



## **D5.4 Main Field Study D5.5.2 Main Study Evaluation**

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Project PLAYTIME

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<b>Summary</b>	In this document, the aim, design methods and procedures of the main field study are described, next to the study results. Therefore, the deliverables 'D5.4 Main Field Study' and 'D5.5.2 Main Study Results' are merged into this final document.

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# 1 Executive Summary

The AAL funded project PLAYTIME consisting of partners within Austria, Belgium and the Netherlands develops an integrated serious game of personalized emotion-oriented training modules to stimulate cognitive processes, to address physical activities and foster social inclusion of people living with dementia. The motivation of people living with dementia is primary triggered by the following three aspects of PLAYTIME: (1) positive affection achieved from social engagement in playful group gatherings, (2) multimodal online training modules, including the multi model training module DTN, the social-emotional game module SERES Dementia™, the use of the emotion slider.

The main field study of the PLAYTIME project aimed to evaluate the usability, feasibility, appropriateness, and acceptability of the beta prototype of PLAYTIME by means of a Living Lab method. Furthermore, it evaluated the usability of the user feedback, in terms of physical performance and physical activity, for determining personalized recommendations.

In the Netherlands 13 people with dementia and their informal caregiver were included in this study. Each participant received the beta prototype of PLAYTIME at home for a period of ten weeks. Besides the individual sessions at home, there were also group sessions organized. Participants were asked to join every week in the group sessions at a health care organization for ten weeks.

After the ten weeks of testing, the prototype was evaluated by means of a reflective semi-structured interview at study participant's home, or in a group environment. The topic list of this interview consists several open and closed questions regarding to their general experiences of playing PLAYTIME and more specific to the four evaluation areas (usability, feasibility, appropriateness, motivation and acceptability).

Results of the Main Field study show that there were issues with respect to the usability of the SERES game that needs attention, such as the login/password structure. The acceptability of the prototype was influenced by its usability, many participants wanted to play the SERES game but do not log on, Wi-Fi problems did not get to play this part of the game. The usability of the DTN system did not give problems, the usability of some of the exercises could be improved. Results with respect to appropriateness show that personalizing more exercises would help to create an appropriate difficulty level for each individual for both games. Finally, for feasibility it was found that participants found it doable to play PLAYTIME frequently. However participants need to be motivated to start playing by an (in) formal caregiver.

## 2 Introduction

Dementia is a broad category of neurocognitive disorders characterized by a long term and often gradual decrease in the ability to think and remember. Other symptoms include impaired language, personality changes, emotional problems, behavioral disturbances, and decreases in motivation (Prince, Albanese, Guerchet, & Prina, 2014). The most common forms of dementia are Alzheimer's disease (<70%), Vascular disease (<20%), Lewy Body Dementia (<5%) and frontotemporal dementia (2%) in descending order of occurrence (Prince et al., 2014). These diseases are progressive and slowly, but severely affect a person's brain, and thus affect his or her ability to live a normal life. Advancing age is the main risk factor for most forms of dementia, and with the ever increasingly aging population, the prevalence of dementia worldwide is expected to nearly double every 20 years to 65.7 million in 2030 and 115.4 million in 2050 (Prince et al., 2014). This expected increase will have profound societal challenges in the sense of costs connected to the care of dementia, the quality of life of people with dementia, and the burden on family care givers.

Currently, no disease modifying drugs for dementia are available and pharmacological treatment is limited to therapies that alleviate the symptoms. However, these treatments are not efficacious in all clients and may introduce undesirable side-effects (Galimberti & Scarpini, 2010). Non-pharmacological (or psychosocial) interventions, such as serious games, are therefore appealing alternatives or add-ons as studies suggest that (1) physical games (games that promote physical fitness) can positively affect several health areas of the players with dementia, such as balance and gait (Padala et al., 2012), and voluntary motor control (Legouverneur, Pino, Boulay, & Rigaud, 2011); (2) cognitive games (games which target cognitive improvement) can improve a number of cognitive functions, such as visuo-spatial abilities (Yamaguchi, Maki, & Takahashi, 2011); and (3) both physical and cognitive games can have a positive impact on social and emotional functions, for instance they can improve the mood and increase positive affect and sociability (Boulay et al., 2011; Yamaguchi et al., 2011) and reduce depression (Calvo et al., 2011). Very few studies investigated the effects of the use of games for social-emotional health (which encourage the players to link with their friends and/or improve their social and emotional life) in dementia, but the results are promising (Boulay et al., 2011).

