KompAï Robot for robotized compreheNsive GeriatrIC Assessment (ARNICA)

End-user Involvement

Reference:	ECHORD++ PDTI
Responsable:	Robosoft Services Robots
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Confidentiality level:

☒ Strictly confidential – Internal use only
☐ Strictly confidential – Restricted access to:
☐ Not confidential – Public

Client:	EC- Echord++
Project:	ARNICA
Product:	Kompaï-CGA

Content

1 - Introduction

European societies have been aging rapidly over the last few years. Recently, the average life expectancy has been increasing by approximately three months per year. The percentage of people belonging to the age group 65 years and over has also grown. In 2013, it amounted to 16.2% in the 28 EU countries. According to forecasts, it will rise up to 23.9% in 2030 and up to 29.4% in 2060. An even faster growth will be observed in the age group 80 and over. This group now accounts for 5.1% and it will rise up to 7.1% by 2030, and up to 11.8 in 2060 (an increase by over 100% compared to 2013)(1).

As time passes, changes in the human body occur. They affect all systems and organs and mean that the risk of morbidity increases with age. In the central nervous system this means an elevated risk of cognitive function disorders.

Cognitive impairment includes, among others, symptoms of time and place disorientation, problems with concentration of attention, counting, reading, writing, but also problems with memorising new information or recalling information already memorised. These are inseparable elements of dementia. Their severity in patients with dementia increases over time. They affect emotional and behavioural functioning and limit functional independence.

Cognitive impairment is a necessary, but not sufficient element of dementia diagnosis. It is universally recognised that dementia affects approximately 1 per cent of persons aged 65-69, but as many as 40 per cent of those aged 90 and more. It is estimated that the number of persons afflicted with this illness exceeds 35.6 million world-wide (2) and that due to the ageing of the world's population it will double by 2030. However, it should be stressed that recent epidemiological data indicate a significantly lower frequency of dementia compared with the prognoses. This is explained by the steadily improving education of subsequent cohorts entering old age, a healthier life style and better prevention of cardio-vascular diseases (3); for example, studies conducted by Matthews et al. (4) in United Kingdom in the years 1990-1993 predicted the occurrence of dementia in 2011 in 8.3 per cent of the studied population. In reality, such disorders were diagnosed only in 6.5 per cent of these persons, i.e. nearly 25 per cent less. The differences were much greater in age sub-groups above 80 years. This indicates a possibility of modifying the risk of the occurrence of cognitive functions disorders thanks to lifestyle changes. Consequently, this should be taken into account in the strategies of care for the elderly, in particular, those with an increased risk of dementia.

Usually, those who organize care for the elderly do not realize that even minor cognitive impairment significantly increases the demand for care and hamper its provision. For example, in such cases elderly persons may need supervision taking their medication. They may forget to take their medicines even if these have been placed in a special container or may take them at the wrong time. In such cases the family and/or carers should take control of the medication-taking regime. In such and similar cases there are opportunities for solutions based on new technologies, including the deployment of robots in the care for the elderly.
The first step in the diagnosis of dementia is a screening for cognitive impairment. One of the recommended screening tests in this regard is the Mini Mental State Examination (MMSE)(5). According to Kim et al. (6) MMSE can also be considered as a promising screening tool for mild cognitive impairment (MCI).

Besides mental state, it is also mandatory to assess other aspects of the older adult's health. Indeed rates and direction of change in measures of mental, physical, emotional, functional and social status are the most accurate means of predicting outcome of illness in older patients. An approach that includes an assessment of all these variables and takes into account the interaction among them is referred to Comprehensive Geriatric Assessment (CGA). In CGA tests, questionnaires and scales are used to collect data and to focus the care plan on issues of greatest concern in the health of the older person. Some instruments to help in this type of evaluation and document the patient status are the following: Get up and go test (mobility and balance), Lawton scales (functional scales of basic and instrumental activities of daily living for evaluation of functional status), Yesavage scale (emotional state) and Face pain scale (pain evaluation). The caregiver's burden is also crucial to examine (Zarit scale).

