



engAGE

**Managing cognitivE decliNe throuGh theatre therapy, Artificial intelligence
and social robots drivEn interventions**

D2.1 User co-creation phase report



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List of acronyms

Acronym	Description
AAL	Ambient Assisted Living
SMCI	Seniors with Mild Cognitive Impairment
MCI	Mild Cognitive Impairment
IC	Informal Caregiver
FC	Formal Caregiver
EU	End-users
KRD	Karde AS
INRCA	National Institute for Hospice and Care for the Elderly
HUG	University Hospitals of Geneva
WP2	Work package 2

Executive summary

engAGE aim is to enable people over 65 with signs of cognitive impairment or with actual mild cognitive impairment, to live independently and in good condition by providing an ecosystem of services based on social robots and IoT-based monitoring. engAGE wants to co-create a technological tool corresponding to the needs of this target audience to maintain their cognitive state.

Following the agreement between partners' projects, a social robot with a tablet has been selected to help these seniors on a daily or weekly basis, by specifically providing them with some exercises. The social robot will also serve carers, either formal or informal, to remotely manage home care in accordance with the seniors' situation. This co-creation phase will then serve to determine if the engAGE suggestion matches seniors' requisites and those of their relative and professional caregivers who provide them home care.

To ensure that the project is moving in the right direction, the principles of the user-centred approach will be applied. To do so, two rounds were set to meet end-users. The first one was dedicated to interviews grasping users' needs, challenges, and expectancies and the second one was an end-user workshop to discuss the first gathered results. These first meetings took place in three different sites: in Switzerland (HUG), in Italia (INRCA) and in Norway (KARDE). End-user partners have gathered the results of such interviews to purpose this deliverable on the needs of end-users and to give an idea on the potential technical requirements.

1 Introduction

The deliverable D2.1 is part of the Task 2.1 “*Co-creation phase and innovation approach*”. During this task, all the end-user partners (KRD, INRCA, and HUG) set up and conducted individual sessions with seniors, relatives, carers facing problems of cognitive decline or mild cognitive impairment. Primary and secondary end-users’ needs, challenges and expectations revolving around cognitive and dementia care have been tackled.

To provide such insights, partners from Norway (KRD), Italy (INRCA) and Switzerland (HUG) gathered and shared results and perspectives from the end-users’ met on an excel sheet (Appendix 9.2). The data collection co-creation phase was carried out using a consent form (Appendix 9.1) and following a co-creation interview protocol (Annex 9.3). This deliverable presents the interviews data enabling researchers: 1) to better understand the functionalities to implement in such robot to satisfy end-users regarding their needs challenges and expectations and 2) to give an idea on the use environment and the potential interactions between the robot and SMCI (Seniors with Mild Cognitive Impairment) and identify the use-case scenarios.

The social robot-based system thought by engAGE partners has been sorted out to provide them memory exercises. To ensure a qualitative tool responding to SMCI and their relatives and carers, the engAGE project adopts a user-centred development methodology. In this framework, the use-case scenario created from data collected in interviews will be evaluated by the same type of end-users. This approach will ensure that the inherent demands of the audience have correctly taken into consideration. Mild Cognitive Impairments (MCI) are common among old people and frequent given the increasing population. Statistics show that each 7 seconds a new case of dementia or MCI is unveiled worldwide. By the year 2040, 80 millions of people would be affected by cognitive decline. In Europe, it's not just the elderly population and cognitive decline that will increase, but also the lack of professional health caregivers, who are already stretched. Health systems will then have to face resource issues such as financial, ethical, and practical. That’s why engAGE is moving towards a technological solution which will help to support at lower cost, home care for seniors suffering from MCI.

This co-creation phase will offer for the engAGE project partners better insights on the MCI issues and on the needs, challenges, and expectations from frail seniors but also from formal and informal carers. The running of interviews and workshops will help to define technical requirements in line with the end users identified and to implement them in different prototypes at later stages of the project.

1.1 Intended Audience

This document is of interest to all those who are affected from afar or nearby an elderly person with mild cognitive impairment. Elderly people, as well as formal or informal caregivers, doctors, insurance companies can find new care ideas in this project in respond to their problems. Anyone interested in innovative projects relating to social robots or in the new technologies’ contribution in the care field, will also be interested in reading this document.

1.2 Relations to other activities

The WP2 main objectives are firstly to establish the extent of the needs, difficulties, and expectations of SMCI, relatives and professional carers, then to map and develop use-case scenarios corresponding

to it. The findings of WP2 and its composing tasks are used in both the technical WP 1 as well as in the testing and evaluation WP 3.

1.3 Document overview

The remainder of the report is organised as follows:

- Section 2: Literature, state of the art
- Section 3: User's co-creation phase
- Section 4: System characteristics and technology acceptance
- Section 5: Supportive games and exercises
- Section 6: Use Case Scenarios
- Section 7: Conclusion
- Section 8: Appendix

2 Literature, state of the art

2.1 MCI definition

Gauthier et al (2006) illustrate MCI by being “characterised by a cognitive decline greater than expected as compared to that typically associated with an individual’s age, but which does not significantly interfere with daily activities.” [2] this opinion is shared by the authors of the 3rd referenced who said, “when a person’s mental faculties are impaired without affecting their daily life, they have mild cognitive impairment (MCI).” [3]

To detect MCI, “the physician analyses brain performance using rapid tests, such as the Mini-Mental Status Examination (MMSE) and the Clock Test” [3]. To do so, other tools are used such as “miniCog, Montréal Cognitive Assessment (MoCA)” [4].

In the document “care and prevention of dementia” [4], Swiss neurologists and geriatricians, constantly faced to MCI, drawn up a table of the main characteristics of early and mild stages of MCI regarding seniors' patients. Some prevention points are also given to better take care of SMCI.

Table 1: Early and Mild stage of cognition impairment: side problems and prevention tips

Early stage
Problems encountered by the patient
<ul style="list-style-type: none"> ● Driving ● Advance directives and therapeutic representative ● Legal disposition: succession, testament
Prevention: patient and family support
<ul style="list-style-type: none"> ● Contact with associations: caregiver consultation ● Help with instrumental activities: availability of family and friends, volunteers, social service, and home care (financial management, meals, medication, transportation, etc.) ● Depending on the patient and their family: respite care, temporary care centre
Mild stage
Problems encountered by the patient
<ul style="list-style-type: none"> ● Difficulties in the basic activities of daily living: toileting, dressing. ● Behavioural disorder ● Sleep disorder ● Accidents (falls, running away)
Prevention: patient and family support
<ul style="list-style-type: none"> ● Home assistance and adaptation of the environment (fall prevention, cooking) ● Identification bracelet ● Mobile team of psychiatry of advanced age, ambulatory geriatrics ● Temporary care centre ● Respite care (short stay, Alzheimer's vacation)

Mild cognitive impairment is a heterogeneous phenomenon that can have several causes, including:

- A. A temporary disorder (e.g., emotional breakdown)
- B. A permanent disorder (e.g., brain injury)
- C. A beginning of dementia (e.g., Alzheimer)

The engAGE project will focus on seniors aged more than 65 years old, presenting signs of cognitive decline (Bullet C), because they represent a huge part of the elderly population. “Cognitive impairments are those affecting a significant part of people aged 65 plus: the Alzheimer Association

reported approximately 15 to 20 percent of people aged 65 or older who have Mild Cognitive Impairments (MCI).” [2] Some reports on longitudinal studies reported that elderly people with MCI are 10% to 30% more inclined to have Alzheimer, than other seniors with no cognitive decline (1%-2%) [7] Also "according to experts, more than 50% of people with a diagnosis of MCI develop dementia within five years." [3]

2.2 Needs and requirements identification

The needs and requirements from the literature will be checked with engAGE project target audience who are directly or indirectly affected by MCI. These literature data will be brought to end-users' attention to validate/reject some of the needs and requirements identified and add some. This validation will further help to define functional and technical requirements for the first prototype of the system's design.

