenzione e le funzioni esecutive; sia il vostro corpo, in particolare *nominare cosa si allenerà, tipo mobilità delle gambe*.
Vi aiuterà a gestire meglio le vostre attività quotidiane, come ricordare appuntamenti o risolvere problemi pratici in autonomia. Allo stesso tempo, vi aiuterà a sentirvi più energici e a sentire minor fatica durante il giorno.
Per queste attività, tutto ciò che serve è una sedia stabile, che useremo solo in alcuni esercizi.
Se siete pronti per vedere il primo esercizio, premete il pulsante "Inizia sessione".
Se invece volete riguardare il video, premete su "Riguarda video".

ISTRUZIONI´

1) Ricorda i movimenti
Video 1
Il primo esercizio è "Ricorda i movimenti".
In questo esercizio, verranno presentati diversi movimenti, uno alla volta.
A seguito di ogni movimento, apparirà una schermata con la scritta 'tocca a te'. In quel momento, dovrete ripetere i movimenti mostrati nella schermata precedente.
Prestate attenzione perché i movimenti da ricordare e ripetere saranno sempre di più. Questo esercizio è ottimo per il vostro corpo, ma anche per la memoria!
Cliccate su "Vedi esempio" per vedere un esempio dimostrativo.

Video 2
video esempio
Se siete pronti per iniziare, premere su "Inizia sessione". Se volete riguardare il video, premere su "Riguarda video".

Esercizio
Osserva: *Descrizione esercizio 1.*
Ripetere: Ripetete il movimento precedente.
Osserva: *Descrizione esercizio 1+2.*
Ripetere: Ripetete i movimenti precedenti.
Osserva: *Descrizione esercizio 1+2+3.*
Ripetere: Ripetete i movimenti precedenti.

Observe: *Exercise description 1+2+3+4.*
Repeat: Repeat the previous movements.

2) Bingo
Video 1
In this exercise, you will play bingo. On your screen, you will have a table with numbers. Numbers will be called, and they will appear at the top and middle of the screen. If you have in your table the number called, do the movement you will see to the left of the table. This exercise is great for your body, but also for improving your attention.
Click on "See example" to see a demonstration example.

Video example
video example
If you are ready to start, press "Start Session." If you want to watch the video again, press on "Watch video again."

Exercise
2 - 56 - 74 - 85 - 11 - 30

3) Follow the arrow
Video 1
On the next screen, you will see four arrows as shown on the screen. To each arrow, corresponds a movement. When an arrow lights up, repeat the movement corresponding to it. This exercise is useful for improving your executive functions and your body. Click on "See example" to see a demonstration example.

Video example
example video
If you are ready to start, press on "Start session". If you want to watch the video again, press on "Watch video again".

4) Keep the beat
Video 1
In this exercise, you will hear a melody. Tap your feet on the floor by raising and lowering your knees to follow the rhythm of the music. Click on "See example" to see a demonstration example.

Osserva: *Descrizione esercizio 1+2+3+4.*
Ripetere: Ripetete i movimenti precedenti.

2) Bingo
Video 1
In questo esercizio, giocherete a bingo. Sul vostro schermo, avrete una tabella con dei numeri. Saranno chiamati dei numeri, che appariranno nella parte superiore e centrale dello schermo. Se avete nella vostra tabella il numero chiamato, fate il movimento che vedrete a sinistra della tabella. Questo esercizio è ottimo per il vostro corpo, ma anche per migliorare la vostra attenzione.
Cliccate su "Vedi esempio" per vedere un esempio dimostrativo.

Video esempio
video esempio
Se siete pronti per iniziare, premere su "Inizia sessione". Se volete riguardare il video, premere su "Riguarda video".

Esercizio
2 – 56 – 74 – 85 – 11 - 30

3) Segui la freccia
Video 1
Nel prossimo schermo, vedrete quattro frecce come mostrato nello schermo. Ad ogni freccia, corrisponde un movimento. Quando si illumina una freccia, ripetete il movimento corrispondente ad essa. Questo esercizio è utile per migliorare le vostre funzioni esecutive e il vostro corpo. Cliccate su "Vedi esempio" per vedere un esempio dimostrativo.

Video esempio
video esempio
Se siete pronti per iniziare, premere su "Inizia sessione". Se volete riguardare il video, premere su "Riguarda video".

4) Tieni il ritmo
Video 1
In questo esercizio, sentirai una melodia. Batti i piedi sul pavimento alzando e abbassando le ginocchia per seguire il ritmo della musica. Cliccate su "Vedi esempio" per vedere un esempio dimostrativo.

Video example
video example
If you are ready to start, press "Start Session." If you want to watch the video again, press on "Watch video again."

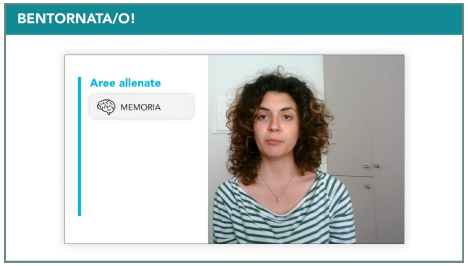
FEEDBACK
The session has ended. Please share your opinion with us by clicking on the smiley face that best represents you.
How much did you enjoy the physical exercises?
How much did you enjoy the games?
How easy did you find it to understand and carry out the instructions?