Despite these results, there is to date no serious game geared towards people living with dementia that stimulates physical health, cognitive performance, and social-emotional functioning at the same time. Therefore, the AAL funded project PLAYTIME consisting of partners within Austria, Belgium and the Netherlands develops an integrated serious game of personalized emotion-oriented training modules to stimulate cognitive processes, to address physical activities and foster social inclusion. The objective of the project PLAYTIME is to motivate people with dementia to enter a positive feedback cycle of periodic training with sensors that enable diagnostics on a daily basis, and to receive recommendations on the basis of these data that propose more personalized and better suited exercises for improved training. The motivation is primary triggered by the following three aspects of PLAYTIME: (1) positive



affection achieved from social engagement in playful group gatherings, (2) multimodal online training modules, including a cognitive, social-emotional and physical exercises, to offer the user playful experience at home and group gatherings, and (3) user feedback, in terms of physical performance and physical activity, that provide diagnostics to determine personalized recommendations and, in turn, optimize user experience.

The serious game PLAYTIME may only provide benefits to people living with dementia if it is easy to use, accepted, useful, and feasible to fit into users' daily life (Meiland et al., 2017). Yet, a number of studies showed that people with dementia have problems in using many of the serious games currently available on the market. These difficulties derive from the fact that they are seldom developed considering the users' needs and context (Robert et al., 2014). Understanding the daily context of users in the development of new innovations is therefore essential to cater to their, often complex needs. Moreover, the first-hand perspective from the person with dementia itself is rarely sought in the design process of innovations (Topo, 2009). Instead, the designer or an informal caregiver generally voice product or service evaluations on their behalf. This absence of a first-hand perspective and the need to develop and evaluate innovations as an integral part of daily context of people with dementia motivates the use of the Living Lab method for PLAYTIME. A Living Lab represents is a user-centered research methodology in which multiple stakeholders are all collaborating for creating, prototyping, validating and testing new innovations in real-life contexts (Bergvall-Kareborn & Stahlbrost, 2009; Markopoulos & Rauterberg, 2000), with the goal to develop the innovation further for a market introduction (Leminen, Westerlund, & Nyström, 2012). We rarely see people with dementia getting involved in Living Labs, nevertheless, they are perfectly capable to do so when adequately prepared (Span et al., 2013).

Given the preceding paragraphs, it is clear why the serious game PLAYTIME needs to be carefully evaluated by the use of a Living Lab method. Therefore, this main field study aims to evaluate the prototype of PLAYTIME in order to retrieve insights on its usability, feasibility, appropriateness, motivation and acceptability in real-life environments. Furthermore, it will evaluate the usability of the user feedback, in terms of physical performance, physical activity and emotional measurements, for determining personalized recommendations. The results of this study are input for the final development of the PLAYTIME project that fits with the user's needs and context.

### 3 Research Questions

The research questions of this study can be formulated as follows:

- (a) To evaluate the beta prototype of PLAYTIME with respect to its **usability, acceptability, appropriateness, and feasibility** for PWD (and their informal caregivers).
- (b) To evaluate the beta prototype of PLAYTIME with respect to **users' motivation** to continue with gameplay.
- (c) To evaluate **users' emotional status** during PLAYTIME to allow for better understanding of the interplay between emotion and performance.
- (d) To evaluate the data measured by the beta prototype of PLAYTIME in relation to the **cognitive, social-emotional and physical status** of PWD (and their informal caregivers).

## 4 Methods and materials

### 4.1 Study design

For this research, an explorative in-context study was conducted to evaluate users' experiences with the PLAYTIME prototype and to look for improvement and personalization opportunities. The Living Labs were positioned in the Netherlands and Austria and people living with dementia were involved as co-creators rather than subjects of study (Almirall, Lee & Wareham, 2012). Each participant in both the Netherlands and Austria were asked to test PLAYTIME at home for a period of ten weeks, or in group gatherings for ten weeks.

### 4.2 Participants

In total 19 participants living with dementia were included in the Netherlands. One participant participated in an user friendly test, 13 participants played the individual PLAYTIME module, five groups played in a group setting, each group had a minimum of three participants and a group leader. In Austria 19 persons were included in the main study. One person (female, 77 years old) participated in the friendly user test. Among the 19 persons participating, 2 persons decided to terminate the study prematurely. In Austria, 17 people played the individual PLAYTIME module, 4 of these 17 persons also took advantage of the group offer.

