COGNIVITRA

D1.2 – CO-DESIGN RESULTS

DOCUMENT ID - TYPE:	D1.2 (REPORT)	**PROJECT TITLE:**	COGNItive VItality TRAining at home (COGNIVITRA)
DELIVERABLE LEADER:	RHZ	**GRANT AGREEMENT Nº:**	AAL-2018-5-115-CP
DUE DATE:	V1.0 30/09/2019 V2.0 31/01/2021	**CONTRACT START DATE:**	1 February 2019
DELIVERY DATE:	V1.0 30/09/2019 V2.0 31/01/2021	**CONTRACT DURATION:**	36 Months
DISSEMINATION LEVEL:	Public	**PROJECT COORDINATOR:**	IPN
STATUS - VERSION:	2.0	**LAST UPDATED:**	24/02/2021

(Page intentionally blanked)

AUTHORS - CONTRIBUTORS

Name	Organization
Alireza Emami	IPN
Lúcia Neves	IPN
Sérgio Sousa	IPN
André Gradil	IPN
David Beshain	RHZ

PEER REVIEWERS

Name	Organization
Judit López	PSSJD
João Quintas	IPN

REVISION HISTORY

Version	Date	Author/Organisation	Modifications
0.1	03.04.2019	João Quintas / IPN	Initial version of the document
0.2	29.05.2019	Alireza Emami / IPN	Add new section
0.3	28.06.2019	Alireza Emami / IPN	Chapter 3 added info
0.4	24.09.2019	Alireza Emami / IPN	New section 5 and restructured old section 5 now 6
1.0	29.09.2019	João Quintas / IPN David Beshain / RHZ	Revision / proof reading / Release
1.1	20.12.2019	Alireza Emami / IPN	Section restructuring, added new content in section 3
1.2	20.02.2020	Alireza Emami / IPN	Added new content in section 4
1.3	23.06.2020	André Gradil / IPN	Added new content in section 3
1.4	16.07.2020	Sérgio Sousa / IPN	Added new content in section 3
1.5	30.07.2020	Judit López / PSSJD	Revision

1.6	05.08.2020	Lúcia Neves / IPN	Update section 4 and revision
1.7	11.08.2020	Hugo Santos / NIV	Add new content in section 3
1.8	12.08.2020	João Quintas / IPN David Beshain / RHZ	Revision and Release
2.0	31.01.2021	Hugo Santos / NIV Sérgio Sousa / IPN	New content. Revision and release

GLOSSARY

ABBREVIATION	DESCRIPTION
ANI-VA	Advanced Natural Interaction Virtual Agent
MVP	Minimum Value Product
SBC	Single Board Computer

Executive Summary

This document will present the requirements from the COGNIVITRA system, where these requirements are defined by possible end-users. The features identified in the Co-creation process will be detailed in this document. The results will serve as an aid to understanding and clarifying users' requirements and expectations of the system's functionality and to provide a basis for the definition of the different system functional features.

For the conceptualization of requirements, we organize a design-thinking session, with focus groups to determine what is more important for all involved stakeholders in the process, i.e. not only technical partners and health care professionals that represent themselves but also informal caregivers and patients.

More than inviting designers or engineers to contribute to the process, users, customers, patients and other stakeholders are crucial to confront the big issues and develop actionable ways to improve their current experiences or co-create a new solution.

Table of Contents

Index of Figure

Index of Table

1. Introduction

The involvement of all parts is crucial to build a system that is realistic from technicians' point of view as well as the expectation of the final users like physicians, nurses, informal caregivers and patients.

1.1. Brain Writing Process

The brain writing process was developed since the kick of meeting in the monthly technical meetings where the inputs from the Personas Method, Value Proposition, User Stories and the Questionnaire are widely discussed to extract the key features to the CogniViTra. During these sessions the approach of "Minimum Value Product" was defined according to the features that are crucial to demonstrate the idea and collect more inputs and validation, at this point two MVP was delivered and the MVP3 is under development.

The first MVP has a Virtual Agent UI, a few games and allow the interaction by mouse click or by visual interaction with the user face position all deploy in a SBC with a web cam connected, this version was tested by external users on AAL Forum 2019.

In the MVP2 the number of games was improved and the interaction was changed to body poses, regarding the need of increasing physical activity on the patients, it also allows some interactions by voice with ANI-VA. The pandemic situation prevented it from being widely tested, but we used external users connected to the team to validate this version.

Currently the MVP3 is under construction, is expected to full integrate Cogweb to retrieve the prescribed games sessions and also provide the video-consultation, a feature that gained importance in confinement. Other feature that should be integrated on this stage, identified since the beginning of the project, is group sessions.

2. Features

Based on the results of Task 1.1 (D1.1) a set of features were elected so the solution can meet all the expected behaviours. This section describes all the features which will be implemented in the system. Cognitive Training Exercises (CTE)

CogniViTra provides a set of games grouped by their respective cognitive domain. Each cognitive domain encloses one or more games that have their own specific settings, like number of levels as well as the expected and possible answer. Table 1 list all the games available grouped by cognitive domain.

TABLE 1 AVAILABLE GAMES GROUPED BY COGNITIVE DOMAIN

Cognitive domain	Game	Task	Number of answers	
			Level	Answers
Attention	Equal or different	Assess if two set of symbols are equal or different	1 – 14	Yes/No
	Attention to the letter	Check if one (or more) target letters appear on the screen.	1 – 8	1
	Attention to the number	Check if one (or more) target numbers appear on the screen.	1 – 8	1
	Attention to the symbol	Check if one (or more) target symbols appear on the screen.	1 – 8	1
	Coloured squares	Check if one (or more) target colours appear on the screen.	1 – 9	1
	Tiles	Asses if two set of images are equal or different	1 – 10	Yes/No
	Pages	Asses if two set of images are equal or different	1 – 12	Yes/No
	Patterns	Asses if two or more sets of images are equal or different	1 – 11	Yes/No
	Plants	Asses if two or more sets of images are equal or different	1 – 11	Yes/No
Language	Commands	Select the image which describes the sentence	1 – 2	2
			3 – 10	3
Calculus	Math	Math solving	1 – 3	2

Cognitive domain	Game	Task	Number of answers	
			Level	Answers
			4 – 8	3
Memory	Frames	Memorize a set of images	1 – 9	Yes/No
	Trees	Memorize a set of images	1 – 8	Yes/No
	News Time	Listen and memorize a text	1 – 6	3
	Mixed Letters	Memorize a set of images	1 – 9	Yes/No
	Coloured Squares	Memorize a set of colours	1 – 3	2
			4 – 7	3
	Windows	Memorize a set of images	1 – 2	2
			3 – 5	3
	Coloured Letters	Memorize a set of images	1 – 9	Yes/No
	Canvas	Memorize a set of images	1 – 9	Yes/No
Executive Functions	Match the Colour	Match the written colour name with a canvas	1 – 9	Yes/No
	Flames	Check whenever a flame appears in a house	1 – 3	1
			4 – 6	2
			7 - 9	3
	In and Out	Assess if the bird is in or out of the cage	1 – 3	2
	Opposites	Point the opposite direction of the arrow	1	1
	At the right moment	Check if one or more target colours appear on the screen	1 – 9	1
	Into the Sea	Check if one or more target images appear on the screen	1 – 9	1
	Logical Mind	Complete a logical sequence	1	2
			2 – 4	3

Cogweb games are designed so that user would be able to respond either by clicking on a specific button, selecting a specific answer or by pressing a keyboard/mouse button whenever a certain condition is meet. Table 2 summarizes all the expected input types for Cogweb's games.