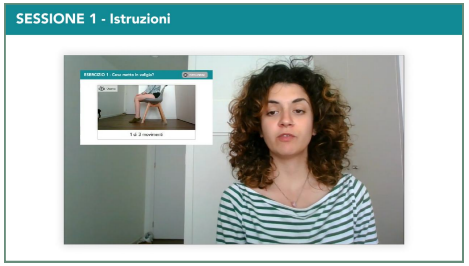
Video esempio
video esempio
Se siete pronti per iniziare, premere su "Inizia sessione". Se volete riguardare il video, premere su "Riguarda video".

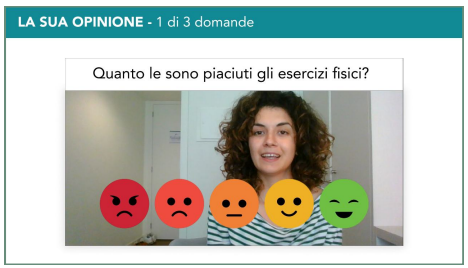
FEEDBACK
La sessione è terminata. Per favore, condivida con noi la sua opinione cliccando sulla faccina che più la rappresenta.
Quanto le sono piaciuti gli esercizi fisici?
Quanto le sono piaciuti i giochi?
Quanto ha trovato facile capire ed eseguire le istruzioni?

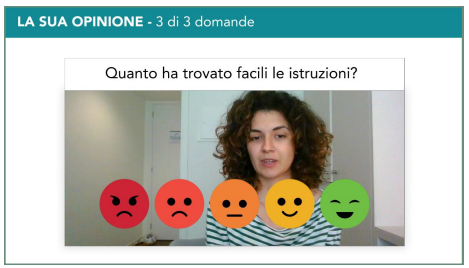
EVALUATION FORM
- Overview
  - Che ne pensi di questa parte?
- Instructions
  - Che ne pensi di questa parte?
- Esercizi
  - Che ne pensi di questo esercizio e di come è spiegato?
- Feedback
  - Che ne pensi di questo modo di dare feedback?
- Valuta da 1 a 5 quanto:
  - Il gioco/esercizio sia stato coinvolgente: 2, 1, 3
  - Ti sia sentito guidato in maniera chiara: 5, 5, 4
  - Ti sei sentito di poterti affidare alla guida e alle istruzioni: 5, 3 (non aveva capito ripetere istruzioni), 4
  - Ti sei sentito capace di svolgere gli esercizi: 5, 5, 5
- Hai feedback in generale da dare per migliorare questo concept?: più chiare istruzioni, più esercizi coinvolgenti e complessi, motivante sarebbe confrontarsi con gli altri e sapere di non essere l'unico incapace
- Rifaresti una sessione del genere, immaginando che oltre a questo unico esercizio ce ne siano altri simili ma con attività differenti?

EVALUATION FORM
- Overview
  - Che ne pensi di questa parte?
- Instructions
  - Che ne pensi di questa parte?
- Esercizi
  - Che ne pensi di questo esercizio e di come è spiegato?
- Feedback
  - Che ne pensi di questo modo di dare feedback?
- Valuta da 1 a 5 quanto:
  - Il gioco/esercizio sia stato coinvolgente: 2, 1, 3
  - Ti sia sentito guidato in maniera chiara: 5, 5, 4
  - Ti sei sentito di poterti affidare alla guida e alle istruzioni: 5, 3 (non aveva capito ripetere istruzioni), 4
  - Ti sei sentito capace di svolgere gli esercizi: 5, 5, 5
- Hai feedback in generale da dare per migliorare questo concept?: più chiare istruzioni, più esercizi coinvolgenti e complessi, motivante sarebbe confrontarsi con gli altri e sapere di non essere l'unico incapace
- Rifaresti una sessione del genere, immaginando che oltre a questo unico esercizio ce ne siano altri simili ma con attività differenti?









FULL PROTOTYPE

SCAN ME

I. Final prototype

NIVEL MEIO-FÁCIL

OVERVIEW

Bem-vindo de volta! Sou Valentina, a sua fisioterapeuta, e vou apresentar a sessão de exercícios que faremos hoje.
Vamos fazer quatro exercícios, com uma duração total de X minutos.
Nesta sessão, vai treinar ao mesmo tempo tanto o seu cérebro quanto o seu corpo. Em particular, vamos treinar a memória, a atenção e as funções executivas; e ao mesmo tempo faremos exercícios para a mobilidade e a força de todo o corpo, concentrando-nos nos músculos das pernas, braços, pescoço e costas.
Isso vai ajudá-lo a gerir melhor as suas atividades diárias, como lembrar de compromissos ou resolver problemas práticos de forma autónoma, e vai ajudá-lo a sentir-se mais energético e a sentir menos cansaço durante o dia.
Para estas atividades, tudo o que é necessário é uma cadeira estável, que usaremos apenas em alguns exercícios.
Se estiver pronto para ver o primeiro exercício, carregue no botão "Iniciar sessão". Se preferir rever o vídeo, carregue no botão "Rever vídeo"

ISTRUÇÕES

1) Lembrar os movimentos

Vídeo.7
O primeiro exercício é "Lembrar os movimentos".
Neste exercício, serão apresentados diversos movimentos, um de cada vez.
Após cada movimento, aparecerá uma tela com a mensagem 'sua vez'. Nesse momento, você deve repetir os movimentos mostrados na tela anterior e clicar no botão 'terminei' quando acabar. Preste atenção, porque os movimentos para lembrar e repetir serão cada vez mais. Este exercício é ótimo para todo o seu corpo, mas também para a memória!
Se estiver pronto para começar, pressione "Iniciar sessão". Se quiser rever o vídeo, pressione "Rever vídeo".

Exercício

Movimento 1
Primeiro movimento, sentado numa cadeira. Estendemos os braços na horizontal e fazemos dois círculos para a frente e dois para trás.