In the context of ARNICA project, the role of the robot is to conduct the CGA module taking into consideration not only complex ethical and legal issues but also the **needs and expectations of final users**. These information are crucial to feed design process conducted in this first phase of the project and also for the second phase.

2 - Methodology

In ARNICA, activities involving end-users (requirements, evaluation of prototypes) will be carried out in **Lusage Living Lab** (phase 1 and 2) and in the **care services** (phase 3) of **Broca Hospital**.

The Lusage living-lab (LL) is specialized in the design, the development and assessment of technological products and services for elderly people in Broca hospital (AP-HP).

The Lusage living lab is located in the gardens of the Broca hospital.

Settings are shown below:
Lusage Living Lab

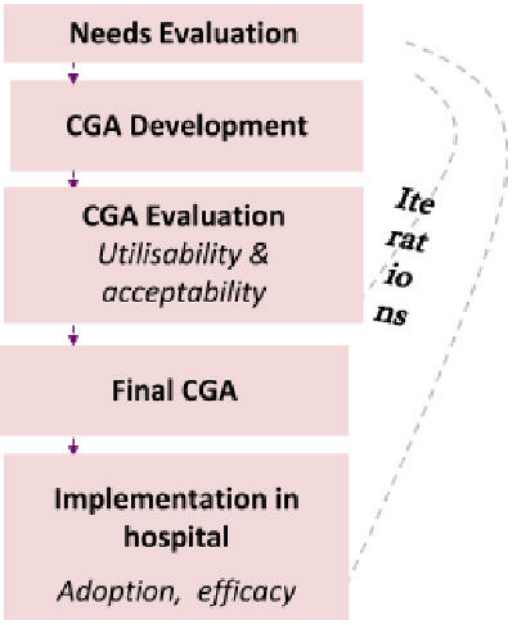
(outside left and inside below)

Broca Hospital is a public University Hospital in Geriatrics. It includes medical care, research and teaching activities in Geriatrics with a day care hospitalization, acute and rehabilitation care hospitalization, long-term hospitalization, an expert memory clinic and frailty center, a Geriatric

network in the community. Broca hospital provides all the medical and support services necessary for the management of elderly people including a geriatric department, comprehensive clinical expertise with geriatricians, neurologists, psychiatrists, cardiologists (and other specialists), biology, MRI, CT scan.

Methods

In the ARNICA project, we will apply an end-user driven design approach and involve end-users (patients, relatives and health professionals) regularly in their development process in order to receive feedback from a clinical perspective. Our work will be conducted within a muti-dimensional framework including medical, social and ethical expertise. We have adapted the traditional methods of human-computer interaction research to work effectively with older adults with fraily or cognitive deficits taking in consideration their abilities, motivations and limitations. We will follow the following steps in the development of the CGA.



Assessment of needs and expectations of users

In ARNICA, we will match the robot with the needs and expectations of end-users (patients, caregivers, professionals). These needs will be collected by focus groups. Needs assessment helps a) identifying situations that are problematic for users in a given context, b) the exploration of solutions implemented by the person using his/her own resources, c) definition of needs that are not met by currently available strategies, d) the design of new solutions to meet these unmet needs.