*Table 1. Overview of participants (the Netherlands and Austria).*

	Number of participants	
	The Netherlands	Austria
<b>Female /Male</b>	3/10	1/16
<b>Type dementia</b>		
Alzheimer	10	17
Vascular dementia	2	
LewyBody dementia	1	
<b>Age (range)</b>	65-86	71-95
<b>MoCa Scores (range)</b>	14-25	5-26
MoCA not performed	1	0

All participants had a diagnosis of mild to medium dementia based on the Clinical Dementia Rating (CDR) scale, and lived at home with an involved informal caregiver. Persons with dementia were not included if they had frontotemporal lobar degeneration (FTLD), visual and auditory processing disorders, and insufficient physical abilities to perform the movement

exercises of PLAYTIME. The physical ability of a person with dementia was tested by the MoveTest on three domains; balance, gait, chair rise. Participants were included when a score was reached of at least one point on each domain. General characteristics of the Dutch and Austria participants that using the individual PLAYTIME module are presented in Table 1. No data was available for the participants of the groups sessions.

The research was carried out in accordance with the latest version of the Declaration of Helsinki. All participants and their informal caregivers gave written informed consent prior to participation to the study, which was approved by the Ethical Committee of the Netherlands (School of Social and Behavioral Sciences of Tilburg University).

## 4.3 Materials

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The prototype of the serious game PLAYTIME contains an interactive mat for group gatherings and an application on a Tablet PC consisting of multimodal trainings modules. The trainings modules involve:

- (1) Multimodal training module (DTN): this module is the core component of PLAYTIME. It involves the person with dementia into different training modules consisting of physical and cognitive exercises (e.g. multiple choice questions, puzzles, spot-the-difference, memory, and knowledge-based questions). Each trainings module is based on one theme (for example summer) and can be played at three different levels (1, 2 or 3). In Austria the participants had 4 levels of difficulty to choose from (1, 2, 3 or 4).
- (2) Social-emotional game module (SERES Dementia™): this module involves the person with dementia or/and the caregiver into a social-emotional context and asks for decision-making and reflection upon social imaginative scenarios. The module is applied complementary to the training units and as a serious game trains the social-emotional awareness of the user.
- (3) Motion module (MoveTest and MoveMonitor): this module involves the person with dementia in several motion analysis procedures: it is capable to measure physical performance during controlled tests and physical activity of the persons with dementia within a longer period of time (1 week in daily life). Both procedures rely on a sensor unit worn around the waist with an elastic strap. With MoveTest measurements, markers can be set in de measurement data to highlight the data to be used for further analysis. Data collected with the MoveMonitor is analyzed entirely.
- (4) Attention module: this module will provide a gaze interface for games that at the same time provide assessment indicators for cognitive control. Furthermore, it provides an analysis of the eye tracking movements of the person with dementia which can be used as an indicator for the degree of dementia within a specific period of time. This module was only tested in Austria.
- (5) Emotion module: This module provides emotion measurements and calculations in the context of affective computing. It measures basic emotional responses during each training module of PLAYTIME by the Affective Slider (AS), which is a digital self-assessment scale of emotion composed of two slider controls that measure pleasure (sad - happy) and arousal (sleepy - wide awake). As theories of cognitive control stress

that affective states provide the impetus for allocating cognitive control, the examination of the affective states that are associated with successful and less successful cognitive performance can have diagnostic value. Furthermore, examination of emotions are key to understand which game elements encourage motivation to continue with PLAYTIME.

## 4.4 Procedures

### Study procedures

A study design of several phases has been used to evaluate the beta prototype of PLAYTIME. In the figure below, a summary of the study procedure is provided, including the total amount of investment minutes needed from each PWD and his or her informal caregiver for the home

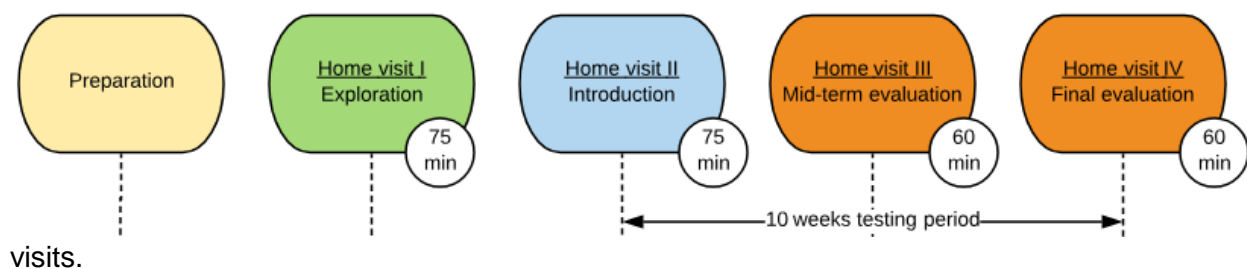


Figure 1. Summary of study procedures.