Repetir
Repita o movimento anterior. Pressione "terminei" quando terminar.

Movimento 2
Refazemos o movimento anterior com os braços. Um, dois. Um, dois. Depois, inclinamos o pescoço primeiro para a direita e depois para a esquerda.

MEDIUM-EASY LEVEL

OVERVIEW
Welcome back! I'm Valentina, your physiotherapist, and I'm going to introduce the exercise session we'll be doing today.
We're going to do four exercises, lasting a total of X minutes.
In this session, you'll train both your brain and your body at the same time. In particular, we'll train memory, attention and executive functions; and at the same time we'll do exercises for the mobility and strength of the whole body, focusing on the muscles of the legs, arms, neck and back.
This will help you to better manage your daily activities, such as remembering appointments or solving practical problems independently, and will help you to feel more energetic and less tired during the day.
For these activities, all you need is a stable chair, which we'll only use for a few exercises.
If you're ready to watch the first exercise, press the "Sign in" button. If you prefer to review the video, press the "Review video" button

ISTRUCTIONS

1) Remember the movements
Video 1
The first exercise is "Remember the movements".
In this exercise, you will be shown several movements, one at a time.
After each movement, a screen will appear with the message 'your turn'. At this point, you have to repeat the movements shown on the previous screen and click on the 'I'm done' button when you've finished. Pay attention, because there will be more and more movements to remember and repeat.
This exercise is great for your whole body, but also for your memory!
If you're ready to start, press "Start session". If you want to review the video, press "Review video".

Exercise

Movement 1
First movement, sitting on a chair. Extend your arms horizontally and make two circles forwards and two backwards.

Repeat
Repeat the previous movement. Press "I'm done" when you've finished.

Movement 2
We repeat the previous movement with our arms. One, two. One, two. Then tilt your neck first to the right and then to the left.

Repeat
Repeat the previous movements. Press "done" when you've finished.

Repetir
Repita os movimentos anteriores. Pressione "terminei" quando terminar.

Movimento 3
Refazemos os movimentos anteriores. Braços, um, dois. Um, dois. Pescoço, direita, esquerda. Depois, inclinamos o tronco para a frente até cerca de 45º com as costas retas e voltamos. Fazemos isso mais uma vez.

Repetir
Repita os movimentos anteriores. Pressione "terminei" quando terminar.

Movimento 4
Refazemos os movimentos anteriores. Braços, um, dois. Pescoço, direita, esquerda. Tronco para a frente e depois para trás. Para a frente e para trás. Depois, fazemos cinco pequenos saltos. Um, dois, três, quatro, cinco.

Repetir
Repita os movimentos anteriores. Pressione "terminei" quando terminar.

Movimento 5
Repetimos os movimentos anteriores. Braços, um, dois. Pescoço, direita, esquerda. Tronco para a frente e depois para trás. Para a frente e para trás. Cinco saltos. 1 2 3 4 5. Finalmente, levantamos o joelho direito e voltamos. Fazemos o mesmo com o joelho esquerdo.

Repetir
Repita os movimentos anteriores. Pressione "terminei" quando terminar.

2) Bingo

Video.7
Neste exercício, vai jogar bingo. No seu ecrã, terá uma tabela com números. Serão chamados números que aparecerão na parte superior e central da tabela. Se tiver o número chamado na sua tabela, levante-se e erga os braços para cima, e sente-se novamente na sua cadeira. Este exercício vai fortalecer as suas pernas e melhorar a mobilidade dos braços, além de treinar a sua capacidade de atenção. Se estiver pronto para começar, clique em "Iniciar sessão". Se quiser rever o vídeo, clique em "Rever vídeo".

Exercício
2 – 56 – 74 - 27 – 85 – 11 – 32 – 51 – 77 - 18

Movement 3
We repeat the previous movements. Arms, one, two. One, two. Neck, right, left. Then tilt your torso forward to about 45º with your back straight and return. Do it one more time.

Repeat
Repeat the previous movements. Press "done" when you've finished.

Movement 4
We repeat the previous movements. Arms, one, two. Neck, right, left. Torso forward, then back. Forward and back. Then we do five small jumps. One, two, three, four, five.

Repeat
Repeat the previous movements. Press "I'm done" when you've finished.

Movement 5
Repeat the previous movements. Arms, one, two. Neck, right, left. Torso forward, then back. Forward and backward. Five jumps. 1 2 3 4 5. Finally, lift the right knee and return. Do the same with the left knee.

Movement 5
We repeat the previous movements. Arms, one, two. Neck, right, left. Torso forward, then back. Forward and backward. Five jumps. 1 2 3 4 5. Finally, lift the right knee and return. Do the same with the left knee.

Repeat
Repeat the previous movements. Press "I'm done" when you've finished.

2) Bingo

Video 1
In this exercise, you're going to play bingo. On your screen, you will have a table with numbers. Numbers will be called out and will appear at the top and in the middle of the table. If you get the number called out on your board, stand up and raise your arms high, then sit back down in your chair. This exercise will strengthen your legs and improve the mobility of your arms, as well as training your attention span. If you're ready to start, click on "Start session". If you want to review the video, click on "Review video".

Exercise
2 - 56 - 74 - 27 - 85 - 11 - 32 - 51 - 77 - 18

3) Follow the arrow

3) **Siga a seta**

Video.7
No próximo ecrã, verá quatro setas. Cada seta corresponde a um movimento. Quando uma seta se ilumina, repita o movimento correspondente. Este exercício é útil para melhorar suas funções executivas e o seu corpo. Clique em 'ver movimentos' para ver a explicação de cada movimento. Não se preocupe, continuará a vê-los durante todo o exercício.