According to the literature [1]:

- Seniors with MCI need to be able to live safely and stay independent to enjoy a normal life with daily routines reinforced and stimulations to help them to overcome their cognitive handicap situation.
- Relatives need to take care of their family member/friend more efficiently, by reducing partly their care burden, their anxiety and by partly providing them support to maintain good mental health.
- Healthcare professionals need to be constantly able to overview their clients' condition. In a broader way, formal carers want to be satisfied by the care they provide and be able to support them in the daily routines of their clients, without time-related problems.

According to literature [2]:

- *“Seniors with MCI often show memory loss or forgetfulness and may have issues with other cognitive functions such as language, attention and visuospatial abilities.”*
- Healthcare institutions will increasingly receive help requests and be confronted with a burden on their caregivers.

According to literature [4]:

- *“Dementia is the leading cause of dependency in patients over 65”.*

2.3 Social robot acceptance

According to researchers, *“to avoid or at least slow down cognitive decline [...] interactive serious games can play an important role [...] tablets, which represent a cost-effective solution, yet offering only limited possibilities for truly engaging such users in a multimodal manner. However, emerging humanoid robots, through their physical embodiment and human-like attributes, including facial expressions and body language, may open up new possibilities in more effectively engaging MCI older adults during repetitive cognitive training”* [4]. Technological solutions, such as the one engAGE project wants to develop, represent a solution for people studying the problem of the MCI but do users share their opinion? For the smooth running of the project, it is necessary to have users convinced of the effectiveness of robots and accepting it as support.

Results from this research showed that even if *“seniors are not used to talking to devices”, “the robot was received with more enthusiasm by the older adults, thus improving their level of engagement”*. Another study has proven that *“interactive technologies can provide positive results in the cognitive stimulation programs twice a week positively influenced cognitive functioning, as indicated by pre-post*

measures on the Mini Mental State Examination” (MMSE) [4, 10]. Also “50 minutes of cognitive stimulation programs twice a week positively influenced cognitive functioning” [12]

Some searchers have studied and overviewed the technologies that have been explored with older adults with mild cognitive impairment and dementia, by analysing usability and acceptability of technology regarding three different point of views: for safe living, for independent living and for entertainment and social communication.[11] These three categories showed positive results. One of the studies involved *“tested verbal instruction technologies to remind persons with MCI about the steps in a given task, and this strategy seemed to help them recapture the performance”* [12] Other studies used reminders via sound, light, written or spoken message to compensate seniors’ loss of cognitive skills.

The same authors underlined the fact that *“the AAL systems can offer multimodal assistive services, with cognition stimulation providing reminders to the person with dementia about events or tasks to carry out and facilitating communication with family and friends”*. Therefore, engAGE is legitimated and on its way to becoming a tool to make life easier for older adults with cognitive declines, especially if it takes the end-user centred approach.

2.4 Technical requirements

McCallum and Boletsis (2013) *“physical games (i.e., promoting physical fitness) can positively affect several health areas of players with MCI and mild AD (such as balance, gait, and voluntary motor control), cognitive games can improve attention, memory and visio-spatial abilities. “To slow down cognitive decline “interactive serious games can play an important role. “The technical solution should provide “cognitive training of a series of repeated and standardised tasks with challenges that target specific cognitive domains (e.g., memory, attention, information processing speed.”* De Oliveira et al (2010) *“found that 50 minutes of cognitive stimulation programs twice a week positively influences cognitive functioning, as indicated by pre-post measures on the Mini Mental State Examination.”* [2]

Nevertheless *“several studies showed that elderly people with cognitive disorders might have problems in using many serious games currently available. This is due to poor familiarity with game technology.”* In a broader way, seniors will certainly need help to go through whether technological system. Kerkhof et al. (2017) *“found that often such older adults still need support to learn how to use the tablet and its apps.”* [2] Pop-up windows, help sections on interfaces, or paper manual should then be given to them, to become more familiar with the use of the tool.

Technical requirements must be relevant to their primary users: older persons (65y+) with MCI. Some guidelines should then be respected *“such as using clear icons, simple and common words, minimal keyboard use, maximum contrast, fonts bigger than 12 pt., labelled icons to reinforce the concept, few colours and large buttons”*. [2] Needs and requirement must also be thought regarding potential customization option. [1] As we know, the more the smart tool fits the person, the more the person will want to use it. So, we must have personalisation items to keep in mind for each type of end-user.

3 Users' co-creation phase

To provide an efficient solution corresponding to the user needs, several meetings through interviews, workshops, evaluations will be conducted with end-users. This project has high ambitions and expectations such as slowing down cognitive decline in the elderly and providing a better quality of life to them and their surroundings.

As the quantity of seniors is constantly increasing, solutions must be found to limit cognitive degradation and the lack of carers. An unfolding of technological and practical tools may be the response.

To do so, engAGE aims to offer elderly people a way to support them through weekly/daily activities and train their cognition by doing some storytelling and role-playing exercises with the robot Pepper. To help on the support, relatives and carers will be included in the loop.

3.1 Context of the study

As it has been shown many of the elderly will be fronted to cognitive impairments, thus the engAGE system wants to provide technological tool for helping in dealing with this statistic. Not by making cognitive impairments never appear or disappear but by helping seniors to maintain a good cognitive condition, or at least limit their cognitive loss.

The project engAGE aims to support the cognitive state of elderly by implementing a buddy robot. This robot will provide its help with an easy and pleasant interface, giving enough choice to SMCI to choose how they want to be supported (games, videos, storytelling, and role-playing). The system must ensure that it's not only a nice tool to use but that is also helping elderly in addressing cognitive decline.

This co-creation phase will help to better define the expectations of our target audience and to better grasp how the system should be implemented in SMCI's life. The project doesn't aim to only help SMCI with their cognitive troubles but also to motivate them to be at the centre of their care. To do so, the project wants to ensure that the use of the system will be done in a safe environment without putting SMCI in danger or in health difficulties.

To achieve the project's goals, an end-user centred approach will be set up, involving both kinds of end-users in important milestones of the project: co-creation, mock-ups evaluation, usability evaluation, real life environment evaluation. The outcomes of end-users will progressively be considered to ensure an efficient solution with positive impacts on the cognitive deficiency.

3.2 Study design

On the "co-creation phase and innovation approach" a mixed method will be used to gather quantitative and qualitative feedback from the primary and secondary end-users. The first stage will be led by interviews with end-users (seniors, informal and formal caregivers), to better grasp their subjective experience of the Mild Cognitive Impairment (MCI) and list some needs, challenges and expectations regarding the existing technological possibilities.

Once those quantitative data gathered, a workshop with end-users will take place to discuss the results obtained on the previous interviews. This second round will help to collect some qualitative data to better illustrate what is expected from end-users regarding the engAGE project. The workshop

will then serve to better know the participants by collecting some practical information on their attitudes, opinions, and recommendations.

Seniors, carers, health institution's needs, challenges and expectative will, jointly with literature data, provide qualitative data to co-create a first prototype.

3.3 Intended users

To design a co-created solution, project partners had to involve the following end-users' categories:

- **Primary users**
 - **Seniors with Mild Cognitive Impairment (SMCI)** are older adults with frequent cognitive disorders, male or female, over 65 years old (exceptions may be excepted), needing care assistance to limit MCI or at least to stabilise their cognitive disability.
- **Secondary users**
 - **Informal Caregivers (IC)** are relatives, friends, neighbours, any supporting person of a SMCI in daily tasks, who are anxious of the SMCI situation and suffer to see SMCI deterioration due to their emotional bond.
 - **Formal Caregivers (FC)** are doctors, nurses, or all healthcare professionals in care institutions, associations; likely to care or used to be involved in SMCI's treatments.
 - **Healthcare organisations (HO)** are day care centres for seniors dealing with elderly with MCI; FCs from HOs have been involved in the co-design stage.