### 4.4.1 Phase 1 Preparation

In the 2nd and 3rd quartile of 2019, a healthcare professional from GGZ has recruited three existing daytime activity centers by contacting group leaders in her network, and two groups within a (psychiatric) hospital. During recruitment, the healthcare professional has provided information flyers (see Appendix II) to the group leaders, which they have used to invite eligible study participants of their daytime activity center to participate the project. If both the PWD and his or her informal caregiver showed interest in participating in the project, they had to contact the healthcare professional of GGZ. Subsequently, the healthcare professional of GGZ has sent an information letter and informed consent to them (by post or email). Two weeks after the information letter and informed consent were mailed (or a couple days longer in case these materials were sent by post), the healthcare professional of GGZ has contacted eligible participants by telephone. The purpose of the call was to verify if they received the information letter and informed consent, to address any remaining questions about the study, and to solicit their preliminary agreement to participate. If both the PWD and his or her informal caregiver agree, the healthcare professional of GGZ has made an appointment to visit them at home together with a research member of the project PLAYTIME (coordinated by TIU) (see phase 2). Next to the recruitment of existing daytime activity centers, the healthcare professional of GGZ has also recruited single study participants, who wanted to test PLAYTIME only at home. During recruitment, the healthcare professional of GGZ has applied the same procedures as described above: distributing information flyers, sending information letters and informed consent forms, and contacting eligible study participants after two weeks to verify if they received the information letter and informed consent, to address any remaining questions about the study

and to solicit their preliminary agreement to participate. If both the PWD and his or her informal caregiver agree, the healthcare professional of GGZ has made an appointment to visit them at home.

In the 2nd and 3rd quartile of 2019, the team of SVD recruit single study participants, who will test PLAYTIME at home or during the group session. During recruitment, they receive information flyers. If both the PWD and his or her informal caregiver are interested in participating in the project, they have to contact the study leader of the SVD, she contacted eligible participants by telephone and made an appointment to visit them at home together.

#### ***User friendly test***

Before the first home visits take place, the healthcare professional of GGZ had asked a PWD of the focus group meeting of Innovate Dementia 2.0 to perform a 'friendly user' test at their home in order to verify if the different training modules of the beta prototype of PLAYTIME are working properly. In doing so, it will be possible to provide the study participants with suitable instructions and manage their expectations on testing PLAYTIME. Furthermore, as long as the beta prototype of PLAYTIME is not working satisfactorily, the testing phase (phase 4) had not be initiated. Important to note is that the PWD who has performed the 'friendly user' test, is not participating in the 10 weeks testing period.

Before the home visits take place, the SVD asked one or two PWD to perform a 'friendly user' test at their home in order to verify if the different training modules of the beta prototype of PLAYTIME are working properly. In doing so, it will be possible to provide the study participants with suitable instructions and manage their expectations on testing PLAYTIME.

### **4.4.2 Phase 2 Exploration (Home visit I) (for individual participants)**

After scheduling an appointment, the healthcare professional of GGZ and the researcher of PLAYTIME have visited a PWD and his or her informal caregiver at home. The main purposes of this home visit was:

- (1) To obtain the informed consent.
- (2) To verify if the inclusion criteria are met (by CDR and MoveTest)
- (3) To introduce the PLAYTIME project step by step.
- (4) To conduct a personal interview and hand out questionnaires.
- (5) To schedule an appointment for the second home visit.

Below, some of these main purposes will be further described

After scheduling an appointment, the clinical psychologist of SVD and the researcher of PLAYTIME have visited a PWD and his or her informal caregiver at home. The main purposes of this home visit was:

- (1) To obtain the informed consent.
- (2) To verify if the inclusion criteria are met (by CDR, MMSE, GDS and MoveTest)
- (3) To administer the Montreal Cognitive Assessment (MoCa)

- (4) To introduce the PLAYTIME project step by step.
- (5) To conduct a personal interview and hand out questionnaires.
- (6) To schedule an appointment for the second home visit.