Video.movimentos
Vamos nos levantar. Quando a seta acima se iluminar, inclinamos nosso tronco para frente, mantendo as costas retas e o abdômen contraído.
Quando a seta à direita se iluminar, inclinamos o tronco para a direita levantando o braço esquerdo para cima.
Quando a seta à esquerda se iluminar, fazemos o mesmo, a espelhar o movimento anterior.
Quando a seta para cima se iluminar, inclinamos o tronco para trás o máximo possível, mantendo as costas retas e o abdômen contraído. Se estiver pronto para começar, carregue "Iniciar sessão". Se quiser rever o vídeo, carregue "Rever vídeo".

4) **Siga o ritmo**

Vídeo 1
Neste exercício, vai ser mostrado um piano a tocar uma melodia. Siga o ritmo da música batendo os pés no chão levantando e abaixando os joelhos: bata o pé direito quando a tecla verde se iluminar, e o pé esquerdo quando a tecla azul se iluminar.
Este exercício ajudará a melhorar a mobilidade e a força das pernas, assim como as funções executivas ao mesmo tempo.
Se estiver pronto para começar, carregue "Iniciar sessão". Se desejar rever o vídeo, carregue " Rever vídeo ".

FEEDBACK
A sessão terminou, hoje fizemos progressos incríveis! Por favor, compartilhe conosco a sua opinião clicando na carinha que mais representa o que sentiu.
Quanto gostou dos exercícios físicos?
Quanto gostou dos jogos?
Quanto achou fácil entender as instruções?

Video 1
On the next screen, you'll see four arrows. Each arrow corresponds to a movement. When an arrow lights up, repeat the corresponding movement. This exercise is useful for improving your executive functions and your body. Click on 'see movements' to see an explanation of each movement. Don't worry, you'll continue to see them throughout the exercise.

Video movements
Let's stand up. When the arrow above lights up, we tilt our torso forward, keeping our back straight and our abdomen contracted.
When the arrow on the right lights up, we tilt our torso to the right, raising our left arm upwards.
When the left arrow lights up, do the same, mirroring the previous movement.
When the up arrow lights up, tilt your torso back as far as possible, keeping your back straight and your abdomen contracted. If you're ready to start, press "Start session". If you want to review the video, press "Review video".

4) Follow the rhythm

Video 1
In this exercise, you will be shown a piano playing a melody. Follow the rhythm of the music by tapping your feet on the floor while raising and lowering your knees: tap your right foot when the green key lights up, and your left foot when the blue key lights up.
This exercise will help improve leg mobility and strength, as well as executive functions at the same time.
If you're ready to start, press "Start session". If you want to review the video, press " Review video ".

FEEDBACK
The session is over, we've made incredible progress today! Please share your opinion with us by clicking on the face that most represents how you felt.
How much did you enjoy the physical exercises?
How much did you enjoy the games?
How easy did you find it to understand the instructions?

NIVEL MEIO-DIFÍCIL

OVERVIEW

Bem-vindos de volta! Sou Ana, sua fisioterapeuta, e vou apresentar a sessão de exercícios que faremos hoje.
Vamos fazer quatro exercícios, com uma duração total de X minutos. Nesta sessão, vamos treinar ao mesmo tempo o seu cérebro e o seu corpo. Em particular, vamos trabalhar a memória, a atenção e as funções executivas, além de fazer exercícios de aeróbica, mobilidade e força para todo o corpo, focando nos músculos das pernas, braços, pescoço e costas.
Isso vai ajudá-lo a gerenciar melhor as suas atividades diárias, como lembrar compromissos ou resolver problemas práticos de forma independente, e vai ajudá-lo a se sentir mais energizado e a reduzir a fadiga durante o dia.
Para essas atividades, tudo o que precisa é de uma cadeira estável, que usaremos apenas em alguns exercícios.
Se está pronto para começar o primeiro exercício, carregue no botão "Iniciar sessão". Se preferir rever o vídeo, carregue " Rever vídeo ".

ISTRUÇÕES

1) Lembrar os movimentos

Video.7
O primeiro exercício é "Lembrar os movimentos".
Neste exercício, serão apresentados diferentes movimentos, um de cada vez.
Após cada movimento, aparecerá uma tela com a mensagem 'é a sua vez'. Nesse momento, você deve repetir os movimentos mostrados na tela anterior. Preste atenção, pois os movimentos a serem lembrados e repetidos aumentarão gradualmente. Este exercício é excelente para nos aquecer e nos preparar para os próximos exercícios, além de beneficiar a memória!
Se estiver pronto para começar, carregue "Iniciar sessão". Se desejar revisar o vídeo, carregue " Rever vídeo ".

Exercício

Movimento 1
Primeiro movimento, levantamos em pé. Levantamos o joelho direito até 90° e estendemos a perna o mais alto possível, mantendo-a reta. Seguramos por cinco segundos e abaixamos. Repetimos o mesmo com a perna esquerda.

Repetir
Repetir o movimento anterior. Carregue "terminei" quando terminar.

MEDIUM-DIFFICULT LEVEL

OVERVIEW
Welcome back! I'm Ana, your physiotherapist, and I'm going to introduce the exercise session we'll be doing today.
We're going to do four exercises, lasting a total of X minutes. In this session, we're going to train your brain and your body at the same time. In particular, we're going to work on memory, attention and executive functions, as well as doing aerobic, mobility and strength exercises for your whole body, focusing on the muscles in your legs, arms, neck and back.
This will help you better manage your daily activities, such as remembering appointments or solving practical problems independently, and will help you feel more energized and reduce fatigue during the day.
For these activities, all you need is a stable chair, which we'll only use for a few exercises.
If you're ready to start the first exercise, press the "Start session" button. If you prefer to review the video, press " Review video ".