Usability assessment

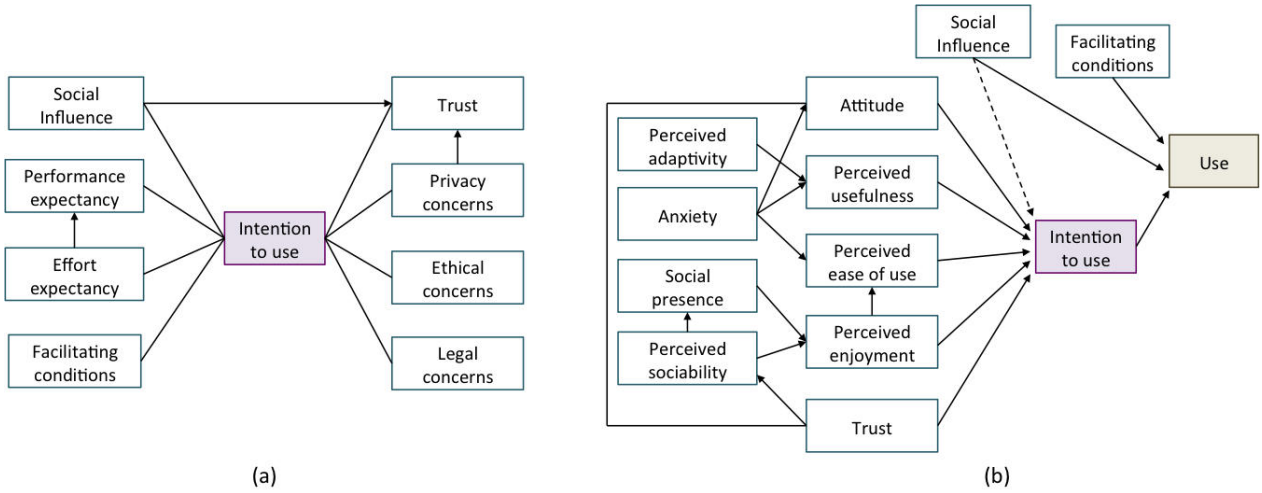
The usability evaluation is a means to ensure that interactive systems are tailored to users, their abilities and that there is no adverse effects to their use [19]. In ARNICA, this technique will improve the design of interfaces thanks to the identification and correction of existing usability problems. It will also ensure the development of a robot that will be considered as useful, easy to use and satisfying by the end-users [7].

The usability evaluation can be based on different methodological approaches. In Arnica, we will use heuristic evaluations which will be led by a group of expert evaluators (professionals) who will identify key usability issues of the robot during working sessions. We will also use user test which is a technique used to collect empirical data (including performance, learning preference and

satisfaction) in an observation controlled position. In user tests, the end-users will be asked to interact with the robot and perform the series of CGA tests on the tablet of the robot.

Acceptability of the robot

For the evaluation of acceptability of the robot, we will use the Almere model (8, 9) as shown below.



Factors that determine the acceptability of a robot (Almere model) are shown in Table 2.

FACTOR	DEFINITION
Intention to use	Intention to use the robot for a long period
Social influence	Perception of opinion that persons who are important for the end-user could have on the use of the robot
Attitude towards the robot	Positive or negative feeling towards technology
Perceived utility	Degree to which the person think that the robot will be useful for him/her
Perceived ease of use	Degree to which the person think that the use of the system will be without effort
Perceived enjoyment	Feeling of joy/pleasure linked to the use of the system
Trust	Belief that the robot acts with integrity, reliability and without causing any harm to the person
Adaptability	Perception of the system ability to adapt to the user needs
Anxiety	Emotional and anxious reaction induced when using the system
Perceived sociabilility	Perceived ability of the system to show a social behavior

Final product assessment

LUSAGE will provide a framework for observing and analyzing the behavior of older persons when using technological devices including the robot in the ARNICA project with non-intrusive methods. These assessments will be conducted under controlled conditions for the first prototypes of the robot, and in real-life conditions (hospital units, day care center) when more advanced versions of the robot will be available for tests (phase 2 and 3). Evaluations will be conducted to evaluate its effectiveness and gather feedback on its use. This approach will also take into account the adverse effects of the use of the robot on the end-users. The field beds assessment will allow assessing device functioning, and determining if it meets the criteria of quality and safety defined. This step will help identifying the difficulties of integration from the perspective of end-users and the needs which are not addressed by the solution.

Table 3 shows a summary of methods that will be used in the ARNICA project.