The SMCI met have two different profiles: early stage to mild stage. Some of them have *“hard time remembering things, don't remember names, faces, places”, “don't remember simple things: name of objects, movies seen”, “feel lost as if in a fog, at the time do not know what to do anymore”, “mix up days and months”,* while others have light impairments: *“don't remember where I put my glasses”, “forget appointments or medication intakes”, “read without retaining the information”.*

Carers, both formal and informal, define the cognitive impairment of seniors as the sine qua non situation for others health or daily problems, such as: hygiene issues on their life environment (forgetting to do the dishes, do washings, clean the flat) and on themselves (hard time to get washed). Cognitive impairment produces loss of consciousness that destabilises older people and prevents them from carrying on with their normal lives. More than a disease, it is a real handicap.

All end-users seem to agree on one point: this cognitive loss is due to a lack of brain and/or physical activity and the fear that this lack causes in the elderly person.

3.4 Participants' criteria

- **Seniors with Mild Cognitive Impairment (SMCI)**
 - Being more than 65 years old
 - Suffering from MCI
 - Living independently in the city or close border
 - Talking and understanding the study's language
- **Informal caregivers (IC)**
 - Being more than 18 years old
 - Helping a SMCI with well-being, nutrition/meals, daily tasks, mobility, etc.
 - Living in the city or close border

- Talking and understanding the study's language
- **Formal caregivers (FC)**
 - Having more than a year of experience
 - Working with SMCI for at least one year
 - Living in the city or close border
 - Talking and understanding the study's language

3.5 Users' involvement

A total of 45 meetings with end-users have been initially set up to co-design the engAGE solution. Each end-user partner site had initially to interview 15 end-users, but only one site succeeds to gather all of them. Table 2 below shows how much participants have been considered per site, enlightening a smaller number of participants than expected. Nevertheless, the participants involved are sufficient to grasp an idea of the needs, challenges and expectations from people suffering from cognitive impairment or taking care of seniors who do. Results from each site were quite similar, justifying a reduced number of participants.

Table 2: primary and secondary end-users' involvement per country partner

EU TYPE	Norway (KRD)	Italy (INRCA)	Switzerland (HUG)
Primary	2 SMCI (age mean: 80.5)	5 SMCI (age mean: 79.8)	2 SMCI (age mean: 77.5)
Secondary	2 IC (age mean: 72)	5 IC, 5 FC	2 IC, 3 FC (age mean: 42.5)
	4 EU	15 EU	7 EU
Total	26 EU		

In Switzerland, the average age is 77.5 years old for primary end-users and they are quite used to technologies, some use tablets, smartphones, computers or all of them. The average age of carers is 42.5 years old for both formal and informal. Carers are involved in mild cognitive impairment care for more than 6 years and have then a good knowledge of the topic. Formal carers were working in an institution where they provide care to SMCI: accompaniment of the resident, stimulating the five senses as well as the psychological and physical resources (autonomy and mobility), Entertainment service offering outdoor and indoor activities. The seniors they take care of have moderate to advanced cognitive impairments, with no efficient solution to help seniors.

In Norway, the average age is 80.5 years old for primary end-users and they are quite used to technologies, some use tablets, smartphones, computers or all of them. The average age of carers is 72 years old, only informal carers take part on the co-creation interview which explains the high average age. Informal carers are used to support SMCI by remembering them things like: Name of people, eating, proceed to hygiene; are helping them in their daily life. The seniors they take care of have moderate to advanced cognitive impairments, with no efficient solution to help seniors excepting self-made tips.

In Italy, the average age is 79.8 years old for primary end-users and 44.4 years old for carers both formal and informal. Carers are involved in mild cognitive impairment care for more than 7 years and have then a good knowledge of the topic. Formal carers are used to set up cognitive stimulation, rehabilitation, cognitive enhancement, prevention of allurement damage, rehabilitative care for allurement, psychological support and indication, suggestion to reduce MCI risks and care load for

their relatives. The seniors they take care of have moderate to advanced cognitive impairments, with no efficient solution to help seniors excepting self-made tips.

3.6 User’s needs, challenges and expectations and requirement categorisation

None of the end-users met for this co-creation phase have used or seen a robot before presenting them the engAGE project. More than half of them showed an interest in trying the robot but the other part think that the idea won’t be relevant for SMCI, if some challenges and expectation are not considered. Therefore, the needs gathered from the whole set of end-users are completed by information regarding challenges and expectations which will be useful to sort out to requirements. All the inputs are summarized in Table 3:

Table 3: listing of the whole set of needs, challenges and expectations in the three sites

Needs	Challenges	Expectations
Have a training for the memory each 2 days	If there is a problem with the robot, FC won’t be able to help	Memory exercises (memory card game with levels of difficulties)
Become healthier and progress cognitively not improve but maintain	Be motivated to achieve goals, don’t give up	Have a supportive and stimulative tool
To be reassured in his/her capabilities	Being able to use a new tool by him/herself	Being very hard to learn how to use the robot
Have a sense of progress, be supported through the exercises by the robot	Afraid to fail using the system and of being overwhelmed by intrusive system	Have to act as a stimulant and be felt as a human presence
To better know how to use a robot	Feel confident while using it	Can no longer do without it, efficient tool
Have a tool that can stimulate the SMCI and is pleasant enough for them to want to use it	Seniors won’t be able to use a robot such as Pepper They haven’t the capacities to do so with MCI	Memory exercises (recognize songs, noises by memory or visually)
Be sustained in the care provided	Make seniors become curious about the robot	System will cost more than its usefulness
To have a tool that can keep them busy while providing them cognitive care	Seniors may use the robot but for a short term, it will be difficult to entertain them with a robot for a while	Give SMCI some suggestions and tips to improve memory skills
System should be able to spot alarming signs of MCI (from scores in games)	Seniors may not want to be constantly observed on their MCI	Easier ways to have those data than by using a robot
To propose new solutions to SMCI feeling desperate and depressed (not all, good wellbeing) assessing wellbeing	Not sure that a robot could be the best tool to train memory faculties	Memory exercises (learn the lyrics of a new or old song to train memory)

A tool which assesses the performance of the senior and his/her cognitive state	Data security of a robot	Having history per seniors with scores and lines of progression/regression
Being constantly informed of the cognitive evaluation	Autonomy questioned; the senior would become dependent	Memory exercises (have to sing or repeat what has been said)
Having a clever robot which can propose SMCI exercises based on the difficulties spotted	Having an IA enough developed (effort proportional to use)	SMCI might be afraid of using a robot but if efficient will forget the form and be focused on the substance
Feel less powerless when faced with the cognitive deterioration of grandparents	It will be difficult to train seniors with MCI to use such robots (lot of time invested)	Playing games where they have to observe (game of 7 differences)
SCMI needs to do more physical exercise	Can be risky (dangerous if SMCI falls during the exercise)	System should provide physical games (with levels of difficulties)
Feel constantly motivated by moral supports	Give customised quotes of motivations	System shouldn't be a psychologist but positive enough to alleviate the SCMI
System can't be stressful but very calm, the design should be spaced, with quiet music in the background	The system has to evaluate the SCMI, the challenge is to not frighten the SMCI with bad results	The system should help SMCI to remain calm if stressed or feeling disoriented
System should provide a way to share results with carers	Difficult to share results, carers don't need an application but to know if there is a progression or not	Have access to some information that the SMCI might forget (scores, progression)
System should help SMCI to accept their cognitive condition and gain forces to fight it	The system has to know exactly what to say, without being offensive	System should get focus on positive aspects
System should be a support to learn or remember things	Have enough database to provide them new knowledges, new things to remember	System has to keep the SCMI active or willing to be productive
Memorise or learn new things	Have enough exercises without overriding the quality	Help SMCI to overcome their shyness and anxiety
SCMI need to feel supported by human beings, system should alleviate loneliness	Create a community of SMCI is difficult due to their cognitive state	System should make SCMI feel like he/she's not facing CI alone
Some exercises should be available with a multiplayer mode / group play	It would be nice if the SCMI in the institution can play against another SCMI (in presence or remotely?)	SCMIs have to create a bond thanks to the system
Support to complement the care offered by the centres and carers	Hard to rely on hundred percent on technology	First and foremost, the system has to work perfectly

A MoSCoW analysis has been done during the consortium meeting in the Technical University of Cluj-Napoca (Romania) to classify results gathered into requirements that must, should, could, would, be implemented in the engAGE system (see Table 4).