ISTRUCTIONS

1) Remember the movements
Video 1
The first exercise is "Remember the movements".
In this exercise, you will be shown different movements, one at a time.
After each movement, a screen will appear with the message 'it's your turn'. At this point, you have to repeat the movements shown on the previous screen. Pay attention, as the movements to remember and repeat will gradually increase. This exercise is excellent for warming up and preparing for the next exercises, as well as benefiting your memory!
If you're ready to start, press "Start session". If you want to review the video, press " Review video ".

Exercise

Movement 1
First movement, stand up straight. Raise your right knee to 90° and extend your leg as high as possible, keeping it straight. Hold for five seconds and lower. Repeat with the left leg.

Repeat
Repeat the previous movement. Press "I'm done" when you've finished.

Movement 2
Repeat the first movement with the knees. Right leg, five seconds raised. Left leg, one, two, three, four, five. Then, with our arms relaxed at our sides, we make circular movements with our necks. Once clockwise and once anti-clockwise.

Movimento 2
Refazemos o primeiro movimento com os joelhos. Perna direita, cinco segundos levantada. Perna esquerda, um, dois, três, quatro, cinco. Depois, com os braços relaxados ao lado do corpo, fazemos movimentos circulares com o pescoço. Uma vez no sentido horário e outra vez no sentido anti-horário.

Repetir
Repetir o movimento anterior. Carregue "terminei" quando terminar.

Movimento 3
Refazemos os movimentos anteriores. Joelho direito, um, dois, três, quatro, cinco. Joelho esquerdo, um, dois, três, quatro, cinco. Pescoço. Giramos no sentido horário e no sentido anti-horário. Depois, com as costas retas e os braços relaxados, giramos o tronco livremente de um lado para o outro por dez segundos.

Repetir
Repetir o movimento anterior. Carregue "terminei" quando terminar.

Movimento 4
Refazemos os movimentos anteriores. Joelho direito, um, dois, três, quatro, cinco. Joelho esquerdo, um, dois, três, quatro, cinco. Pescoço. Horário e anti-horário. Braços relaxados, giramos o tronco de um lado para o outro. Três, quatro, cinco, seis, sete, oito, nove, dez. Por fim, fazemos uma corrida de sete segundos chutando as pernas para trás tocando os glúteos.

Repetir
Repetir o movimento anterior. Carregue "terminei" quando terminar.

2) Bingo

Video.7
Ci levantiamo em pé. Neste exercício, você vai jogar bingo. Na sua tela, terá uma tabela com números. Os números serão chamados e aparecerão na parte superior e central da tela. Se tiver o número chamado na sua tabela, faça primeiro um agachamento e depois um salto para cima. Este exercício é excelente para treinar a força e a potência muscular, melhorar a circulação e queimar calorias. Ao mesmo tempo, também melhora a sua capacidade de atenção! Se estiver pronto para começar, pressione "Iniciar sessão". Se quiser rever o vídeo, pressione " Rever vídeo ".

Exercício
2 – 56 – 74 - 27 – 85 – 11 – 32 – 51 – 77 - 18

Repeat
Repeat the previous movement. Press "I'm done" when you've finished.

Movement 3
We repeat the previous movements. Right knee, one, two, three, four, five. Left knee, one, two, three, four, five. Neck. Turn clockwise and counterclockwise. Then, with your back straight and your arms relaxed, turn your torso freely from side to side for ten seconds.

Repeat
Repeat the previous movement. Press "I'm done" when you've finished.

Movement 4
We repeat the previous movements. Right knee, one, two, three, four, five. Left knee, one, two, three, four, five. Neck. Clockwise and anticlockwise. Arms relaxed, turn your torso from side to side. Three, four, five, six, seven, eight, nine, ten. Finally, we run for seven seconds, kicking our legs back and touching our buttocks.

Repeat
Repeat the previous movement. Press "I'm done" when you've finished.

2) Bingo

Video 1
Standing up. In this exercise, you're going to play bingo. On your screen, there will be a table with numbers. The numbers will be called and will appear at the top and middle of the screen. If you have the number called out in your table, first do a squat and then a jump up. This exercise is excellent for training muscle strength and power, improving circulation and burning calories. At the same time, it also improves your attention span! If you're ready to start, press "Start session". If you want to review the video, press " Review video ".

Exercise
2 - 56 - 74 - 27 - 85 - 11 - 32 - 51 - 77 - 18

3) Follow the arrow

Video 1
On the next screen, you will see four arrows. Each arrow corresponds to a movement. When an arrow lights up, repeat the corresponding movement. This exercise is useful for improving your executive functions and your body. Click on 'see movements' to see an explanation of each movement. Don't worry, you'll continue to see them throughout the exercise.

3) **Siga a seta**

Video.7
No próximo ecrã, verá quatro setas. Cada seta corresponde a um movimento. Quando uma seta se ilumina, repita o movimento correspondente. Este exercício é útil para melhorar suas funções executivas e seu corpo. Clique em 'ver movimentos' para ver a explicação de cada movimento. Não se preocupe, continuará vendo-os durante todo o exercício.