Phase	Goal	Methods
User knowledge	Definition of user profile	Older adults with frailty, chronic diseases and cognitive deficits Caregiver Professionals
	Needs and requirements gathering	Focus groups Prototyping
Phase 1 **Mock-ups, videos**	Prototype design and validation	Guidelines and checklists Prototyping Focus groups
Phase 2 **(Early) prototypes**	Prototype design and validation Usability and Acceptability of the robot	Guidelines and checklists Heuristic evaluations by experts* Focus groups User tests Interviews Questionnaires
Phase 3 **Final prototype**	Final robot assessment Usability and Acceptability of the robot	Focus groups User tests Interviews Questionnaires Evaluation in care units Follow-up
Transversal analysis	Ethical analysis	Guideline and literature reviews Focus groups Interviews
	Market analysis and valorization strategies	Focus groups Value analysis methods*

* Methods that do not require user involvement

End-users involved in ARNICA

End-users will include: Older adults in good health (fit), with frailty, with chronic somatic diseases or with cognitive deficits (MCI or dementia such as neurodegenerative or vascular dementia) their caregivers, and healthcare professionals. In ARNICA, end-users, including caregivers, are involved from the beginning throughout the entire product development lifecycle.

Written informed consent to participate in the programme will be obtained from each patient and each proxy before the beginning of the study (the study plan will have been submitted to the ethical committee: Comité de Protection des Personnes and its approval sought and obtained before patient inclusion). The different documents (informed consent and information letter) will be provided in the ARNICA project.

For phase 2 and 3

End-users that will participate in the project will be older adults and caregivers recruited in the consultation unit (frailty and memory expert centers where 5000 older patients consult per year). They will be explained the ARNICA project and if they accept to participate, they will be included in the study. Caregivers who will accept to participate in the study will also be recruited. Professionals who work in the consultations, day care and hospitalization units willing to participate in the study will also be recruited (at least 50 professionals).

Throughout the project (phase 1, 2, 3)

End-users (patients, caregivers and professionals) participating either to the Café Multi-media or Stall meeting will give their feedback on the ARNICA project.

Café multi-media is a monthly meeting of older adults willing to participate in the Living Lab as pro-active end-users. They perform a follow-up of research projects that are currently undergone in the Lab (entire cycle of developed technology including requirements, testing of mock-ups, first and final prototypes and reflection on ethical issues). The Café Multi-media group includes fit older adults (they may be caregivers or not) as well as people with MCI or dementia. The sessions are supervised by two professionals (neuropsychologists and/or medical doctor). Thirty people participate in Café Multi media group and sessions.

Staff meetings are weekly meetings of professionals dedicated to research in the geriatric department. Every month one session is dedicated to the evaluation of prototypes currently developed in the living lab. Professionals attending the sessions (about 30 persons) are medical doctors, neuropsychologists, psychologists, nurses, physiotherapists, speech therapists, cognitive ergonomists, engineers, anthropologists.

3 - Knowledge Collection

Date	Activity	Source	Main Outcome
27/01/2016	**Name:** Introduction meeting **Purpose:** Presentation of solution and questions for end-user about technical specifications	Name of contact person, company or institution	Short description of main outcome, e.g. important findings, feedback
20/04/2016	**Name:** Meeting with César Gálvez **Purpose:** Check needs for Get Up and Go Test.	**INLOC Robotics:** Josep M. Mirats **Fundació ABAT:** César Gálvez	To check with Doctor which are the specific needs for the Get Up and Go Test. To gather some preliminary images to work with.
25/05/2016	**Name:** Meeting with César Gálvez **Purpose:** Take image data sets to adjust Get Up and Go Test developed algorithm.	**INLOC Robotics:** Josep M. Mirats Ferran Plana **Fundació ABAT:** César Gálvez	To gather images from performed Up and Go Test, acting us as a patient. To check with Doctor the usefulness for them about the outputs of our algorithm.
08/06/2015	**Name:** Meeting with César Gálvez **Purpose:** Check results obtained up to now with our algorithms for Get Up and Go test.	**INLOC Robotics:** Josep M. Mirats Ferran Plana **Fundació ABAT:** César Gálvez	To check with Doctor the results obtained with our first implementation of the Get Up and Go test. To gather a coherent set of images for the test, acting us as patient performing it.
10/06/2016	**Name**: Demo **Purpose**: presentation of the robot functionalities and technical features (hardware, software)	Vincent Dupourqué, CEO Robosoft Pr Anne-Sophie RIGAUD, Broca Hospital, APHP	Mobility Interface Voice →set up requirements & specifications for use in an institution, identify a framework