Table 4: legend for MoSCoW prioritisation

	The white cases stand for the Must of the MoSCoW	High priority
	The light grey cases stand for the Should of the MoSCoW	Medium priority
	The grey cases stand for the Could of the MoSCoW	Low priority
	The dark grey and crossed out cases stand for the Would of the MoSCoW	No priority

All the needs, challenges and expectations listed above can be categorized in four different types of requirements:

- **Motivational requirements:**
 - Games and cognitive stimulation must be available in the institution and at the SMCI's home. The aim is to motivate seniors to use the solution frequently (almost each two days).
 - Maintain their cognitive state and not see it deteriorate further
 - Inform on the progress or regression of their cognitive state
 - Have some motivational quotes to help the senior if he/she doesn't feel well, was wrong or needs help to go through the exercises
 - Informal carers have to receive motivational tips and advices to better face their beloveds' cognitive deterioration
 - SMCI's have to be motivated to do more physical exercises, depending on their score and mobility capacities the system should push them to go through physical exercises
 - System must provide some gamification to motivate SMCI's to achieve goals and don't give up (badge awarding, customization actions available, robot animation, saying Hourrah!, doing a little dance, etc.)
 - Motivational settings must be customized or personalized to offer a better adherence
 - Motivation settings must not be offensive or infantilizing
- **Analytics requirements:**
 - System must give some clear indications allowing to spot alarm signs, by taking the information of the recorded scores
 - System must also assess the well-being of the SMCI and provide some motivational quotes
 - System must be able to suggest SMCI's games and levels of difficulties depending on the results obtained
 - Carers must have access to the data gathered by the system at any time
 - Data gathered by the system have to be secured and only used for analysing SMCI's situation
 - Bad results should come with recommendation and not be scaring
- **Design requirements:**
 - Indicators must be designed in order to help SMCI to complete a game

- Interfaces have to be readable and funny to use to have a better adherence without being childish
- The design should be spaced, the font should be big enough, with quiet music in the background to help SMCI to remain calm and don't feel disoriented
- Interfaces and the information on don't have to be intrusive but must reassure and encourage SMCI to use the system
- The system should be designed to offer carers access on the information gathered (clickable options to share scores, share cognitive analyses or well-being evaluation)
- The design must provide enough satisfaction to help SMCI to accept the solution as a new tool and to be more confident to rely on technology
- Interactions should be designed in a way for SMCI to feel qualitatively supported as well by the machine as by a human
- An history of SMCI's actions and scores should be added to the system, end-users have to be able to read their score and be aware of the games already done and the levels completed
- **Support/training requirements:**
 - Formal carers feel the need to be trained to use the system and comfortable with
 - Formal carers need a system simple to use and non-time-consuming
 - Carers using MEMAS application must be also trained to take it in charge and adapt their care

Training requirements can be provided by creating an informative booklet on how to handle and use the engAGE robot. Furthermore, the robot can provide error messages clear enough to inform the user or the owner on the action to do. Chat bots can also be setup to help end-users to find answer to their questions while using MEMAS.

4 System characteristics and technology acceptance

The categorisation of the requirement being done, it's now critical to gather the system characteristics and assess the eventual barriers for engAGE technology scaling and adoption. Those characteristics will give additional guidance on how to implement the defined requirements. According to the target group interviewed, the engAGE system must have some important characteristics to be correctly used. The characteristics gathered on the workshop brainstorming held during the Consortium Meeting in the Technical University of Cluj-Napoca have been also added. All these characteristics are summarized in Table 5:

Table 5: Robot's characteristics defined by end-users

Robot's characteristics: engAGE must	
	Give a strong cognitive stimulation (the added value regarding cognitive state has to be clear)
	Use different means to create an interaction: speaking, making sounds, movement (increase interest)
	Use simple ways to interact: simple but complete (no technological background needed)
	Offer various games to entertain the senior while he/she works his/her memory skills (increase interest)
	Make a way to see progression/regression in memory skills (creation of different levels)
	Inform carers through an application to adapt treatments (poor scores: more sessions with health carers)
	Allow a simple identification and connection, with tips to remember the seniors' nicknames (ease-of-use)
	Put seniors in contact with other people like them (video testimony of peers, video calls)
	Save previous scores of the senior to give information on progression or regression of the SCMI's state
	Be completed with a strong coaching support, adapted to the levels of difficulty (increase adherence)
	Have to be installed in an institution and not at the seniors' home
	Be delivered with a pen as seniors often have issues on using tablets (problem to click)
	Have a low power consumption and stay autonomous almost for 4 hours straight
	Be able to offer SMCI an easy way to ask the robot to repeat itself

Even if those characteristics are important to consider in order to improve the robot's use, a system such as engAGE may encounter obstacles from the end-users. These barriers can influence the social robot's acceptance of the engAGE project (see Table 6).

Table 6: set of potential barriers to engAGE acceptance

Barriers to engAGE acceptance	
Education level	Other projects linked to robotics in the care of elderly have demonstrated that the educational level of the senior can play a big role in the acceptance of robots. People with a high level of education are more inclined to accept it, while the others are kind of afraid of it. This fact is to consider in a case-by-case situation.
Gender	Other projects linked to robotics in the care of elderly have demonstrated that the gender of the senior can play a big role in the acceptance of robots. People used to work all their lives, who had job opportunities linked to the use of technologies (computers e.g.) are mainly men. This fact is to consider in a case-by-case situation.

Barriers to engAGE acceptance	
Expertise level	Other projects linked to robotics in the care of elderly have demonstrated that the technological expertise level of the senior can play a big role in the acceptance of robots. What matters is not if the seniors use smartphones, tablets, computers... but rather if they feel comfortable and confident while using it. It should be a delight to use engAGE.
Collaboration with institutions	If the institutions or associations taking care of SMCI don't like the idea, it might be a drag making SMCI less inclined to accept it also. In other words, if each site is not supported by at least one institution or association, it would be more difficult to reach participants and ensure a bigger acceptance of engAGE in the medical field of cognitive troubles.
Support	The engAGE system should be itself a support or provide it by using chat-boxes, putting gamification components, displaying error messages with instructions. That way the senior is not left to face a machine and can find ways to overcome his/her difficulties without having to call for help or to close the game.
Human characteristics	The engAGE solution should not replace a human or a profession related to the care of people with mild cognitive impairment, but it does have to "act" as a human on several points and give an impression of conviviality: ask/answer questions, bounce off a topic, have body language, show emotions, etc.
Dissemination of robotics in care field	People tend to have bad judgments on robots, especially if they are not used to it. For people (elderly or not) to accept this solution, they must already be informed and convinced of its usefulness and added value in the care fields. If there is no dissemination regarding robots, it will soon be a barrier to engAGE acceptance.
Robot usefulness	The robot should be a part of the engAGE solution and not a simple tablet holder. If the robot doesn't provide ways of interaction like a human (welcoming, asking on the well-being, making moves, singing) carers would may prefer using only a tablet. The robot should be part of the tool and not an aside gadget.

5 Supportive games and exercises

Initially the engAGE project has been taught to offer SMCI theatre like exercises but when performing the interviews, those exercises weren't sufficient. Furthermore, not every senior with mild cognitive impairment is comfortable with theatre like activities. Some don't want to do specifically storytelling and role-playing with the robot even if they acknowledge the benefits from those exercise. Others are more than pleased to have a robot to train on theatre plays. To satisfy their expectations, other type games have been gathered through end-users' interviews and presented in this section.

End-users' meetings from Switzerland, Norway and Italy have led to design 4 different types of exercises, which can be provided by the engAGE robot:

- *familiar games* which seniors are used to play;
- *quizzes* to train their memory while having fun;
- *physical games* to sustain health issues related to MCI;
- *story / plays telling* to go deeper in memory trainings.