TABLE 2 GAME'S EXPECTED INPUT TYPE

Input	Description
Click or key press	User is asked to either click on the screen or press a key when a certain criterion is meet.
Yes/No	User is asked to click on one of the buttons.
2 or 3 option	User is asked to select an answer from a set of 2 or 3 option

Following, we present concrete examples of the games.
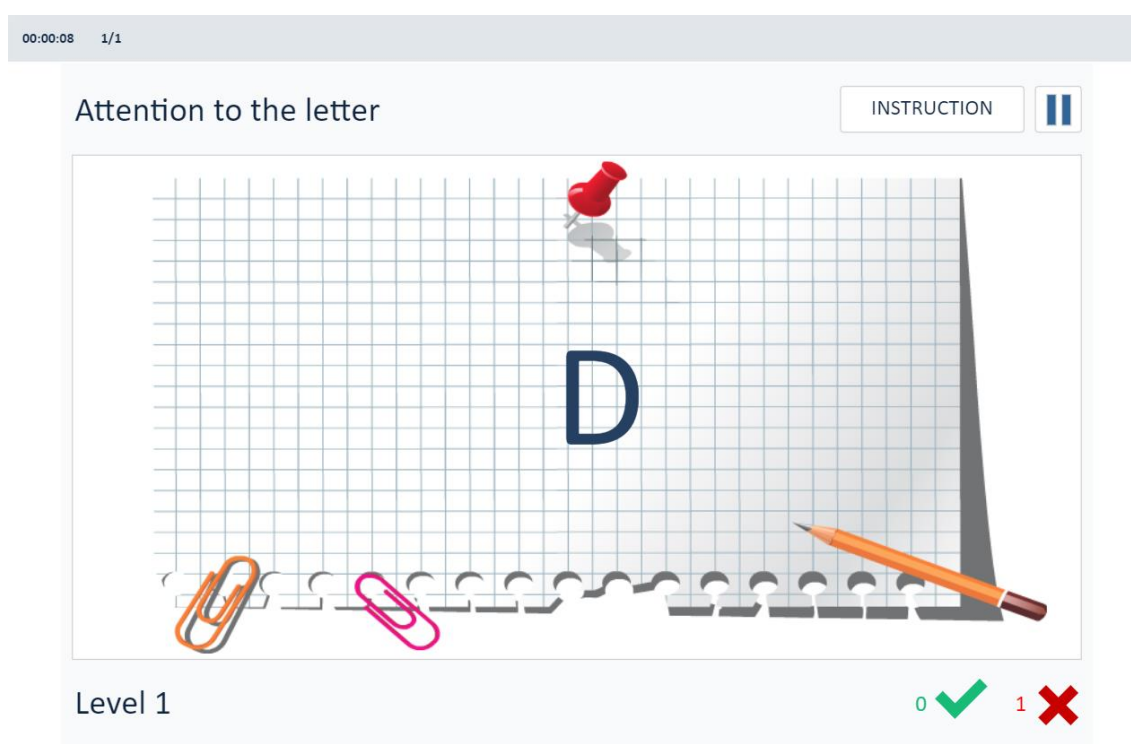
FIGURE 1 CLICK OR KEY PRESS GAME EXAMPLE. USER NEEDS TO MOUSE CLICK OR PRESS A KEY WHENEVER THE LETTER 'D' APPEARS ON THE SCREEN.

Mixed letters

INSTRUCTION ⏸

Are the stamps in the same position that you have memorized?

| YES | NO |

Level 1 ▪ 2/20   0 ✔   1 ✖
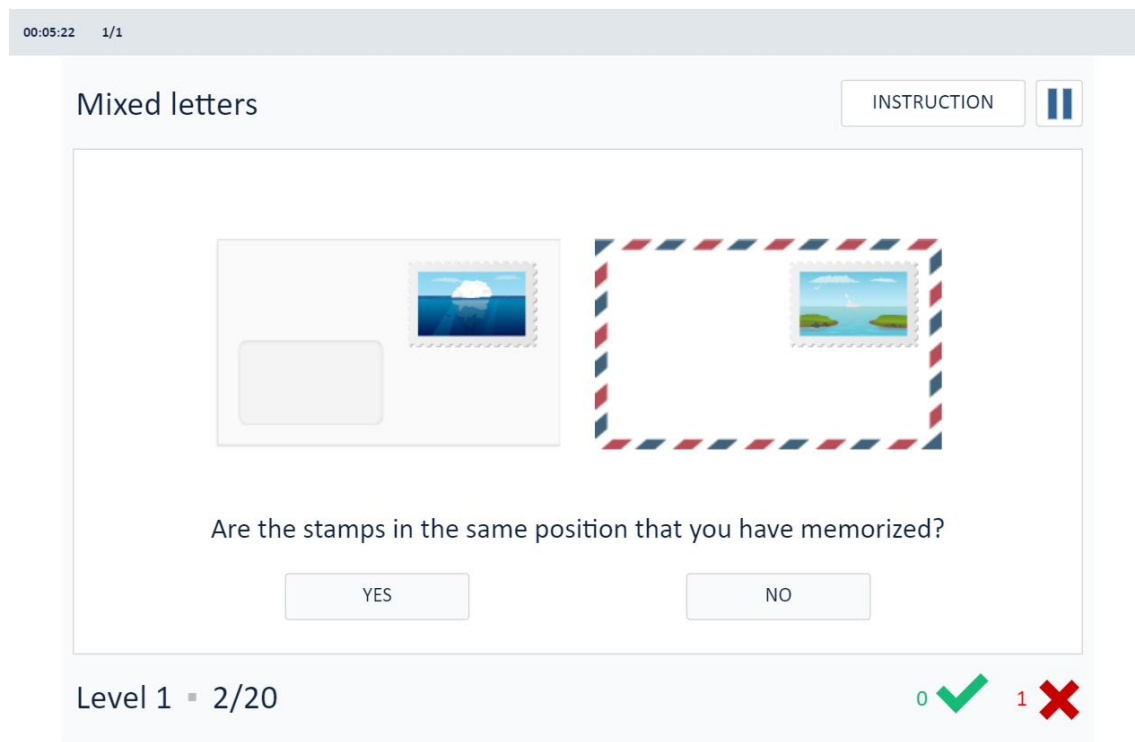
FIGURE 2 YES/NO GAME EXAMPLE. HERE THE USER IS ASKED IF THE CURRENT LAYOUT OF THE IMAGE IS EQUAL TO WHAT WAS PREVIOUS MEMORIZED.

Logical mind

INSTRUCTION ⏸

Level 2 ▪ 1/20   0 ✔   0 ✖
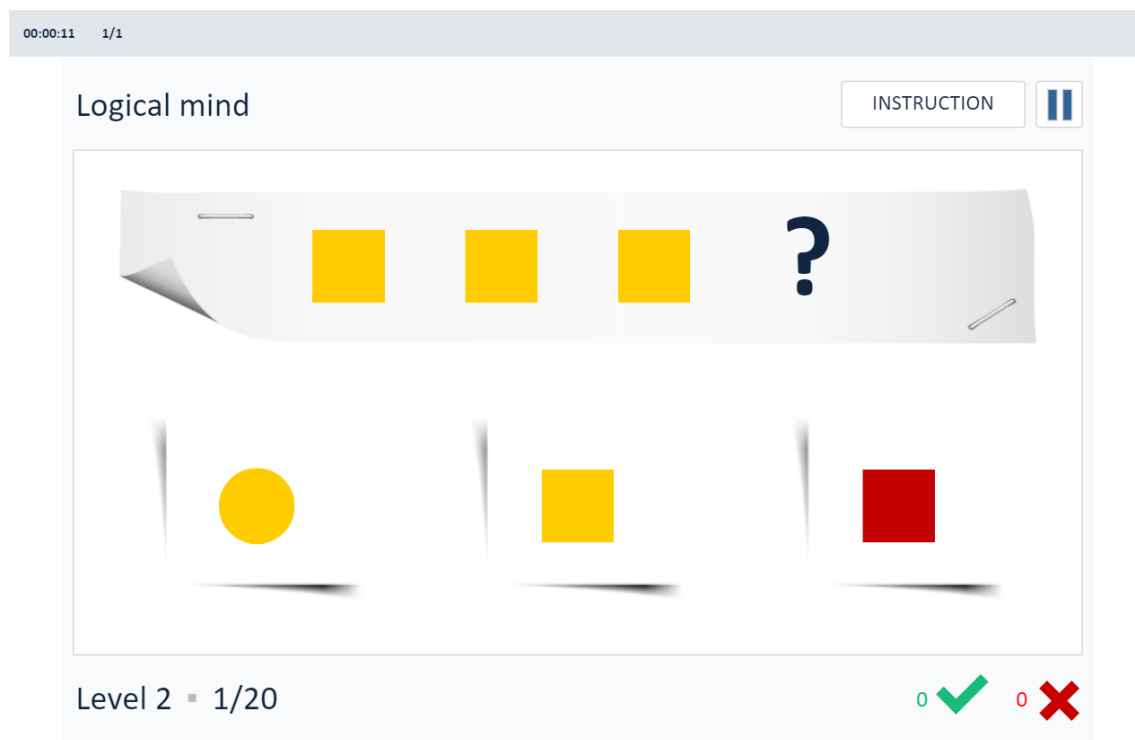
FIGURE 3 2 OR 3 OPTIONS GAME EXAMPLE. USER IS ASKED TO SELECT/IDENTIFY THE IMAGE THAT COMPLETES THE LOGICAL SEQUENCE PRESENTED.