			for exeprimentaton in phase 2
14/06/2016	**Name**: Focus group pro **Purpose**: get feedback from professionals (15 persons) regarding specific aspect of the robot usability	Pr Anne-Sophie RIGAUD, Broca Hospital, APHP	GUI Voice Digital tests
15/06/2016	**Name** Focus group End-users **Purpose**: get feedback from end-users (10 persons) regarding specific aspect of the robot usability	Pr Anne-Sophie RIGAUD, Broca Hospital, APHP	GUI Voice

Methodology in phase 1

In phase I, a demo was performed by robosoft. In addition, the feedback of the end users was elicited in a "Café Multi media" (fit older adults, patients and caregivers) and a professional staff (professionals). In the two focus groups, the ARNICA project was explained. The Kompai robot and mock-ups of the GUI were shown. A small video showing how the Barthel test was performed (with GUI and voice) was presented.

The results of these focus groups are described in the deliverable on Ethics (for the part on ethical issues) and below (for the part dedicated to usability).

Results in phase 1 of the ARNICA project

Results of demo by Robosoft and focus groups (professionals and end-users)
Main outcomes:

During these sessions the following issues were discussed

- Legal framework for the use of the robot (see deliverable on Ethical issues)
- Characteristics of the Kompai robot including security (EC labeling)
- Usability : vocal interaction, humour, GUI, tests framework, physical position of the user in front of the robot, position of the tabl to allow of good vision of the GUI, etc.
- Acceptability : design of the robot (see deliverable on Ethical issues)
- Usefulness : saving time (see deliverable on Ethical issues)
- Validity/efficacy of the evaluation by the robot: reliability of the test results
- Ethical issues (see deliverable on Ethical issues)

Technical characteristics of the Kompai robot and conditions for use and implementation

Hardware:

- Sensors to help the robot move in a setting (detect distance)
- Laser for self-moving (horizontal and vertical/forth and back)
- Button SOS that can be personalized for functionalities and services
- Kinnect 2 : face recognition involved in interaction
- Animated/moving eyes involved in interaction and emotion

- Voice

Functionalities/services of the robot that can be triggered through the tablet

- skype / visioconference
- Physical and cognitive exercises
- agenda /weather forecast / horoscope / music / drug reminder
- software for navigation : 1 or 2 days for mapping a setting and implement navigation
- detection of a person lying on the floor

Questions / remarks to Robosoft by the audience:

- Hardware: good balance / risk of tipping over ?+ autonomy in moving ?
- Feminine voice for the robot? generally preferred by people
- Mapping of different floors? capacity 10 à 20000m2 / the robot can take the elevator
- Security: detection of mobile obstacles? this is possible / EC labeling, EC medical device (ongoing process)
- Autonomy of the robot? between 4 and 8h, charging station
- Kompaï in institution: how many people can be detected and differentiated?

<u>Usability of the GUI evaluated by the participants of the focus groups</u>

<u>Feedback on the video of the Barthel test:</u>

- The Barthel test should be done by the caregiver, not the patient himself (it might be difficult to perform by the patient and thus the results might not be reliable)

- Feedback on the voice

According to all participants (end-users, caregivers and professionals), the voice might still be improved.

One suggestion for the voice could be to use a real human person voice, rather than a synthetic one, in order to be more friendfly.

- Feedback on the GUI (first and second versions of GUI: interfaces and Barthel test are shown in Annex 1)

All participants (end-users, caregivers and professionals) pointed out significant improvements between first and second GUI for the test. More specifically participants noted that the screens showed better contrast, font size and color, user-friendly design, clearer icons, better illustration concepts, better navigation buttons (next / previous question), improved font size and sufficiently large icons

- Usability of interface for professionals is also important: it would be useful to make recommendations for access to tests and scores by professionals

    - o How are patients data recorded in the robot? Are there intermediate screens between the button to have access to the "questionnaires" on the home screen and the launch of the test?