The envisioned games (Table 7), will have to be sorted out by technical partners, as the totality of them will be difficult to implement. Most of the exercises purposed by SMCI's and their carers, either formal or informal, are equipped with levels of difficulty, which are shortly explained on the grey part of the table. The entirety of the games, with description and indication on the difficulty levels options are also summarized.

Table 7: listing of all games and exercises mentioned by end-users to improve any cognitive state

Name of games	Description	
Familiar games		
Crossword	Helps with long term memory, having to find common words based on their definition or pictures.	★: easy level (infinite tips) ★★: medium level (limited tips) ★★★: hard level (no tips)
Karaoke	Helps SMCI to have fun while singing songs they already know (train memory without noticing).	
Memory card	Helps with spatial memory, which can help SMCI to find lost objects in the future.	
Sudoku	Helps with visual memory, using numbers instead of letters can be easier and more enjoyable. It's an appreciated game for SMCI.	
7 differences game	Helps to stay focus, observe, retain the information to seek.	
Quizzes		
Picture quiz	Find the celebrities/animals behind.	★: picture ★ ★: pixelated photo ★ ★ ★: silhouette
Musical quiz	Seniors interviewed share a common passion for music. Musical games and quizzes should be implemented. SMCI will have to complete lyrics of famous songs, recognize singers or the name of the songs and determine some noises.	

	★: remember the singer ★ ★: remember the song's name ★ ★ ★: remember both	
Cultural quiz	Questions regarding arts & literature, entertainment, geography, history, science & nature, and sports & leisure. SMCI will have to answer in different manners.	
	★: two options ★ ★: four options ★ ★ ★: free answer	
Physical games		
Miming	The robot being able to move, it can show SMCI some moves to train their physical condition. The robot can show some videos to the senior that he/she will copy. It can also show a picture that the senior has to interpret.	
	★: reproduce robot actions ★ ★: copy actions on video ★ ★ ★: interpret, mimics an image	
Dancing	Dancing on songs they know and like, with simple dance steps.	
	★: reproduce robot steps ★ ★: learn new steps in video ★ ★ ★: learn new choreography	
Doing yoga	Few SMCI have balance problem which can be helped by doing some simple exercises yoga.	
	★: breath exercises ★ ★: some relaxing exercises (meditation) ★ ★ ★: balance exercises	
Story / plays telling		
Story listening	SMCI have to listen to the story told by the robot and answer questions that appear during the story telling.	No difficulties levels will be set up, but scores will show the performance of the SMCI's.
Plays/poems reciting	SMCI have to listen to theatre plays or songs and learn them with the robot (only short and well-known parts) "Be or not to be".	

The games listed above are designed to be played individually. The multimodal play option is evaluated for now as being too complicated to be set up. For the moment, decisions have been made to offer end-users a simple system which can be updated and improve in further steps.

6 Use-Case Scenarios

EngAGE wants to co-create a technological tool corresponding to the needs of this target audience to maintain their cognitive state. Helping them with CI will help them to better face daily tasks and have a more pleasant and normal life possible.

Regarding the results, some participants pointed out that the system will not be used more than 1 to 3 times a week. They have estimated that they will do some cognitive exercises for approximately an hour; and that having the robot at home would be senseless and too intrusive. The exercises provided by the robot don't have to be specially done at home, this must stay an option. Then, to use the robot Pepper in the most efficient way possible, the robot should not be installed at the seniors' home but in institutions or associations specialized in mild cognitive impairments. Furthermore, exercises provided by Pepper should also be available on an application. So, SCMI also have the option to exercise their cognitive state at home.

The robot could be installed in playrooms of the institutions/associations, in waiting rooms to keep the seniors distracted while they wait, in common rooms where the robot could be a part of the staff or in a room specially dedicated to the robot's use. For the use case scenario, the "waiting room" option has been chosen, because we think that it's the best way for SMCI to get to know Pepper. Once they have met their new cognitive assistant, the engAGE solution can be installed in playrooms. Of course, institutions will decide on where to install it.

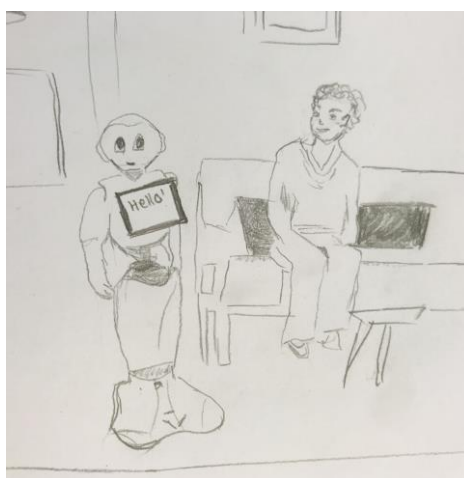


Figure 1: engAGE solution welcoming a senior with mild cognitive impairment in the waiting room of a care institution.

6.1. First interaction with the engAGE solution

To get to know each other, the Pepper robot and the senior should both be able to start an interaction. So, to present itself, the robot could move to the senior or make her/him a hand signal to capture the SMCI's attention or display a "HELLO" on the screen. If the senior goes to meet the robot, his/her voice should be a signal for the robot to start an interaction.

When starting to get each other, the robot should present itself and purpose to the seniors if they want to play games.

“Hello, my name is engAGE, I am here to help you to train your memory skills. I have several games that I think can help you, do you want to try?”

If the SCMI agrees, the engAGE solution will display a welcome screen where the senior can create his/her account. To help them to remember their account the purpose is to tape their name and year of birth, and to choose one image of the library to have an avatar to create a nickname. The identification system does not require an email account and a password. SCMI just must select their nickname to have access to engAGE functionalities. If this option is not feasible technically, simplicity on registration should be kept on mind.

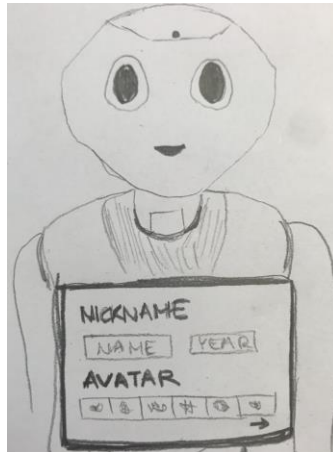
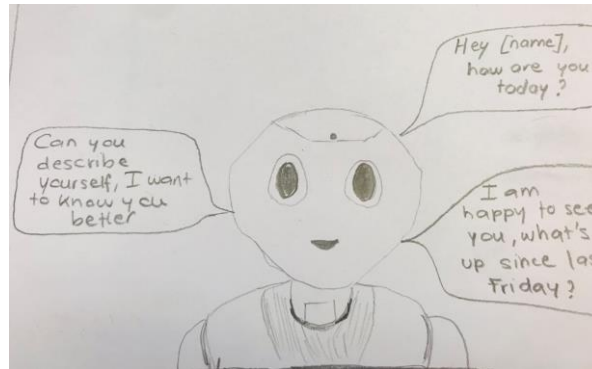


Figure 2: engAGE solution welcome screen to create a simple ID

By creating their account, they can save their scores and levels performed on the system and have access to their history. It's important that the system saves past scores/histories to be able to track the progression or digression in the cognitive state of the SMCI. These scores can be forwarded to carers' application, so carers can have an insight on the SMCI's level of progression or regression. The games proposed will then serve to evaluate if SCMI is maintaining his/her cognitive state.

To train the memory of the SMCI, the robot should be allowed to ask them some general questions. For example, when detecting a senior in front of them, engAGE solution can (1) ask if the senior is doing fine and make some face/body/vocal reactions to SMCI's answers: yes/no. Questions can also be linked to (2) their identity and life story, as it has been demonstrated in several studies that talking about their identity is a beneficial to their memory; it can also (3) make some comments regarding the senior's last connection or ask like:



- (1) *Hey [name], how are you today?*
 (2) *Can you describe yourself? I want to know you better*
 (3) *I am happy to see you. What's up since last Friday?*

Figure 3: engAGE solution starting verbal interactions with the SCMI

The senior should also be able to initiate the interaction with the robot by asking it basic questions. The robot Pepper should be able to give general answers or provide short feedback to the senior. If the robot cannot answer to the senior, it should say “I don’t know”, “You may ask somebody else” but not keep silent. The robot should be able to give small talks to the SCMI just as a human being could do. Conversations don’t have to be too elaborated; the system should provide basic

(4) SMCI: What time is it?