2.1. Face as Input

The user's face on the image (obtained by the webcam) can be used as input for the game. This is achieved by detecting where, on the image, the face is located. This will give two different inputs, left or right. Figure 44 depicts this process.
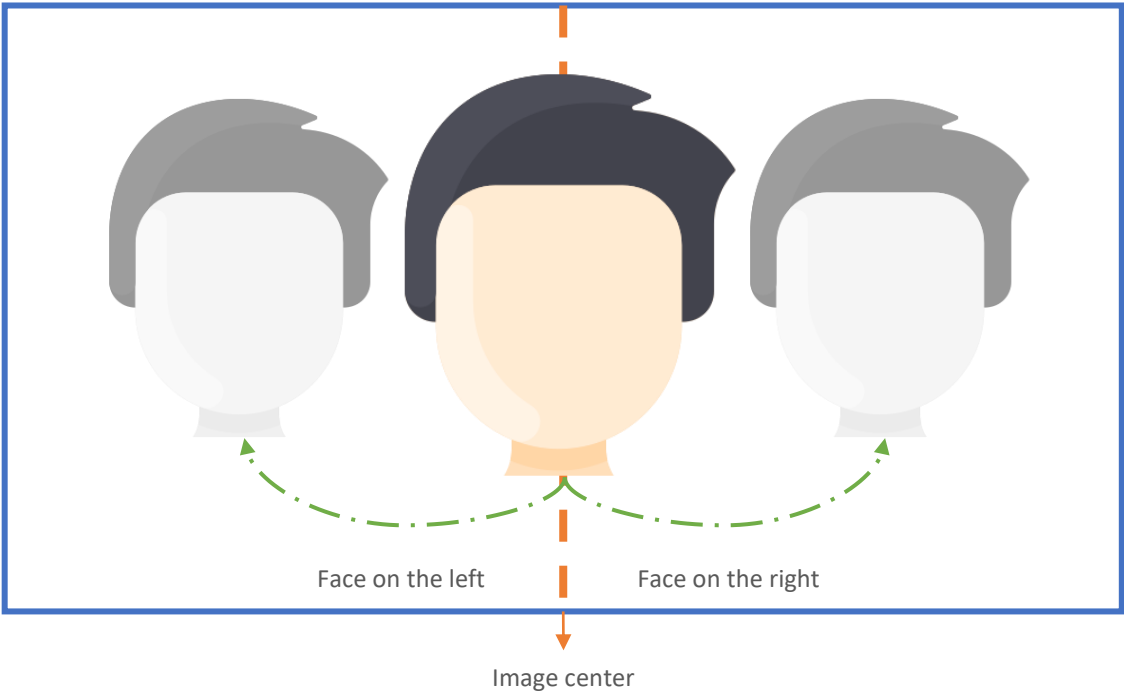
FIGURE 4 FACE POSITION ON THE IMAGE

With this information is possible to convert it for a game input. As such, this is used for games of input type Yes/No (Table 2). Table 3 summarizes how the face input is mapped for a Yes/No game.

TABLE 3 FACE LOCATION MAPPING YES/NO GAME EXPECTED INPUT

Input	Face location	
Yes/No	YES	
	NO	

2.2. Body poses as Input

A set of body poses are defined to be used as inputs for the games. These body poses are listed in Table 4.Table 4 Body pose representations It is important to note that after each pose, user needs to go back to neutral pose, before preforming another pose.

TABLE 4 BODY POSE REPRESENTATIONS

Body pose	Description
	Left hand up
	Right hand up
	Both hands up
	Head tilted to the left
	Head tilted to the right
	Neutral

In order to map each behaviour in the form of a body pose, each game was individually analysed and based on the expected user input, a body pose was defined as input for the corresponding game. To better illustrate this process, in Table 5Table 5 Body pose mapping for each specific game expected input it is presented the different expected game inputs, and how they are mapped on to these body poses:

TABLE 5 BODY POSE MAPPING FOR EACH SPECIFIC GAME EXPECTED INPUT

Input	Body pose			
Click or key press		OR		
Yes/No	YES		OR	

Input	Body pose				
	NO		OR		
2 or 3 option	LEFT OPTION		OR		
	MIDDLE OPTION				
	RIGHT OPTION		OR		

2.3. Gestures as Input

On-going development.

2.4. Voice as Input

The solution should allow for voice commands, in order to interact with the Advanced Natural Interaction Virtual Agent (ANI-VA). These voice commands should have an action, which will have a direct impact on the game, or on the ANI-VA itself. The following table summarize these commands.

TABLE 6 DESCRIPTION OF VOICE COMMANDS

Voice command	Description
Mute speakers	Turn off the speakers. ANI-VA will not speak anymore
Unmute speakers	Turn on speakers.
Mute microphone	Actives the privacy mode. ANI-VA will not accept any voice command.
Unmute microphone	Start speech recognition
Go back	Return to home screen
Pause game	Game should enter pause status
Resume game	Game should resume previous state
Read instructions	ANI-VA must read game's instructions

2.5. Voice feedback

The system response to the voice commands after the keyword of activation "Rachel", according to the description of the table above. If the command is not defined or not detected the ANI-VA ask the user to repeat the sentence

2.6. Prescribe Cognitive Training Exercises

The prescription of cognitive exercises is done through the session programming option, available in the professional's browser, Figure 5. This menu is only available when a patient is chosen, which can be done on the first page after the login, Figure 6.
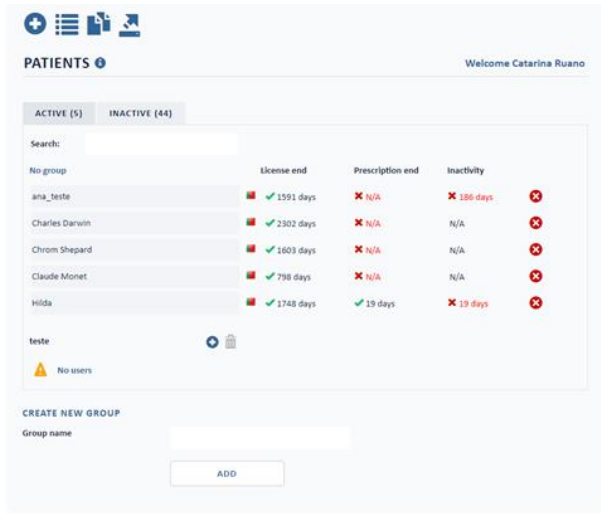
FIGURE 5 PATIENTS PAGE
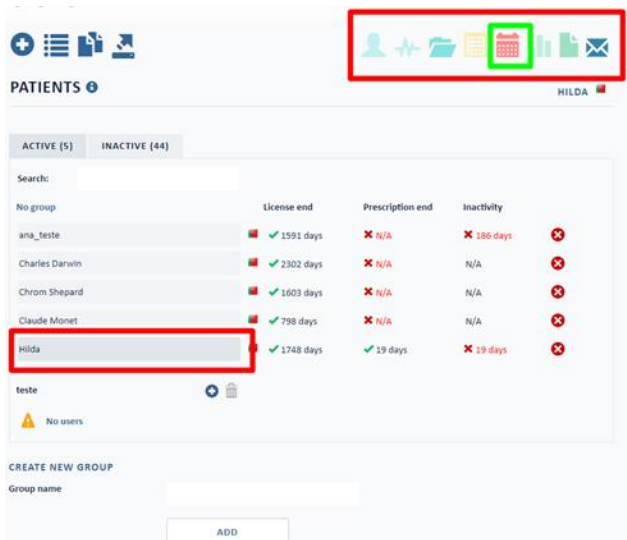
FIGURE 6 PATIENT MENU

After pressing the button 📅, the professional switches to the session programming page, Figure 7.
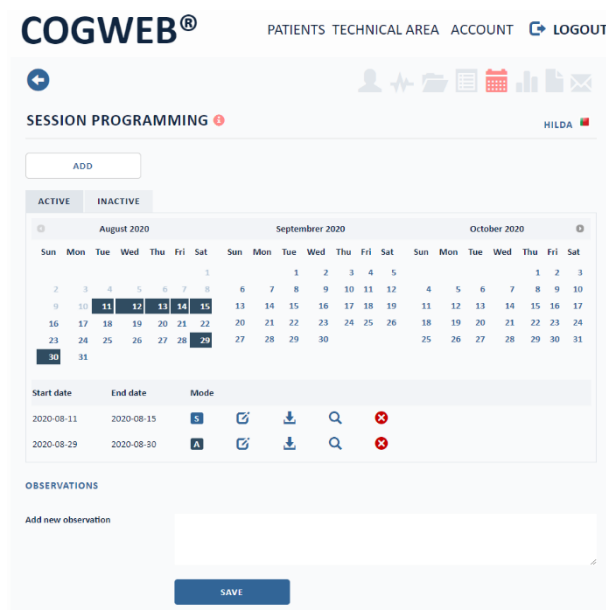
FIGURE 7 SESSION PROGRAMMING PAGE

2.6.1.   Session Programming page

From this page it is possible for the professional to perform the following tasks:

- Create and edit prescriptions sessions for the selected patient;
- Consult dates and information about patient´s prescriptions, Figure 8;
- Make notes and set reminders relevant to the patient, Figure 9.