For example in the e-test project (performed in the Broca hospital: there is either an anonymous mode or an identified mode for the follow-up of the patient. In the "identified" mode, it would be useful to create a patient profile and enter the trigram.
o It is possible to use the anonymous mode and recover at the end of each test results that are displayed on a screen
o Specify characteristics of the screens displaying the test results as well as the screens to rate the subject's responses recorded by the robot (for each end-user)

General remarks:

- It is important to specify whether the answers are verbal or by touching the screen
- It is important to check whether the patient understands the instruction and is able to interact with the robot. The suggestion would be to include a feasibility test before beginning the CGA.

Feedback of the professionals on the development of the other tests
MMSE

The MMSE might be difficult to transpose in digital test

- Problem of transition from paper / digital human;
- For the MMSE the following points are particularly problematic because difficult to check by the robot:

Eg praxis "take this paper, fold it in there 2 take out the ground"
Eg name "what the object (watch and pencil)"

- either we have to change / adapt and recalibrate digital tests
- either we have to choose easily transferable tests: significance of test selection

Lawton: it might be difficult to answer by the patient if cognitive impairment is present (because of anosognosia), it is better to ask the caregiver

Timed up and go test:
Tinetti gait test
Tinetti balance test:

- How to evaluate time for performing the test? Possibility to combine with other sensors (actigraphy, position) that would allow a quotation by the robot

Pfeiffer test:
The test is easily transferable

Yesavage test: the test is easily transferable in a digital test because it is self-administered, but there might be some ethical issue: Risk and management of sadness of the person performing the test alone with the robot

Zarit test: easily transferable

Face pain scale: easily transferable, rather interaction via GUI (in this test the voice interaction is not crucial)

Visual analogic scale (pain): easily transferable in digital test

Suggestions for ultimate phases of ARNICA (by professionals)

Evaluation of efficacy/validity of the robot evaluation
→ In next phase, it will be important to examine validity of testing by the robot.
Different protocols could be proposed for the evaluation of validity.
We could compare tests results (robotic vs human testing), cross the groups (group A : first robot testing, second human testing ; group B : first human testing, second robotic testing)
For inter-rater reliability, we could also compare three conditions:

- robot alone
- clinician alone
- clinician quote what the robot has registered

To avoid test-retest effect: it would be better to do the re-test a few days after the first test