Video.movimentos
Levantamos-nos em pé. Quando a seta à direita se iluminar, fazemos um avanço com a perna direita para frente: dobramos ambos os joelhos a 90 graus, tocando levemente o chão com o joelho traseiro e garantindo que o joelho dianteiro fique na altura do tornozelo. Quando a seta à esquerda se iluminar, fazemos um avanço com a perna esquerda para frente. Quando a seta para cima se iluminar, fazemos um salto para cima. Quando a seta para baixo se iluminar, fazemos um agachamento, dobrando os joelhos e descendo mantendo o abdômen contraído e as costas retas. Se estiver pronto para começar, pressione "Iniciar sessão". Se quiser rever o vídeo, pressione "Rever vídeo".

4) **Siga o ritmo**

Video 1
Neste exercício, vai ser mostrado um piano a tocar uma melodia. Siga o ritmo da música batendo os pés no chão levantando e baixando os joelhos: bata o pé direito quando a tecla vermelha se iluminar, e o pé esquerdo quando a tecla azul se iluminar. Este exercício ajudará a melhorar a mobilidade e a força das pernas, além das habilidades executivas. Se estiver pronto para começar, pressione "Iniciar sessão". Se quiser rever o vídeo, pressione "Riguarda vídeo".

FEEDBACK
A sessão terminou, hoje fizemos progressos incríveis! Por favor, compartilhe conosco a sua opinião clicando na carinha que mais representa o que sentiu.
Quanto gostou dos exercícios físicos?
Quanto gostou dos jogos?
Quanto achou fácil entender as instruções?

Video movements
Stand up straight. When the arrow on the right lights up, step forward with your right leg: bend both knees to 90 degrees, lightly touching the floor with your back knee and ensuring that your front knee is at ankle height. When the left arrow lights up, step forward with your left leg. When the up arrow lights up, jump up. When the down arrow lights up, we do a squat, bending our knees and descending while keeping our abdomen tight and our back straight. If you're ready to start, press "Start session". If you want to review the video, press "Review video".

4) Follow the rhythm

Video 1
In this exercise, you will be shown a piano playing a melody. Follow the rhythm of the music by tapping your feet on the floor while raising and lowering your knees: tap your right foot when the red key lights up, and your left foot when the blue key lights up. This exercise will help improve mobility and leg strength, as well as executive skills. If you're ready to start, press "Start session". If you want to review the video, press "Riguarda video".

FEEDBACK
The session is over, we've made incredible progress today! Please share your opinion with us by clicking on the face that most represents how you felt.
How much did you enjoy the physical exercises?
How much did you enjoy the games?
How easy did you find it to understand the instructions?

FULL PROTOTYPES

Level 1 (medium-easy)

SCAN ME

Level 2 (medium-difficult)

SCAN ME

L. Final evaluation materials

FINAL EVALUATION FORM

- Ask to think out loud what they think during the exercise: what they are doing and their opinions
- Introdução
  - How much was it clear (1 to 5)
  - General opinion
- Ex. 1: Lembrar os movimentos
  - How much was it engaging (1 to 5)
  - How much was it challenging (1 to 5)
  - How much was it easy to understand (1 to 5)
  - General opinion
- Ex. 2: Siga as setas
  - How much was it engaging (1 to 5)
  - How much was it challenging (1 to 5)
  - How much was it easy to understand (1 to 5)
  - General opinion
- Ex. 3: Bingo
  - How much was it engaging (1 to 5)
  - How much was it challenging (1 to 5)
  - How much was it easy to understand (1 to 5)
  - General opinion
- Ex. 4: Siga o ritmo
  - How much was it engaging (1 to 5)
  - How much was it challenging (1 to 5)
  - How much was it easy to understand (1 to 5)
  - General opinion
- General concept: how much did you feel, from 1 to 5
  - Engaged
  - Guided
  - Trusting / you could trust the 'guide'
  - In control / capable
  - (Proud) > testable with the progress report but not present in this test
- General opinion

P1

- very clear instructions, you have to pay attention but if you do it it is clear. she was doing wrong some things but after listening to the istructions again she understood it correctly (e.g. bingo, she was moving all the time and not only when she had the number. also the loop was confusing)
- challenging also because the degree of difficulty raises
- ex 1 lembrar, she does the exercises also while 'olhar' but it is not a bad consequence cause it means she is moving more
- the levels of difficulty (expecially for the cognitive tasks) are challenging enough to be engaging and wanting to continue the game, but not too much to make her feel frustrated → flow
- the general concept is interesting cause the games create enjoyment and enterteinment, they're not just physical exercises. she would do them at home.
- she believes that they could be adapted to every condition, physical and cognitive cause the tasks are very well explained and the degree of difficulty can be easily adapted

P2

- very clear instructions
- he did all the exercises correctly
- only 'lembrar' he does the exercises while 'olhar' but just once. then did it correctly
- 'bingo' movement distract, he doesnt need it because he already remember it seeing it once
- 'ritmo' miss a bit of training, like the other exercises where there's the example of people doing it but he understood correctly
- everything is fun and challenging at the right point
- good idea for people who don't do PA at home, in this way they are entertained and engaged in a fun activity and not just forced to do exercises

P3

- physically active, does cogweb since 2018 after a traumatic brain injury. exercises for memory and language
- doesnt do physical exercises in the meanwhile but says what she would do. she would do everything correctly
- she finds some exercises fun and engaging, she laughs and she is taken
- she says that the instructions are clear, when you try it at the beginning it could be confusing for the first time, but once you do it again then it's easy
- img in bingo helps to remember the movement. but loop its a bit confusing
- setas: perna dereita is counterintuitive respect to the arrow, but it's also a degree of difficulty different for exercutive functioning (as she does a similar exercise in cogweb)
- setas is intuitive cause they literally point what you have to do
- she thinks is fun for her cause instead of clicking while doing cog exercises, she has to answer in an alternative way (moving) →at the same time instead of doing just physical exercises, you play at the same time. this double 'challenge' makes it engaging
- siga o ritmo: animation a bit confusing compared to the instructions 'when the tecla lights up, you have to move your feet' but the animation shows other things. make it match
- siga o ritmo: no example, with an example it would have been even better