FIGURE 8 DATES AND LIST OF SCHEDULED SESSIONS

OBSERVATIONS

Date	Observations		
2020-08-11	Informacion Note 1	✏	❌
2020-08-11	Informacion Note 2	✏	❌

Add new observation

[   ]

SAVE
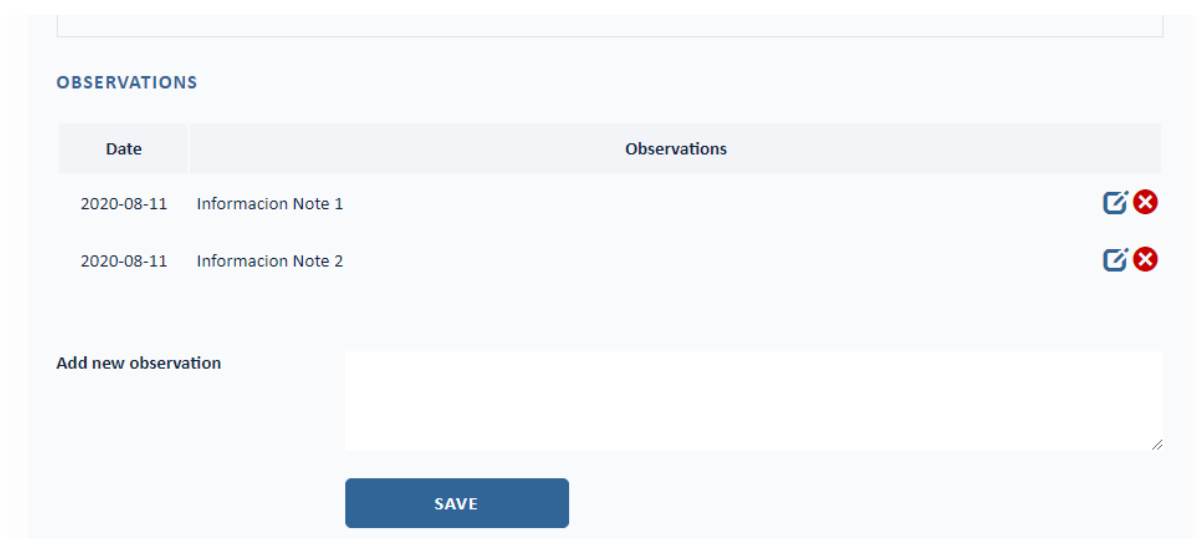
FIGURE 9 SYSTEM OF MEDICAL NOTES AND OBSERVATIONS

2.6.1.1. Creating and editing sessions

As mentioned above, the professional has the possibility to create a new precision by clicking on the button [ADD], or by editing a pre-existing one, to do so, just click on the edition ✏ of the target prescription, Figure 10.

2020-08-11	2020-08-15	S	✏	⬇	🔍	❌
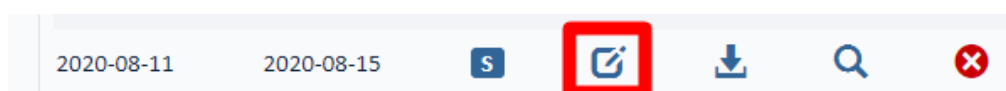
FIGURE 10 EXAMPLE OF A SCHEDULED SESSION

2.6.1.2. List of sessions in progress

This list contains all prescriptions programmed for the patient, Figure 8, through which it is possible to:

- Consult the start and end date of the program;
- Determine the type of program, as seen in chapter 2.6.2.1:
    - S of Standard, in which the session takes place once every day between defined start and end dates;
    - A of Advanced, in which the session runs on specific days defined by the professional during the creation of the plan;
- Edit prescription, ✏;
- Download a pdf with the list detailed in the program, ⬇;
- Consult the prescribed program, 🔍, see Figure 11;
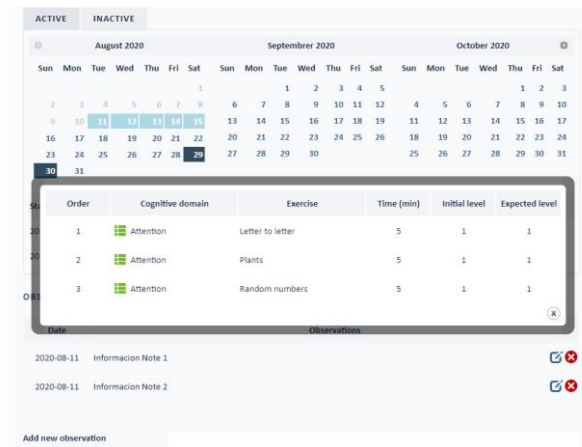
- Cancel the program, ❌.

FIGURE 11 POPUP WITH DETAILS OF A SCHEDULED SESSION

2.6.2. Creating or editing a scheduled session

In both cases, the page for editing scheduled sessions is loaded. However, the difference between a created session and an edited one is that in the ladder the page is already filled with data the professional previously added.

The Editor can be divided into five main steps:

- Select a program type;

- Filter by the type of games the prescription requires;

- Choose a game from the list available;

- Structure the session to be held;

- Save the session.

At the end of this process, the system automatically assigns the session to the patient for the defined period.

2.6.2.1. Selection of program type

There are two ways to configure a session program. The first is the standard mode, in which the professional sets the start and end dates and the system automatically assigns a session to the patient every day within the defined period, see Figure 12. Alternatively, the doctor can choose the advanced mode, in which he can manually define the days the patient will perform such sessions, see Figure 13.

FIGURE 12 TYPE OF PROGRAMMING - STANDARD

FIGURE 13 TYPE OF PROGRAMMING - ADVANCED

2.6.2.2.   Game list filtering tool

In order to facilitate the choice for the professional, there is the Filter Panel, which allows filtering the list of games by parameters such as the type of game, type of action performed on the game, whether or not there is a time limit, etc., see Figure 14. This filtering directly affects the list of games below, removing all games that are not defined by the chosen filters.

FIGURE 14 FILTER PANEL

2.6.2.3.   Games list

As the name implies, in this part of the page, the list of all games that the professional can assign to a patient is available. The games are separated into seven categories to facilitate the user to assess which games are most suitable for the patient. They are attention, language, calculation, memory, constructive capacity, executive and experimental functions. An example can be seen in Figure 15.
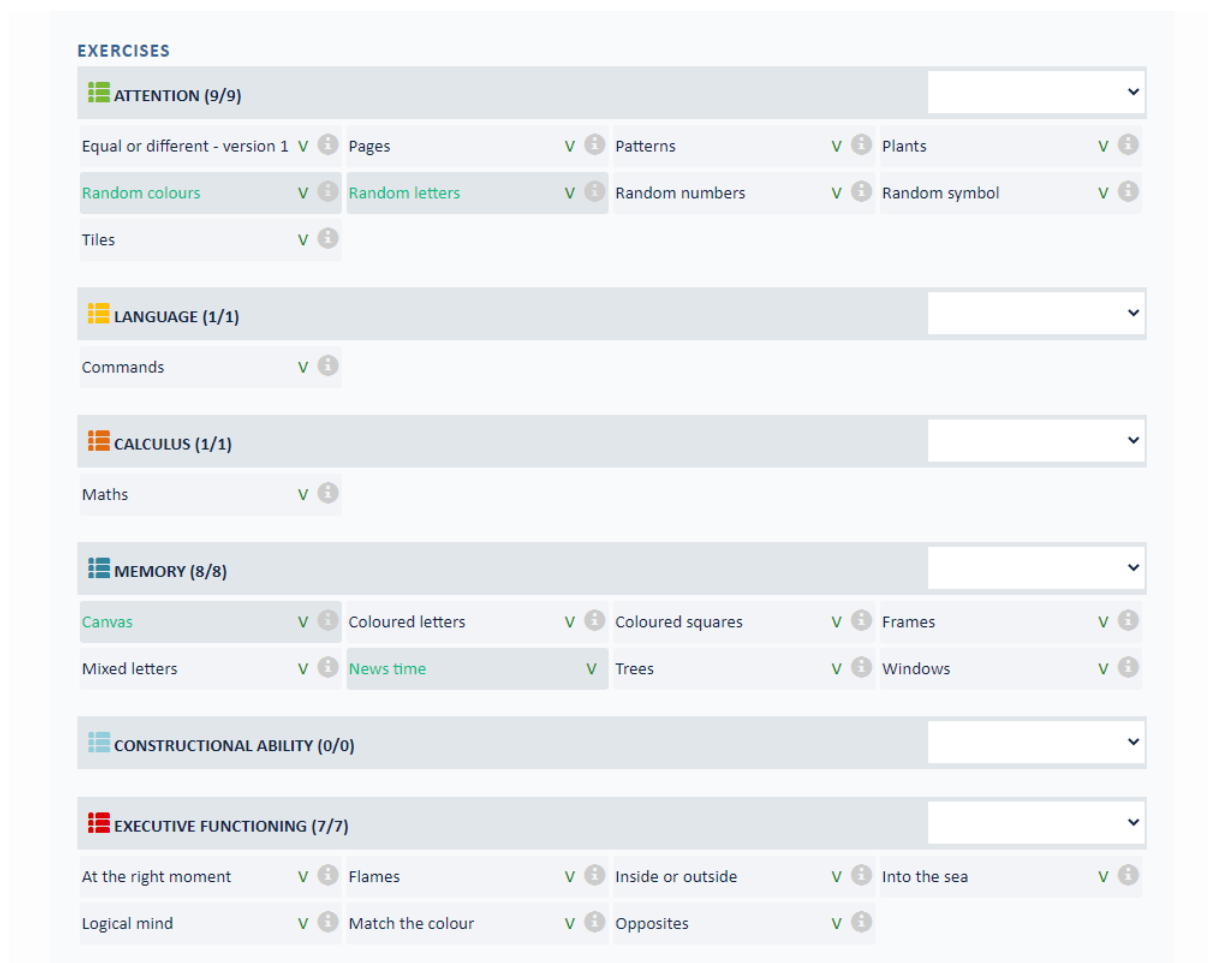
EXERCISES