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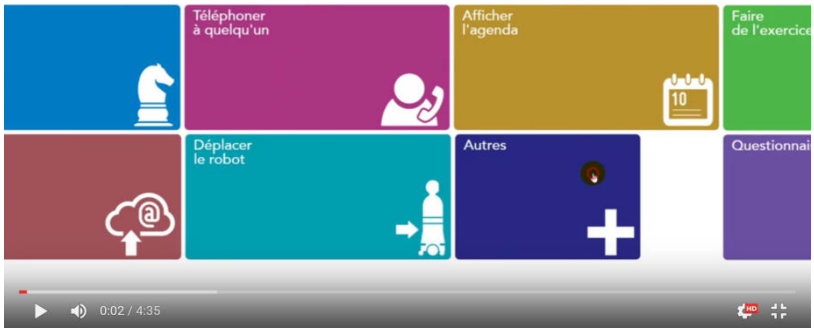
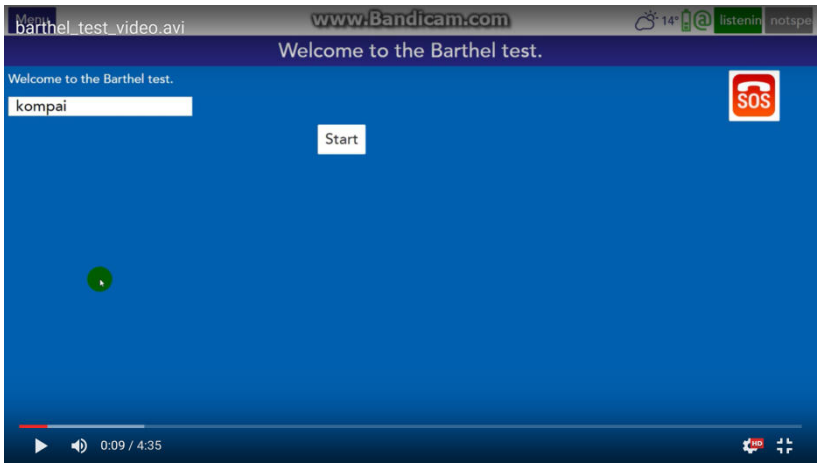
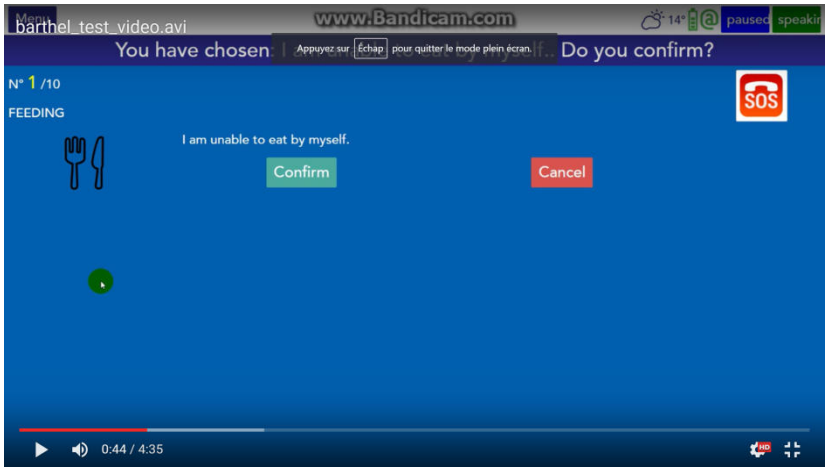
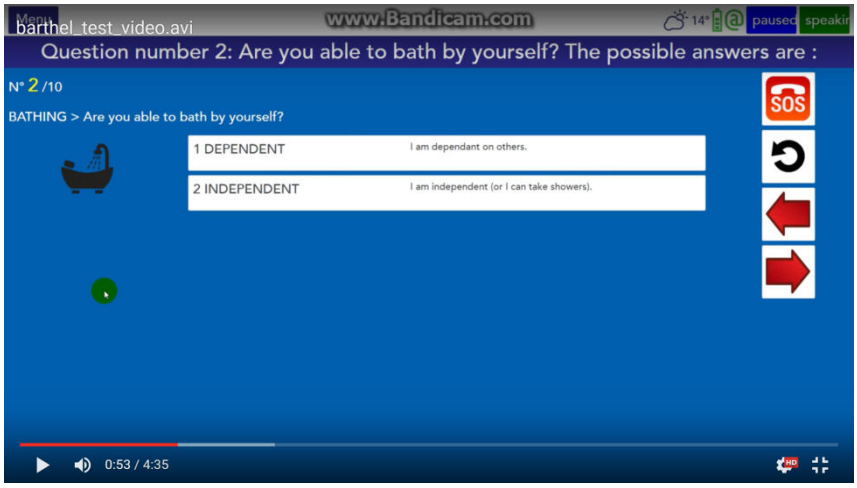
ANNEX 1

First version of GUI: interfaces and Barthel tests






barthel_test_video.avi
www.Bandicam.com
paused
speakin
You have chosen I am unable to eat by myself. Do you confirm?
Appuyez sur Échap pour quitter le mode plein écran.
N° 1 /10
FEEDING
SOS
I am unable to eat by myself.
Confirm
Cancel
0:44 / 4:35


barthel_test_video.avi
www.Bandicam.com
paused
speakin
Question number 2: Are you able to bath by yourself? The possible answers are :
N° 2 /10
BATHING > Are you able to bath by yourself?
SOS
1 DEPENDENT
I am dependant on others.
2 INDEPENDENT
I am independent (or I can take showers).
0:53 / 4:35

Second version of GUI: interfaces and Barthel test