P4

- lembrar: she does it correctly, both in olhar and both in repetir
- bingo: she doesnt remember to get up when there's the number. but she says it is fun
- she was really having fun and appreciating
- also confused about the teclas but she enjoys it
- 'toda a gente devia fazer isto'

quantitative evaluation
- introduction, clear: 5
- ex 1 lembrar
  - engaging: 5, 4, 5, 5
  - challenging: 4, 4, 2, 5
  - easy to understand: 5, 5, 5, 5
- ex 2 bingo
  - engaging: 5, 5, 5, 5
  - challenging: 5, 5, 3, 2
  - easy to understand: 3, 5, 5, 5
- ex 3 setas
  - engaging: 5, 5, 4, 5
  - challenging: 5, 5, 3, 3
  - easy to understand: 5, 5, 5, 5
- ex 4 siga o ritmo
  - engaging: 5, 5, 4, 5
  - challenging: 5, 5, 4, 4
  - easy to understand: 5, 5, 3, 5
- interaction qualities
  - engaged: 5, 5, 5, 5
  - guided: 5, 5, 5, 5
  - trusting: 5, 5, 5, 5
  - in control / capable: 5, 5, 5, 5
  - proud: 5, 5, 5, 5

Valentina Guadagno

M. Project brief

TU Delft

DESIGN FOR our future

IDE Master Graduation Project

Project team, procedural checks and Personal Project Brief

In this document the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document may also include involvement of an external client, however does not cover any legal matters student and client (might) agree upon. Next to that, this document facilitates the required procedural checks:

- Student defines the team, what the student is going to do/deliver and how that will come about
- Chair of the supervisory team signs, to formally approve the project's setup / Project brief
- SSC E&SA (Shared Service Centre, Education & Student Affairs) report on the student's registration and study progress
- IDE's Board of Examiners confirms the proposed supervisory team on their eligibility, and whether the student is allowed to start the Graduation Project

STUDENT DATA & MASTER PROGRAMME
Complete all fields and indicate which master(s) you are in

Family name	Guadagno	IDE master(s)	IPD ☐ Dfl ✓ SPD ☐
Initials	V.	2nd non-IDE master	
Given name	Valentina	Individual programme (date of approval)	
Student number	5860539	Medisign	✓
		HPM	☐

SUPERVISORY TEAM
Fill in he required information of supervisory team members. If applicable, company mentor is added as 2nd mentor

Chair	Jos Kraal	dept./section	HCD-AED
mentor	Christina Schneegass	dept./section	HCD-HICD
2nd mentor	Ana Isabel Martins		
client:	Neuroinova		
city:	Porto	country:	Portugal
optional comments	Prof. Ana Martins will be my supervisor from the client's side. She is associated with University of Aveiro, partner of Neuroinova for research activities.		

! Ensure a heterogeneous team. In case you wish to include team members from the same section, explain why.

! Chair should request the IDE Board of Examiners for approval when a non-IDE mentor is proposed. Include CV and motivation letter.

! 2nd mentor only applies when a client is involved.

APPROVAL OF CHAIR on PROJECT PROPOSAL / PROJECT BRIEF -> to be filled in by the Chair of the supervisory team

Sign for approval (Chair)

Name Jos Kraal Date 26 Mar 2024 Signature

TU Delft

DESIGN FOR our future

Personal Project Brief – IDE Master Graduation Project

Name student Valentina Guadagno Student number 5,860,539

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

Project title Optimizing the adherence of older adults to cognitive and physical remote training for an active and healthy aging

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)

This graduation project is conducted in partnership with Neuroinova, a Portuguese company specializing in technology development for cognitive rehabilitation. The primary focus will be their product ACTIVAS, which aims to ensure an enhanced, active and healthy quality of life for the elderly population through intelligent products and services. One of ACTIVAS' areas of intervention will be the development of a web-based program to promote human functionality through the integration of physical exercises into Neuroinova's main product for remote cognitive rehabilitation, CogWeb.
The elderly population is expected to increase significantly by 2050, with a notable rise in individuals over the age of 80 [1]. Ageing often brings about issues related to cognitive, physical, and social decline [2], leading to increased care costs in the long term. It is a priority to apply health and social policies that slow the rate of health decline associated with ageing. [3] Interventions such as physical activity (PA) and cognitive training (CT) programs are proven to be effective to counteract these challenges and promote better health outcomes [2]. Continuous personalized assistance from healthcare practitioners is vital but often requires extensive resources and personnel. Remote training can be a facilitator in overcoming social and spatial barriers, enabling easy communication, providing feedback, and increasing motivation for elderly individuals to engage in activities that promote their well-being and active ageing [5,6].
It is necessary, to reach ACTIVAS' main goal, to guarantee the adherence of end users to the physical and cognitive remote program. Opportunities will be generated by understanding the perception of users and their healthcare practitioners and exercise providers of barriers and motivators towards CT, PA and remote platforms (Figure 1).
Other opportunities: knowledge and resources offered by the collaboration with Neuroinova and the close contact with users, experts and professionals. Experience acquired in previous design projects with elderly users.
Stakeholders: users >65 with risk of developing cognitive impairments. Neuroinova will allow access to the main actors and resources. R&D team, neuropsychologists, web developers and the commercial team closely involved. University of Aveiro will contribute to carry out research activities. Others will be caregivers, family members and healthcare practitioners.
Limitations: challenges due to cognitive and physical decline of users. Portuguese communication expected with users. Low digital literacy of users. Regulatory, ethical, technology, costs and resource limitations. Time costraint of 100 days.