ATTENTION (9/9)

Equal or different - version 1	Pages	Patterns	Plants
Random colours	Random letters	Random numbers	Random symbol
Tiles			

LANGUAGE (1/1)

Commands			

CALCULUS (1/1)

Maths			

MEMORY (8/8)

Canvas	Coloured letters	Coloured squares	Frames
Mixed letters	News time	Trees	Windows

CONSTRUCTIONAL ABILITY (0/0)

EXECUTIVE FUNCTIONING (7/7)

At the right moment	Flames	Inside or outside	Into the sea
Logical mind	Match the colour	Opposites	

FIGURE 15 GAME LIST – ATTENTION

Also, each of these categories has several subcategories and it is possible to filter the original list to obtain any of them, see Figure 16 below as an example.
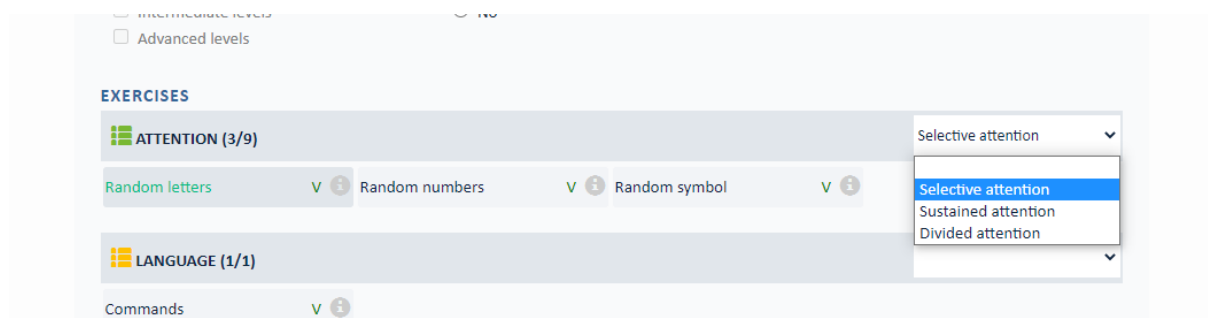
FIGURE 16 ATTENTION SUBCATEGORIES

2.6.2.4. Session Structure

After choosing all the games to be played by the patient, the professional must go to the session structure panel, from where it is possible to:

- Define the order of each played game, dragging game by the icon ↕ to the desired placement;

- Establish the minimum training period in minutes for each game;

- Select the initial difficulty level of the game;

- Edit the movements for each game by clicking in the game movements setup button;

- Establish the number of attempts before assessing the rise or fall of difficulty level;

- Remove the game, ❌.

SESSION STRUCTURE   🕐 25 minutos

Order	Cognitive domain	Exercise	Time (min)	Initial level	Expected level	Vitra	Trys	Delete
↕	Attention	Random colours	5	1 ▶	1	✓ 🔧	20	❌
↕	Attention	Random letters	5	1 ▶	1	✓ 🔧	20	❌
↕	Memory	Canvas	5	1 ▶	1	✓ 🔧	20	❌
↕	Memory	News time	5	1 ▶	1	✓ 🔧	20	❌
↕	Executive functioning	At the right moment	5	1 ▶	1	✓ 🔧	20	❌

FIGURE 17 EXAMPLE OF A TYPICAL SESSION STRUCTURE.

It is necessary to configure the list of movements intended for the patient for each game, otherwise the prescription is not validated. Games with a movement list already configured will show the icon in the Vitra field in green, (see Figure 18) otherwise, it will be gray (see Figure 19).

| ↕ | Memory | News time | 5 | 1 ▶ | 1 | ✓ 🔧 | 20 | ❌ |

FIGURE 18 EXAMPLE OF A GAME WITH MOVEMENTS ALREADY CONFIGURED

| ↕ | Executive functioning | At the right moment | 5 | 1 ▶ | 1 | ✓ 🔧 | 20 | ❌ |

FIGURE 19 EXAMPLE OF A GAME WITH MOVEMENTS TO BE CONFIGURED

2.6.3. Setup Game Movements

One of the great needs of this system is the dynamic configuration of the intended movements for each game. To make this possible, a setup interface was implemented, which can be accessed by clicking on the game movements setup button, see Figure 18 and Figure 19.
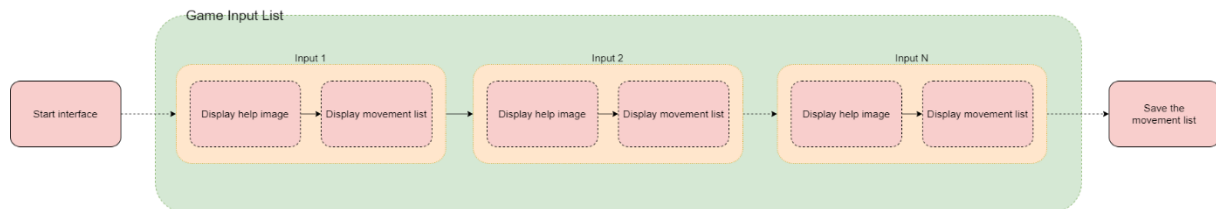
FIGURE 20 OPERATING FLOW OF GAME MOVEMENTS SETUP

The association of movements with the respective game input will be performed sequentially until the game has all its inputs pre-filled or the process canceled by the professional, as can be seen in the flow described in **Erro! A origem da referência não foi encontrada.**.

For each possible input, the movement manager must present first example images, which must clearly demonstrate to the professional what action this input corresponds to, with the corresponding caption, Figure 21.
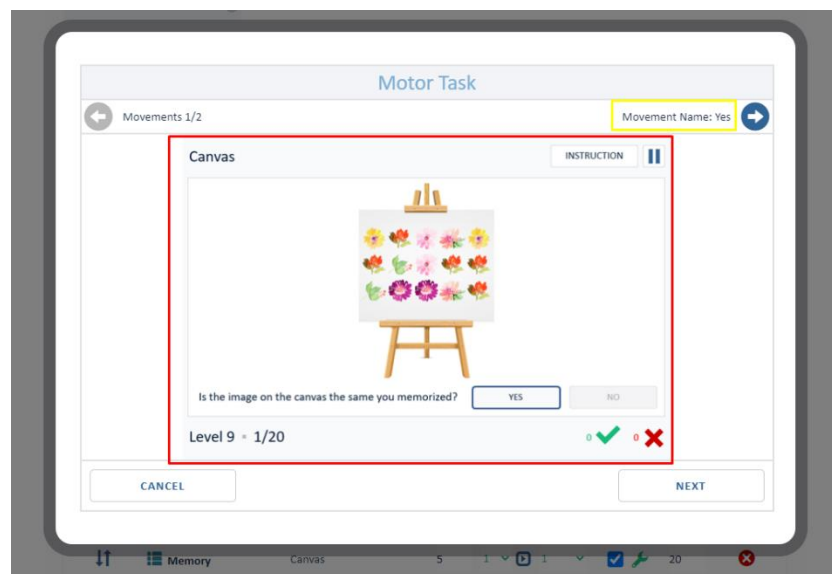
FIGURE 21 EXAMPLE OF HELP IMAGE OF THE GAME CANVAS