(5) SMCI: what will the weather be like after my appointment?



- (4) *it's quarter past 5 PM. Why?*
 (5) *It will be sunny, keep hydrated!*

Figure 4: engAGE solution answering to two questions of the SCMI

6.2 Functionalities of engAGE

To stimulate seniors, 4 different types of games will be displayed and purposed to SMCI on Peppers’ tablet. All the games sorted out are useful to maintain their memory skills (Table 7): *familiar games, quizzes, physical games, and storytelling*. The games gathered by end-users’ interviews are well-known of this population. Most of seniors are already adept so it won’t ask them too much energy to understand how the games work, but the system has to be ergonomic enough for them to know how to play.

These games will be available on the robot but also on a remote system, which is part of the engAGE solution. The SMCI will then be able to continue the games started on the robot, at their home using their own technological devices. This remains an option, the SMCI decides the frequency of its use.

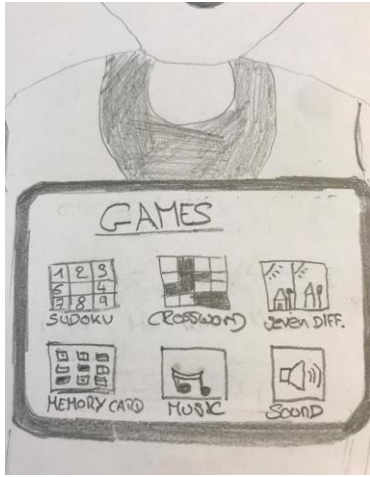


Figure 5: engAGE screen displaying the different kind of available games



Figure 6: engAGE screen displaying the level of difficulty per game

Whether they are used face-to-face or remotely, all games will have distinct levels of difficulties: low-medium-high; scored with stars (★-★★-★★★). Levels will help to situate the SCMI regarding their cognitive state and underline signs of regression or progression, the goal also being to have scalable games. So after, the screen showing all the type of games on the system, when clicking on a type of game, a second screen should appear to choose the level of difficulties.

All levels of games should have a set of game parts, displayed on a screen to better help the SCMI to situate him/herself on the exercises' progression. When one of the game parts is completed, some gamification such as: badge awarding, robot animation (Hourrah!), etc. will serve to cheer the senior and motivate him/her to continue playing games. After the little animation, the SCMI reaches the next level and arrives in a new screen.

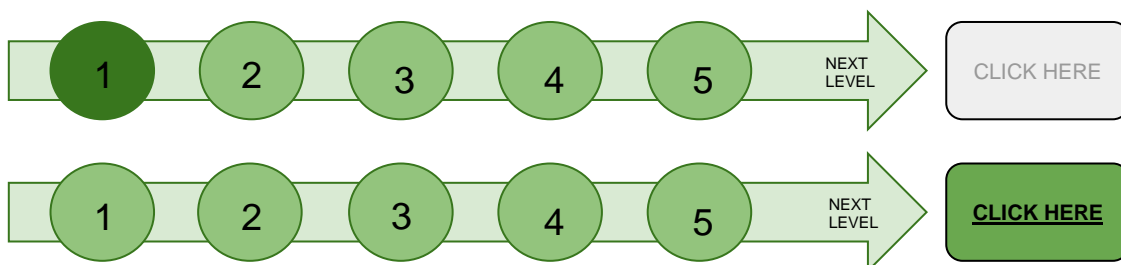
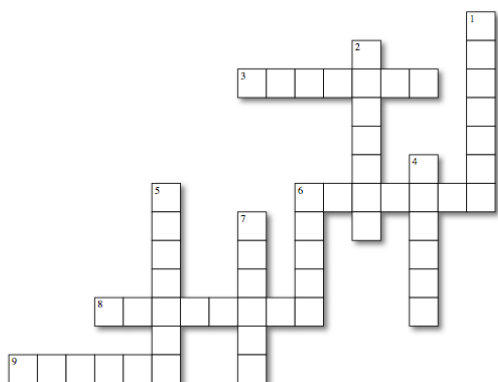


Figure 7: Playing path (top starting point, bottom finishing point)

Moreover, the games must be stimulating. If the senior is stuck and hasn't made a move or clicked for more than 3 minutes, the robot could give him/her some indicators to find how to solve the game.

The indicators will be different in function of the levels of difficulty. In the low level a part of the response or images will be given, in the medium level part we can have some tips and in the expert level the indicator could be a riddle. Furthermore, to help the SMCI to solve games, the robot can have reassuring words to address her/him so she/he can try things out without anxiety.



To find the word n°4, engAGE can purpose indicators:

- ★
The word starts with a B
and ends up with an A
- ★★
It's often yellow but can be green or black.
- ★★★
It's a common fruit

Figure 8: engAGE crossword game with examples of indicators per levels of difficulty

To go further, we can imagine that the robot could have a multiplayer mode, which is not feasible with the robot Pepper. Alternatively, some games can be purposed on a group counted as a single player. Playing in group can be interesting to stimulate seniors and make them wanting to participate and play. The group effect in interaction with the robot could be beneficial to them on a cognitive and social level.



Figure 9: engAGE solution welcoming and inviting two SCMI to train their memory skills together with Pepper's help

It would be also nice if the engAGE solution can also analyse the content of the games the seniors are interested with, to purpose them or advise them on what exercise they can do on their own, at home. The robot's suggestions and advice may not be followed, but it may make SCMI's want to be more involved in their healthcare.



engAGE can also display other things than games and have a special feature for testimonial videos of other SMCI narrowing the difficulties fronted, the solutions found or simply videos aiming to share advice, life experiences, etc. The aim is to give them the possibility for them to be less alone with their cognitive problems and find solutions with people who face the same difficulties as them. For now, priority is given to games to sustain their memory.

7 Conclusions

engAGE solution has been quite accepted and end-users found some interesting added values regarding the cognitive impairment's issues. As Pepper is a machine, it will remain a machine and will not be judgmental or tired of repeating things nor angry, which is a great benefit. On the contrary, it will always try to stimulate the senior with mild cognitive impairment which is kind of appreciated. Nevertheless, all insisted on needing an efficient system which is not childish but respectful.

Lot of seniors are in the denial phase and think that the cognitive trouble is temporary, so the system should be pleasant enough to use to get them into "cognitive care" without noticing it and finding a certain pleasure in it. To ensure the user satisfaction, the system has then to be very simple to use (the SCMI should not question him/herself, tablet pen at disposal) and provide different games and exercises propositions (tastes of SCMI are not the same and everyone must find something interesting to do).

The figure below summarises the way the engAGE system was thought to intervene. Its 4 cognitive function stimulation were: Human-Machine-Interaction support (dialog and role playing), Cognitive support (memories and storytelling), Coaching support (reminders and step by step instructions on ADL) and Social interaction (virtual meeting with friends and family).

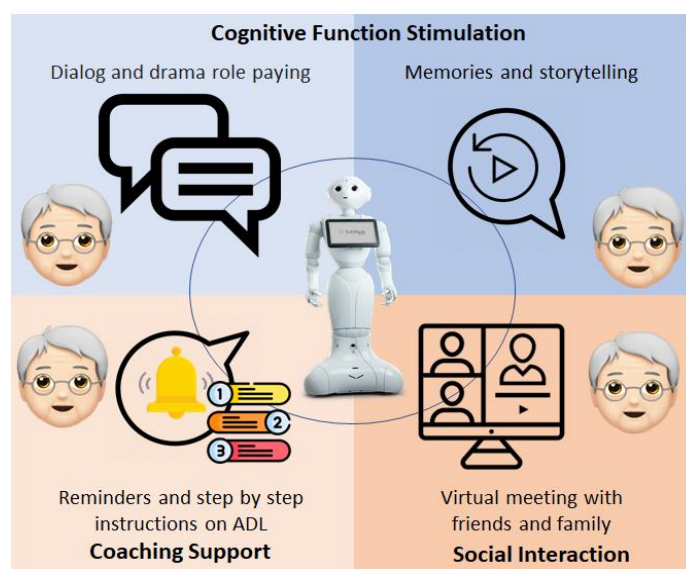


Figure 10: Cognitive Function Stimulation

These 3 functions were considered in the previous results but weren't thought the same way as end-users did.