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introduction (continued): space for images

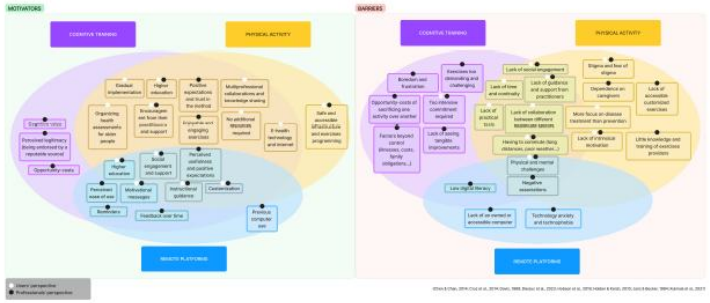

image / figure 1 Barriers & Motivators of cognitive training, physical activity and remote platforms

image / figure 2 Research Questions & Guidelines and respective methods

DESIGN FOR our future

TU Delft

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)

Neuroinova offers a remote platform for cognitive training, CogWeb, scientifically validated and used by healthcare practitioners for cognitive rehabilitation. Its efficacy is evidenced by the good results obtained in terms of patient adherence and training intensity [7]. However, despite its effectiveness, users of the platform exhibit poor levels of physical activity, a crucial component in mitigating the decline of health conditions and their impact on functional abilities. Neuroinova is working on reaching ACTIVAS' goal through the implementation of physical activity into CogWeb. While a first stage interface has already been designed and tested by usability experts, revealing several issues, actual user feedback remains unexplored. My intervention would bridge this gap by actively involving users, fundamental for understanding their experience. The program's ability to ensure adherence remains in general untested: my intervention would aim to investigate the factors that influence it and to make use of them to enhance user engagement and motivation. Additionally, the project includes designing the interface where healthcare practitioners prescribe the exercises, which still has to be developed. Studies have consistently highlighted the role of encouragement, motivation, support, and guidance in facilitating adherence to such interventions [8, 9, 10]. My role extends to investigate the relationship between users and practitioners from the professionals' perspective as well, and to design the platform in a way to effectively support and track their patients, aiming for the program success. Given the availability of both users and experts, there exists an opportunity to identify commonalities and gaps to formulate an intervention to reach ACTIVAS' goal.

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:

(Re)design a remote web-based platform for older adults that integrates physical activity exercises to Neuroinova's cognitive training program, CogWeb, with the supervision of a specialized practitioner. My objective is to design this integration by ensuring an increased adherence of users to the program through a supportive, engaging and guided interaction with their healthcare practitioners.

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)

My approach will follow a first research phase guided by targeted research questions to acquire knowledge on:
- Physical activity among the elderly in general and those with cognitive deficits, with a focus on the situation in Portugal
- Cognitive training, with a focus on the situation in Portugal
- Company: main products, areas of intervention, approach on cognitive training and how they intend to implement PA
- Remote training platforms: benefits and case studies
- Stakeholders involved: users, professionals, and their perception on barriers, motivators, needs, preferences and routines
- Modalities of intervention and prevention

The research methods for each research question are mapped in Fig. 2. I will use secondary sources such as literature reviews, company reports, and market research. These will be supplemented with on-field research activities with users, experts, and other relevant stakeholders. I will conduct usability analysis and study the CogWeb platform and the one developed for physical activity. Based on the insights generated from the research, I will propose and test several different concepts, that will involve a subsequent evaluation, aimed to reflect and improve the design. By iterating this process and gathering feedback, the final goal will be the convergence of a single, optimized concept design.

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	22 Mar 2024
Mid-term evaluation	17 Mag 2024
Green light meeting	19 Lug 2024
Graduation ceremony	30 Ago 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	
Number of project days per week	

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)

Embarking on this project resonates with my passion for user-centered design, aiming to meet individuals' needs and motivations. As a medisign student, I find great purpose in designing solutions that create a meaningful impact and improve the lives of individuals in vulnerable or disadvantaged conditions. This project presents the opportunity to combine my passion and curiosity with a focus on improving the quality of life of elderly individuals by addressing an important societal issue: preventing and delaying the decrease of health conditions of the elderly members of our society.
Expanding my knowledge of cognitive psychology learning from the company's expertise is a key aspect I aim to explore further, given my fascination for psychology and my attitude to include it in user research.
Collaborating with a company and a university research team expert in the field presents an invaluable opportunity for professional and academic growth, allowing me to bridge theoretical knowledge with practical application in a real-world setting. Throughout this project, I aim to refine my user research skills, empathize with users, and apply user-centered design principles effectively. This implies employing qualitative research methods like interviews and focus groups to gather explicit perception on needs and preferences. Additionally, I aim to conduct generative sessions with users, leveraging their latent and tacit knowledge [11] and co-design sessions with experts, actively involving them in the design process making use of their experience and expertise. Furthermore, this project presents an opportunity to enhance collaboration and communication skills by actively engaging stakeholders for diverse perspectives and feedback. Ultimately, my goal is to contribute to social impact by positively impacting the lives of elderly users at risk of developing cognitive impairments through lifestyle interventions.