By pressing the Next or ➡ button, the manager must present the list of possible movements, see Figure 22.
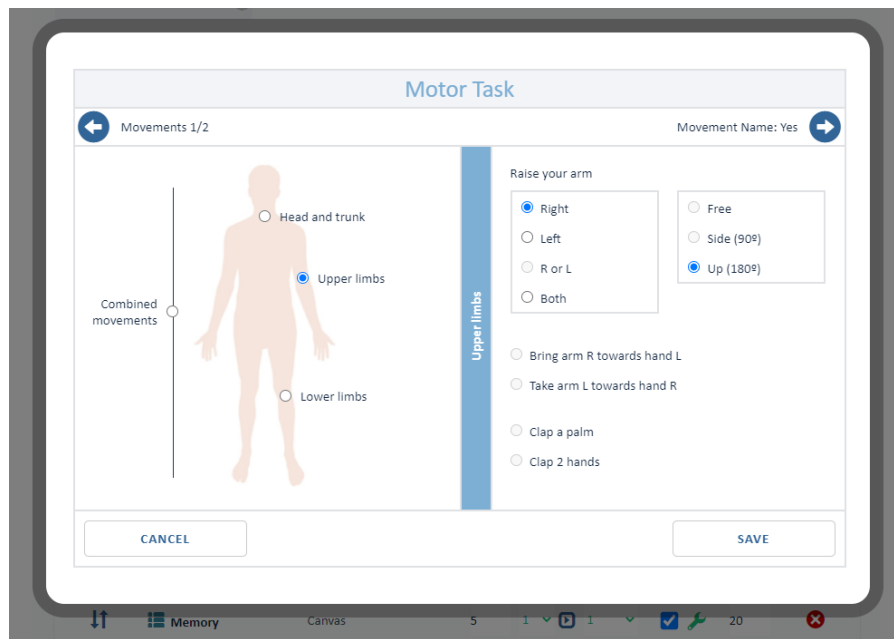
FIGURE 22 LIST OF MOVEMENTS

The list of possible movements by the system is separated into four different categories:

- Head and trunk;

- Upper limbs;

- Lower limbs;

- Combined movements.

Each of these categories has several associated movements, see Figure 23, Figure 24, Figure 25 and Figure 26. It is important to note that not all movements presented in these categories are still developed, in these cases the option is disabled.
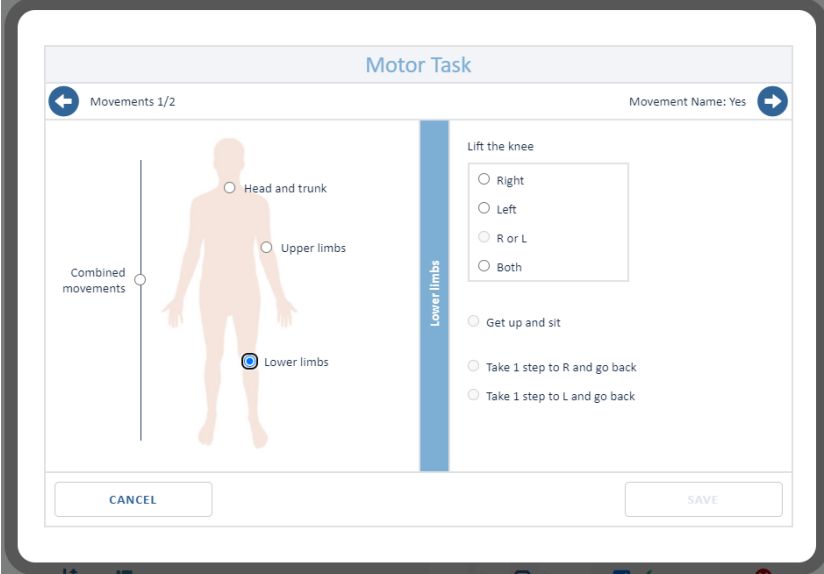
FIGURE 24 UPPER LIMBS LIST

FIGURE 25 LOWER LIMBS LIST
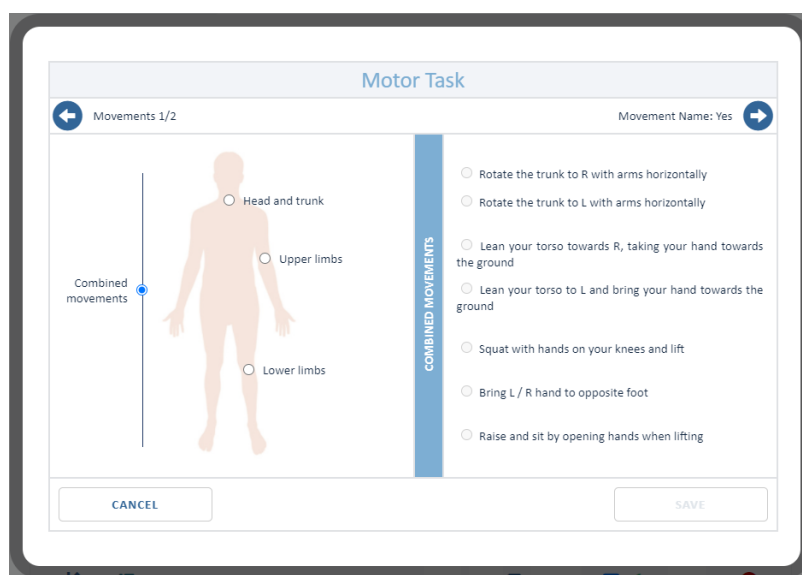
FIGURE 26 COMBINED MOVEMENTS LIST

After choosing a valid movement, the Save button will be active, so that it is possible to confirm the movement and move on to the next input. Alternatively, if it is the last input to define, it finalizes the configuration process, thus turning the Vitra icon of the game to green.

If the professional chooses a repeated movement for two different inputs, then trying to save the second one should be presented with the following error, see Figure 27.
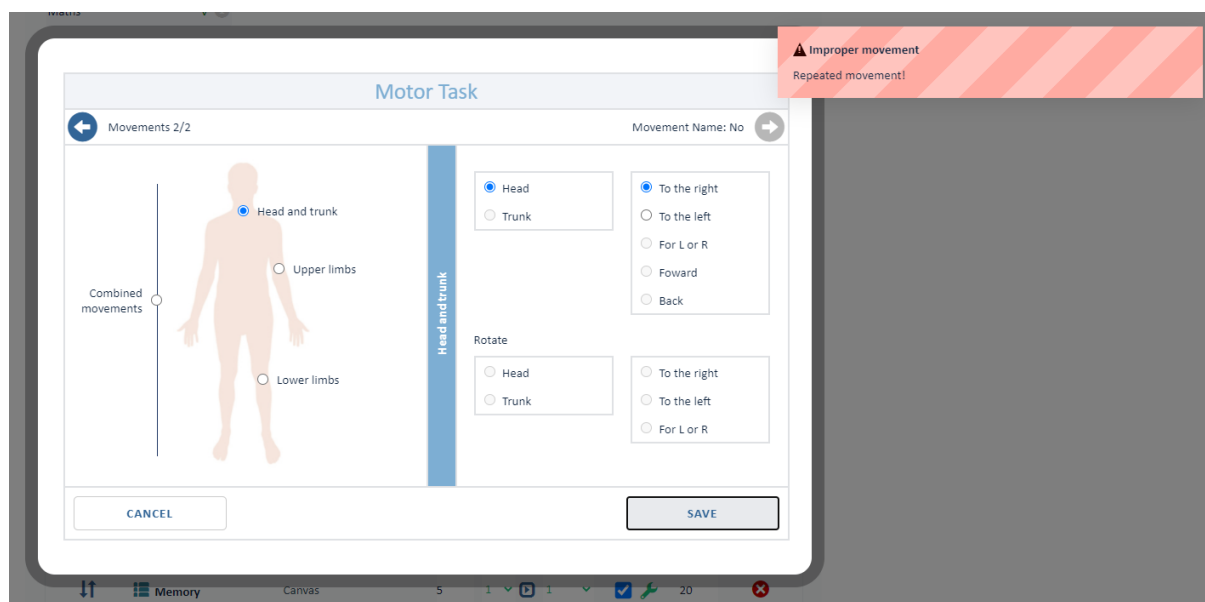
FIGURE 27 EXAMPLE OF IMPROPER MOVEMENT

2.7. Support for Group sessions

To be developed, new feature identified early in the project but not anticipated during proposal stage.