The interaction between the SCMI and the robot has to be bidirectional, both of them/it should ask questions and be able to answer them. The dialogs haven't to be too developed as the robot will principally serve as a support for memory games and exercises but will have to be very welcoming, polite and supportive during its use. Furthermore, SCMI's won't have so much to tell them and might forget what they were saying. The interaction must then be supported by useful interaction due to their cognitive state: simple ways for asking the robot to repeat itself.

Regarding the coaching support, end-users haven't talked about special needs to receive reminders or instructions. So, the reminders and step by step instructions on ADL, thought about by partners, haven't been considered during the co-creation period. The coaching interaction has been brought in a new way but reminders and step by step instructions on ADL will be kept and proposed for evaluation to end-users in the further steps. The coaching support is more on gamification, tutorials, indicators while gaming; which serve to help and coach them.

The social interaction is now designed for institutions or associations taking care of SCMI. Regarding the scenario presented (waiting room scene), virtual meeting with friends and family was not relevant as SCMI are almost always accompanied by relative(s). Anyways it would be nice for the SCMI to start a call with the person he/she has an appointment within the institution. Virtual calls with formal carers despite informal carers could then be a good manner to offer them social interaction.

8 Appendix

8.1 Co-creation Interview Protocol

INTERVIEW PROTOCOL

The co-creation interviews can be realised face-to-face or remotely, as long as the sessions are recorded, and we can see the participant and conversely. This round will involve seniors with Mild Cognitive Impairment, their relative carers and healthcare professionals working on the field of cognitive impairment.

To gather inputs from the primary and secondary end-users a set of questions will be asked to them. Those questions try to draw the situation of people faced with mild cognitive impairment, directly or indirectly. **Questions regarding mental health have been greyed out, end-users' partners (NO, CH, IT) are free to choose whether or not to ask them.** The aim of these questions is to have an idea of the potential mental health issue worsening the cognitive situation of the senior.



“When planning cognitive interventions including robots, it is important to analyse the attitude of older adults towards this technology” [2] and seek to differentiate between curiosity interest and use interest.

PRIMARY END-USER: SMCI

DEMOGRAPHIC QUESTIONS	
<i>When were you born?</i>	<input type="checkbox"/>
<i>What job did you have?</i>	<input type="checkbox"/>
<i>Do you live alone?</i>	<input type="checkbox"/>
<i>What are your hobbies?</i>	<input type="checkbox"/>
GENERAL QUESTIONS	
<i>Please describe yourself</i>	<input type="checkbox"/>
<i>What have you understood regarding the engAGE project or do you have questions?</i>	<input type="checkbox"/>
<i>Do you have "health-related" or other reasons that make you unable to participate in our study?</i>	<input type="checkbox"/>

MILD COGNITIVE IMPAIRMENT - MCI	
<i>Do you have any health problems that would make it difficult when coming to use a technological solution?</i>	<input type="checkbox"/>
<i>How would you define MCI regarding your own experience?</i>	<input type="checkbox"/>
<i>What do you do to overcome MCI?</i>	<input type="checkbox"/>
<i>What doesn't work to overcome MCI?</i>	<input type="checkbox"/>
MENTAL HEALTH - MH	
<i>Since you have had cognitive problems, how do you feel psychologically?</i>	<input type="checkbox"/>
<i>Is your MH state getting better, staying the same, getting worse since the beginning of the year?</i>	<input type="checkbox"/>
<i>What doesn't work to overcome MH issues?</i>	<input type="checkbox"/>
<i>Please describe a situation that has been really challenging.</i>	<input type="checkbox"/>

TECHNOLOGICAL SOLUTION - TS	
<i>Do you use technologies daily? If so, which devices? What do you do with it?</i>	<input type="checkbox"/>
<i>Have you already used a social robot?</i>	<input type="checkbox"/>
<i>What kind of technological appliances do you have at home? Are they easy to use?</i>	<input type="checkbox"/>
<i>What difficulties do you encounter when using it?</i>	<input type="checkbox"/>
<i>Do you think that intelligent assistive technologies (applications, social robots) could be a solution? Why?</i>	<input type="checkbox"/>
THEATRE EXERCISES- TE	
<i>Do you think that theatre can bring benefits regarding MCI?</i>	<input type="checkbox"/>
<i>Do you think that theatre can bring benefits regarding MH?</i>	<input type="checkbox"/>
<i>What would you like to do regarding theatre possibilities, cognitive games and exercises?</i>	<input type="checkbox"/>
<i>Would you like to have some theatre exercises to do at home?</i>	<input type="checkbox"/>

SECONDARY END-USER: CARERS (FC/IC)

DEMOGRAPHIC QUESTIONS	
<i>When were you born?</i>	<input type="checkbox"/>
<i>What job do/did you have?</i>	<input type="checkbox"/>
<i>Since when do you provide home care?</i>	<input type="checkbox"/>
<i>What type of care do you provide SMCI with?</i>	<input type="checkbox"/>
GENERAL QUESTIONS	
<i>Please describe yourself</i>	<input type="checkbox"/>
<i>What have you understood regarding the engAGE project or do you have questions?</i>	<input type="checkbox"/>
<i>Do you have any other issues or concerns regarding MCI challenges?</i>	<input type="checkbox"/>

MILD COGNITIVE IMPAIRMENT - MCI	
<i>How would you define MCI regarding your own experience?</i>	<input type="checkbox"/>
<i>What is the most problematic part of taking care of seniors with MCI?</i>	<input type="checkbox"/>
<i>What kind of strategies do you use to better take care of SMCI?</i>	<input type="checkbox"/>
<i>Have you seen some SMCI improve their cognitive state? What is the percentage?</i>	<input type="checkbox"/>
<i>How do SMCI react when facing cognitive issues?</i>	<input type="checkbox"/>
<i>What doesn't work to overcome MCI?</i>	<input type="checkbox"/>
MENTAL HEALTH - MH	
<i>Do SMCI suffer from a psychological point of view? Why?</i>	<input type="checkbox"/>
<i>When do they feel better?</i>	<input type="checkbox"/>
<i>When do they feel worse?</i>	<input type="checkbox"/>
<i>What do you do to overcome their sadness, depression?</i>	<input type="checkbox"/>
<i>What doesn't work to overcome MH issues?</i>	<input type="checkbox"/>
<i>Please describe a situation that has been really challenging.</i>	<input type="checkbox"/>

TECHNOLOGICAL SOLUTION - TS	
<i>Do you use technologies daily in your personal life? If so, which devices? What do you do with it?</i>	<input type="checkbox"/>
<i>What kind of technological appliances do you use to provide care? Are they easy to use?</i>	<input type="checkbox"/>
<i>Do you already have or own a social robot?</i>	<input type="checkbox"/>

Do you think that intelligent assistive technologies (applications, social robots) could be a solution? Why?	<input type="checkbox"/>
THEATRE EXERCISES- TE	
Do you think that theatre can bring benefits regarding MCI?	<input type="checkbox"/>
Do you think that theatre can bring benefits regarding MH?	<input type="checkbox"/>
What would you like SMCI to do regarding theatre possibilities, cognitive games and exercises?	<input type="checkbox"/>
Do you like the idea of implementing theatre exercises or would you like to offer something else (painting, dancing, etc.)?	<input type="checkbox"/>

8.2 End-users' consent form

PARTICIPANT'S INFORMED CONSENT FORM (IFC)

engAGE - Managing cognitivE decliNe throuGh theatre therapy, Artificial intelliGence and social robots drivEn interventions

Initially considered a normal effect of ageing, mild cognitive impairment is a syndrome that affects older adults (not only) and causes changes and decline of their cognitive abilities. To manage such negative effects on wellbeing and health there is a strong need for innovative technologies to engage, support, and coach older adults in training their cognitive function in a rather personalised manner considering their cognitive state, preferences, and wishes. Social robots, non-invasive Internet of Things, and Artificial Intelligence are key technologies that are innovatively and uniquely combined by engAGE to support the self-management of cognitive decline. engAGE main target groups are: older adults with mild cognitive impairment, family caregivers and healthcare professionals. engAGE approach to the self-management of cognitive decline from non-invasive monitoring and assessment up to advanced intervention, cognitive function stimulation, and social interaction.