2.8. Video conferencing

The solution should provide a simple but fully functional video conference system. This is a very important feature made even more important due to the sticking pandemic of CoVid-19.

The video conference system must allow for communication between the therapist and the patient in a single one-to-one session. In the future this can be expanded to allow for multiple patients to interact with the therapist at the same time, but for the current desired behavior, a 1:1 approach must suffice.

Several options were considered, from the available off-the-shelf solutions such as Twillio[1], Temasys[2] among others, as well as an own implementation of the WebRTC[3] protocol.

2.9. No prescription games

The Table 7 list the games that are available in the system and how the users can interact with the game performing one of the possible poses.

TABLE 7 AVAILABLE GAMES GROUPED BY COGNITIVE DOMAIN. EACH GAME HAS ITS OWN SPECIFIC ANSWERING POSE.

Game	Body pose response
Equal or different	
Attention to the letter	
Attention to the number	
Attention to the symbol	
Coloured squares	
Tiles	
Pages	
Patterns	

---

[1] https://www.twilio.com/

[2] https://temasys.io/

[3] https://developer.mozilla.org/en-US/docs/Web/API/WebRTC_API

Game	Body pose response
Plants	OR / OR
Commands	/
Math	/
Frames	OR / OR
Trees	OR / OR
News Time	/
Mixed Letters	OR / OR
Coloured Squares	/
Windows	/
Coloured Letters	OR / OR
Canvas	OR / OR
Match the Colour	OR / OR
Flames	/ /
In and Out	/
Opposites	/
At the right moment	OR
Into the Sea	OR
Logical Mind	/ /

3. Requirements Analysis

The work developed led us to identify a set of requirements, functional and non-functional, that will guide the development of CogniViTra System.

3.1. Functional Requirements

3.1.1. Therapists side
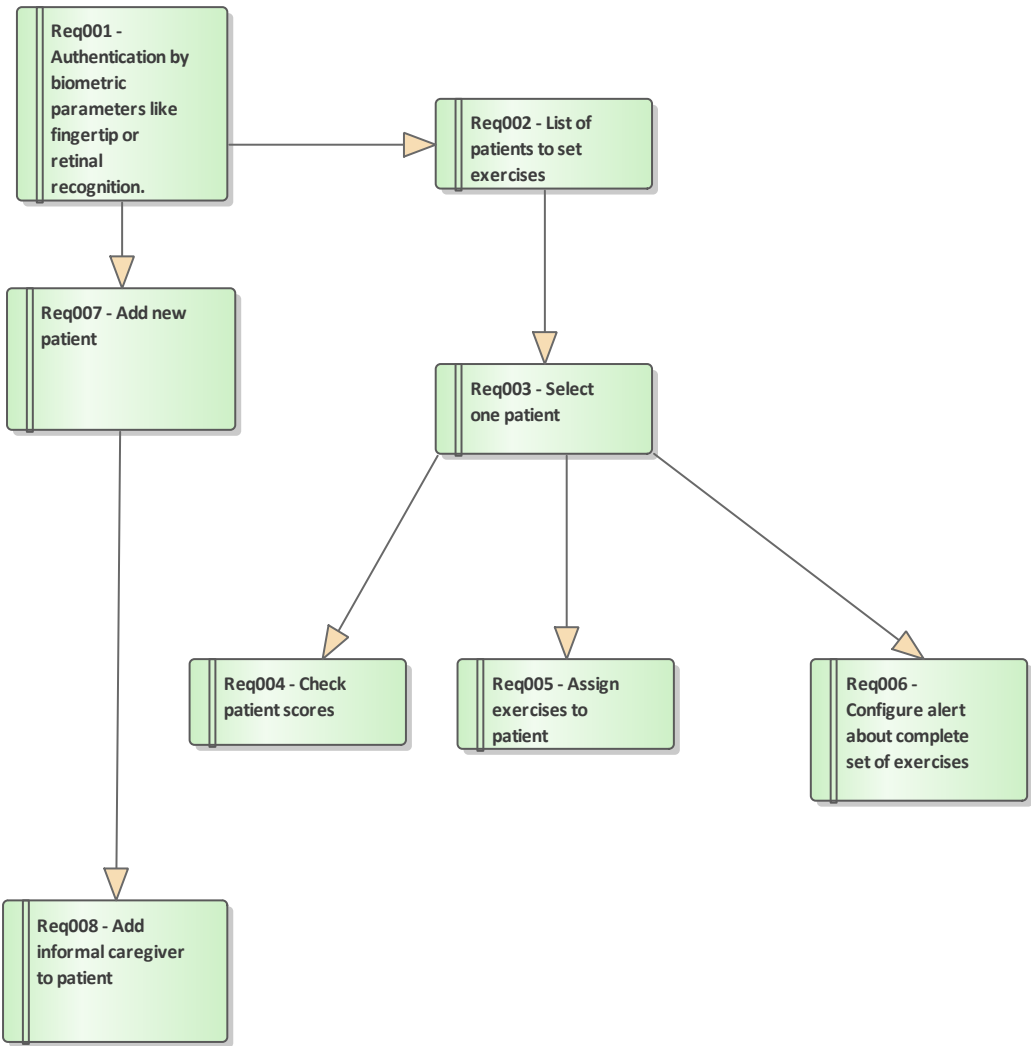
FIGURE 28 - THERAPISTS SIDE REQUIREMENTS

Req001 - Authentication by biometric parameters like fingertip or retinal recognition
TABLE 8 - REQ001 OUTGOING RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS
← Generalization from Req001 - Authentication by biometric parameters like fingertip or retinal recognition. to Req007 - Add new patient [Direction is 'Source -> Destination'.]
← Generalization from Req001 - Authentication by biometric parameters like fingertip or retinal recognition. to Req002 - List of patients to set exercises [Direction is 'Source -> Destination'.]

Req002 - List of patients to set exercises
TABLE 9 – REQ002 OUTGOING RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS
← Generalization from Req002 - List of patients to set exercises to Req003 - Select one patient [Direction is 'Source -> Destination'.]

TABLE 10 – REQ002 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
⇒ Generalization from Req001 - Authentication by biometric parameters like fingertip or retinal recognition. to Req002 - List of patients to set exercises [Direction is 'Source -> Destination'.]

Req003 - Select one patient
TABLE 11 – REQ003 OUTGOING RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS
← Generalization from Req003 - Select one patient to «Functional» Req006 - Configure alert about complete set of exercises [Direction is 'Source -> Destination'.]
← Generalization from «Functional» Req003 - Select one patient to «Functional» Req005 - Assign exercises to patient [Direction is 'Source -> Destination'.]
← Generalization from «Functional» Req003 - Select one patient to «Functional» Req004 - Check patient scores [Direction is 'Source -> Destination'.]

TABLE 12 – REQ003 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from «Functional» Req002 - List of patients to set exercises to «Functional» Req003 - Select one patient [Direction is 'Source -> Destination'.]

Req004 - Check patient scores
TABLE 13 – REQ004 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from «Functional» Req003 - Select one patient to «Functional» Req004 - Check patient scores [Direction is 'Source -> Destination'.]

Req005 - Assign exercises to patient
TABLE 14 – REQ005 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from «Functional» Req003 - Select one patient to «Functional» Req005 - Assign exercises to patient [Direction is 'Source -> Destination'.]

Req006 - Configure alert about complete set of exercises
TABLE 15 – REQ006 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from «Functional» Req003 - Select one patient to «Functional» Req006 - Configure alert about complete set of exercises [Direction is 'Source -> Destination'.]

Req007 - Add new patient
TABLE 16 – REQ007 OUTGOING RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS
⬅ Generalization from «Functional» Req007 - Add new patient to «Functional» Req008 - Add informal caregiver to patient [Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from «Functional» Req001 - Authentication by biometric parameters like fingertip or retinal recognition. to «Functional» Req007 - Add new patient
[Direction is 'Source -> Destination'.]

Req008 - Add informal caregiver to patient

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from «Functional» Req007 - Add new patient to «Functional» Req008 - Add informal caregiver to patient
[Direction is 'Source -> Destination'.]

3.1.2. Patient side
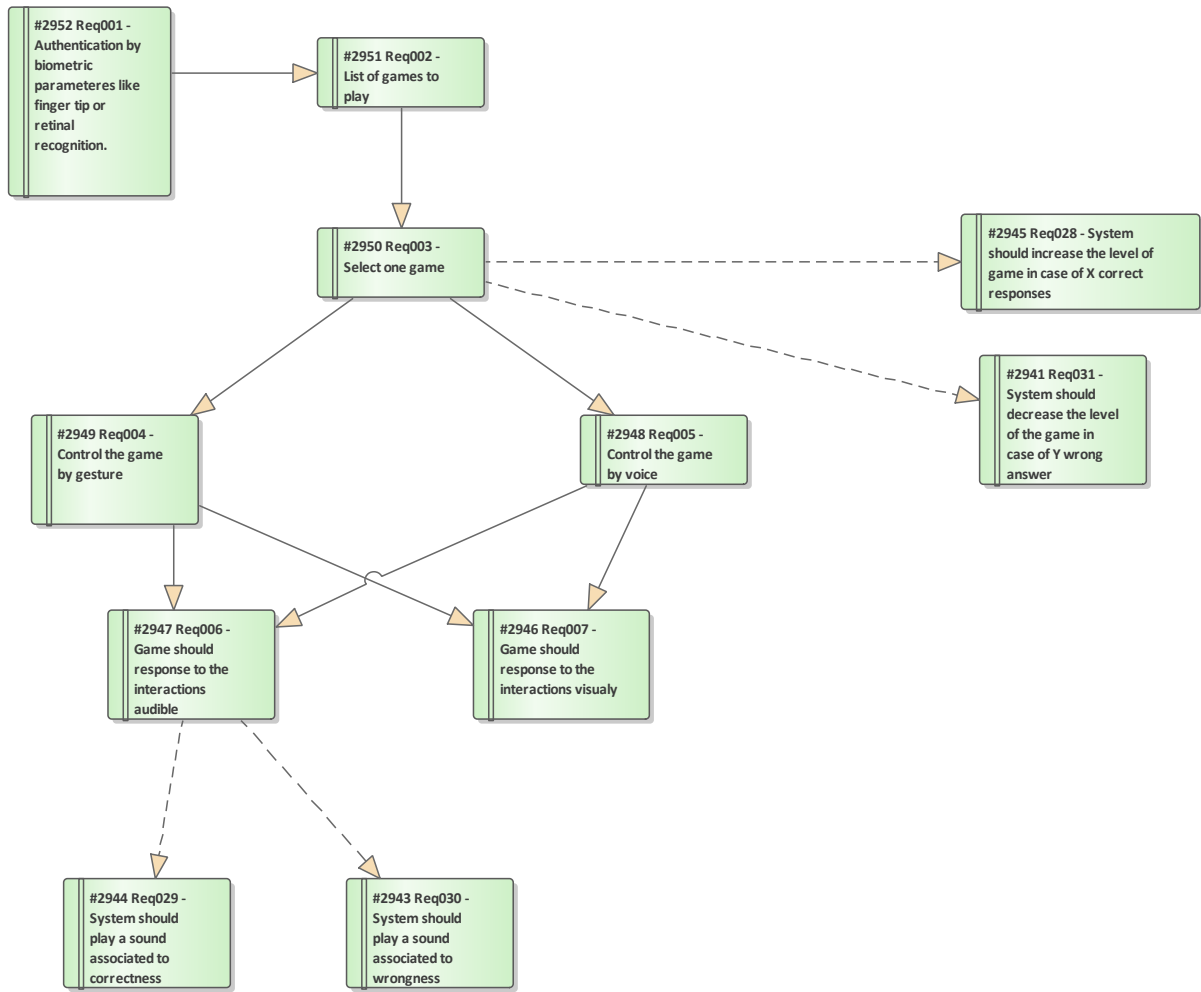
Req001 - Authentication by biometric parameters like fingertip or retinal recognition.

TABLE 19 – REQ001 OUTGOING RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS
⇐ Generalization from Req001 - Authentication by biometric parameters like fingertip or retinal recognition. to Req002 - List of games to play   [Direction is 'Source -> Destination'.]

Req002 - List of games to play

TABLE 20 – REQ002 OUTGOING RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS
⬅ Generalization from Req002 - List of games to play to Req003 - Select one game
[Direction is 'Source -> Destination'.]

TABLE 21 – REQ002 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from Req001 - Authentication by biometric parameters like fingertip or retinal recognition. to Req002 - List of games to play
[Direction is 'Source -> Destination'.]

Req003 - Select one game

TABLE 22 – REQ003 OUTGOING RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS
⬅ Realization from Req003 - Select one game to Req028 - System should increase the level of game in case of X correct responses
[Direction is 'Source -> Destination'.]
⬅ Realization from Req003 - Select one game to Req031 - System should decrease the level of the game in case of Y wrong answer
[Direction is 'Source -> Destination'.]
⬅ Generalization from Req003 - Select one game to Req005 - Control the game by voice
[Direction is 'Source -> Destination'.]
⬅ Generalization from Req003 - Select one game to Req004 - Control the game by gesture
[Direction is 'Source -> Destination'.]

TABLE 23 – REQ003 OUTGOING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from Req002 - List of games to play to Req003 - Select one game
[Direction is 'Source -> Destination'.]

Req004 - Control the game by gesture

OUTGOING STRUCTURAL RELATIONSHIPS
⬅ Generalization from Req004 - Control the game by gesture to Req007 - Game should response to the interactions visually [Direction is 'Source -> Destination'.]
⬅ Generalization from Req004 - Control the game by gesture to Req006 - Game should response to the interactions audible [Direction is 'Source -> Destination'.]

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from Req003 - Select one game to Req004 - Control the game by gesture [Direction is 'Source -> Destination'.]

Req005 - Control the game by voice

OUTGOING STRUCTURAL RELATIONSHIPS
⬅ Generalization from Req005 - Control the game by voice to Req006 - Game should response to the interactions audible [Direction is 'Source -> Destination'.]
⬅ Generalization from Req005 - Control the game by voice to Req007 - Game should response to the interactions visualy [Direction is 'Source -> Destination'.]

Req006 - Game should response to the interactions audible

EXTERNAL REQUIREMENTS
☑ Requirement. Req030 - System should play a sound associated to wrongness [Stereotype is «Functional».]
☑ Requirement. Req029 - System should play a sound associated to correctness [Stereotype is «Functional».]

TABLE 28 – REQ006 OUTGOING RELATIONSHIPS

OUTGOING STRUCTURAL RELATIONSHIPS
⬅ Realization from Req006 - Game should response to the interactions audible to Req030 - System should play a sound associated to wrongness [Direction is 'Source -> Destination'.]
⬅ Realization from Req006 - Game should response to the interactions audible to Req029 - System should play a sound associated to correctness [Direction is 'Source -> Destination'.]

TABLE 29 – REQ006 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from Req004 - Control the game by gesture to Req006 - Game should response to the interactions audible [Direction is 'Source -> Destination'.]
➡ Generalization from Req005 - Control the game by voice to Req006 - Game should response to the interactions audible [Direction is 'Source -> Destination'.]

Req007 - Game should response to the interactions visually
TABLE 30 – REQ007 OUTGOING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Generalization from Req004 - Control the game by gesture to Req007 - Game should response to the interactions visually [Direction is 'Source -> Destination'.]
➡ Generalization from Req005 - Control the game by voice to Req007 - Game should response to the interactions visually [Direction is 'Source -> Destination'.]

Req028 - System should increase the level of game in case of X correct responses
TABLE 31 – REQ028 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Realization from Req003 - Select one game to Req028 - System should increase the level of game in case of X correct responses [Direction is 'Source -> Destination'.]

Req029 - System should play a sound associated to correctness

TABLE 32 – REQ029 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Realization from Req006 - Game should response to the interactions audible to Req029 - System should play a sound associated to correctness [Direction is 'Source -> Destination'.]

Req030 - System should play a sound associated to wrongness

TABLE 33 – REQ030 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Realization from Req006 - Game should response to the interactions audible to Req030 - System should play a sound associated to wrongness [Direction is 'Source -> Destination'.]

Req031 - System should decrease the level of the game in case of Y wrong answer

TABLE 34 – REQ031 INCOMING RELATIONSHIPS

INCOMING STRUCTURAL RELATIONSHIPS
➡ Realization from Req003 - Select one game to Req031 - System should decrease the level of the game in case of Y wrong answer [Direction is 'Source -> Destination'.]

3.2. Quality Attributes

Commonly named as "Non-functional requirements", Quality Attributes define system attributes such as security, scalability, persistence and performance. This kind of requirements help to build the system regarding the best practices to obtain a quality and robust system.

- Security – Communications over secure channels
- Scalability – Allow several users in simultaneous
- Persistence – Data persistence is crucial to have
- Performance – The system should have a low response time.

4. Conclusions

The Co-design process allows to identify precisely what is more important for all different users. It helps to achieve the defined objectives more efficiently and precisely. Cooperating the users in developing a system also helps the system to be acceptable and more user-friendly. Co-design is not only allowed to utilize the knowledge, experience and technical issues of users in a system but also the chance of system's acceptance by its users could rise up. Therefore, such system could gain more success and achievement as it is being developed in a collaborative way.