Objective

The goal of the engAGE project is to combat and slow down cognitive decline progression, to enhance the intrinsic capacity of the users, and to support the wellbeing of older adults with mild cognitive impairment by providing an ecosystem of services that integrates:

1. Holistic monitoring of the ability to conduct activities of daily living and wellbeing
2. Machine learning-based cognitive decline evaluation
3. Coaching, cognitive stimulation and social interaction using social robots.

For more information, please visit the website of engAGE: <https://engage-aal-project.eu/>

Participation & inclusion criteria

PRIMARY

- **Older adults** over 65 years suffering from MCI, living independently in the city or close border and supported by caregivers, male or female, needing care assistance to self-

manage and support their cognitive function, being friendly with technologies and talking and understanding the local language.

SECONDARY

- **Informal caregivers:** Must be 18 years old, family carers supporting the older adult with MCI, living in the city or close border, being friendly with technologies and talking and understanding the local language.
- **Formal caregivers:** Professional caregivers having, more than a year of experience and working with SMCI for at least one year, such as nurses supporting older adults with home care, other home care professionals, being friendly with technologies and talking and understanding the local language.
- **Healthcare organizations:** Day care centres for seniors dealing with elderly with MCI

Description and process of the study

We are conducting interviews with primary (older people with MCI) end-users faced with cognitive impairments to better understand their needs, challenges and expectations towards technology. Data for this study are being collected face-to-face or through remotely interviews. An audio recording may be conducted. The interview will be guided by a research assistant and will last approximately 1 hour.

Participants' rights

Your participation in this study is solely on your own initiative. No one is allowed to push you or influence you in any way. You will not be asked to justify your refusal. If you choose to participate, you may withdraw your participation at any time. Again, you will not have to give a reason for withdrawing from the study. You may ask any questions you have about the study at any time. To do so, you can contact the research assistant accompanying you or the people listed at the end of this document.

Confidentiality and data anonymization

The data will be collected confidentially and will be anonymized. We will comply with all applicable EU data protection laws. We will only use your data for the purpose of the study. All persons involved in the project are subject to professional secrecy.

Consent form

Participant's signature

Place, date	Name	Signature
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Researcher's obligation

I certify to have explained to the participant all the information related to the study. I hereby declare that I have complied with all obligations related to this project in accordance with the applicable law. If I become aware, at any time during the course of the project, of elements

that could influence the participant's consent to participate in the study, I undertake to inform the participant immediately.

Research assistant's signature

Place, date	Name	Signature
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Responsible of the study:

Person in charge of the study:

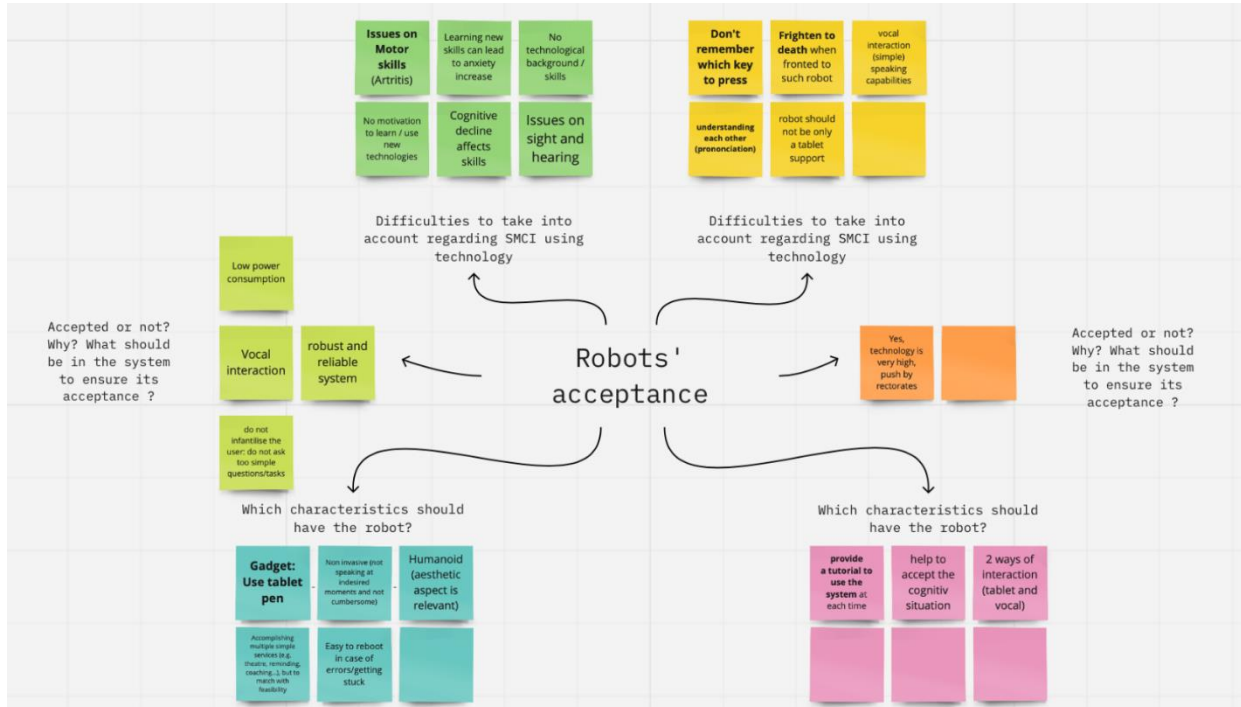
8.3 Results file on excel for site partners

This excel file illustrated below was be shared in order to gather end-users' inputs. In the example below is the sheet to fulfil regarding SMCI, the same sheets have been created regarding IC and FC who have been part of the interview session.

SMCI	
	SMCI_01
DEMOGRAPHIC QUESTIONS	
When are you born?	
What job did you have?	
Do you live alone?	
What are your hobbies?	
GENERAL QUESTIONS	
Please describe yourself	
What do you know about the project?	
What would you know about the project?	
Do you have "health-related" or other reasons that makes you unable to participate in our study?	
MILD COGNITIVE IMPAIRMENT -MCI	
Do you have any health problems that would make it difficult when coming to use a technological solution?	
How would you define MCI regarding your own experience?	
What do you do to overcome MCI?	
What doesn't work to overcome MCI?	
MENTAL HEALTH - MH	
Since you have had cognitive problems, how do you feel psychologically?	
Is your MH state getting better, staying the same, getting worse since the beginning of the year?	
What doesn't work to overcome MH issues?	
Please describe a situation that has been really challenging.	
TECHNOLOGICAL SOLUTION - TS	
Do you use technologies daily?	
If so, which devices? What do you with it?	
Have you already used a social robot?	
What kind of technological appliances do you have at home?	
Are they easy to use?	
What difficulties do you encounter when using it?	
Do you think that intelligent assistive technologies (applications, social robots) could be a solution? Why?	
THEATRE EXERCISES- TE	
Do you think that theatre can bring benefits regarding MCI?	
Do you think that theatre can bring benefits regarding MH?	
What would you like SMCI to do regarding theatre possibilities, cognitive games and exercises?	
Would you like to have some theatre exercises to do at home?	

8.4 Workshop on robot's characteristics to be accepted

Partners have met each other on a day session work in which they had some time to run a workshop. The workshop aim was to discuss and brainstorm on the characteristics that the robot should have to be better accepted by the targeted group. The platform miro has been used to perform the exercise.



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