### ***Verify the inclusion criteria by the CDR and MoveTest***

To prevent that participating in this study may be too burdensome, the healthcare professional of GGZ has especially make sure that a PWD meets the inclusion criteria and has sufficient abilities to perform the various exercises of the training modules. She did this by (1) administering the CDR and (2) performing three short controlled move tests. Physical performance during the three move tests has been measured with a MoveTest device and analyzed on a cloud-based analysis platform. Basically, the healthcare professional of GGZ have performed the following actions:

- (1) The healthcare professional has explained the test and the methodology to the PWD and his or her informal caregiver.
- (2) When they are fully informed, the PWD have been fitted with a MoveTest device using a comfortable elastic belt around the waist.
- (3) The healthcare professional has programed the MoveTest using MCR's<sup>1</sup> secure online programming and analysis platform and started a recording session.
- (4) The PWD have performed three tests: (1) a balance test with three difficulty levels, (2) a gait test (four meters at comfortable speed) and (3) a five times repeated chair rise test (as fast as possible).
- (5) After the tests, the healthcare professional has stop the measurement and collected the MoveTest device.
- (6) The healthcare professional has connected the MoveTest to a PC and logs in on MCR's secure online programming and analysis platform and the data upload and analysis process will start automatically. Data will be transmitted in pseudo-anonymized form by a number.
- (7) The healthcare professional has presented the outcomes to the PWD and his or her informal caregiver in a report or in the PLAYTIME application.

When a PWD scored below the required minimum, s(he) were excluded from participating in this study. The data from CDR and MoveTest has also be used (1) to evaluate the cognitive and physical status of PWD, (2) to fit the use of PLAYTIME to the individual abilities of the PWD, and (3) to provide feedback to PWD on their level of physical performance.

### ***Conduct a personal interview***

If all inclusion criteria where confirmed, the PWD and his or her informal caregiver were jointly interviewed by the researcher of PLAYTIME to collect some background/baseline information of the PWD and his or her informal caregiver. The interview was a semi-structured format with some general open-ended question on (1) the cognitive, social-emotional and physical abilities of PWD (and his or her informal caregiver) and (2) the motivation of the PWD and his or her

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<sup>1</sup> [www.mcroberts.nl/mymcroberts](http://www.mcroberts.nl/mymcroberts)

informal caregiver to participate in the project and test PLAYTIME. Example questions are: 'Are there any physical conditions that are important to consider when testing physical exercises of PLAYTIME, for example dizziness or balance problems?', 'Do you have experiences with using a Tablet PC?' and 'Do you have troubles with learning new things?' The interview will average 15 minutes in time.

### ***Explain the MoveMonitor***

During home visit I, particular attention was also devoted to the MoveMonitor, which measured the physical activity of a PWD by using a comfortable elastic belt around the waist. The healthcare professional of GGZ did do this as following:

- (1) The healthcare professional explained the test and the methodology to the PWD and his or her informal caregiver, and answered possible questions.
- (2) When they were fully informed, the healthcare professional programmed the MoveMonitor using MCR's secure online programming and analysis platform, and started a recording session.
- (3) The PWD was fitted with the programmed MoveMonitor device using a comfortable elastic belt around the waist. The PWD was asked to wear the MoveMonitor for 4 till 7 days (24 hours per day).
- (4) The healthcare professional explained that the MoveMonitor automatically stops after one week of measuring and can be send back via post, using the provided envelop.

The data from the MoveMonitor was used (1) to provide feedback to PWD on the level of their physical activity, (2) to fit the use of PLAYTIME to the individual abilities of the PWD and (3) to evaluate the physical status of PWD.

### ***Hand out questionnaires***

As one of the final steps, the research member of PLAYTIME handed out two questionnaires to the informal caregiver, including the (1) the NPI. She/he explained that the informal caregiver should complete the questionnaire in the upcoming two weeks and, when completed, should send it back via post, using the provided envelop (subject-related data of the informal caregiver was transmitted in pseudo-anonymized form by a number in the format of the questionnaires). The total time needed to complete the questionnaires was approximately 20 minutes.

The data from the NPI was used to tailor the content of the social-emotional training module to the needs of the PWD and his or her informal caregiver. Furthermore, data from the NPI is used to evaluate the social-emotional status of PWD and their informal caregivers.

*Verify the inclusion criteria by the **CDR, MMSE, Clocktest, MoCa, GDS and MoveTest in Austria***

***Administrate the Movetest, CDR and conduct a personal interview***  
*see procedure GGZ.*

### ***Administrate the MoCA***

During home visit I, the clinical psychologist has devoted particular attention to the administration of the MoCA to PWD. The MoCA assesses eight cognitive domains through several tasks and administered to investigate whether eye movement features collected by the attention training module can predict the degree of specific functional impairments, such as,



explicit memory, visual perception and executive functions. The total administration time of the MoCA is approximately 10 to 12 minutes.

#### ***Administrate the MMSE***

The Mini-Mental State Examination (MMSE) is a 30-point questionnaire that is used extensively in clinical and research settings to measure cognitive impairment. Administration of the test takes between 5 and 10 minutes and examines functions including registration (repeating named prompts), attention and calculation, recall, language, ability to follow simple commands and orientation.

#### ***Administrate the Clock Drawing test***

The Clock Drawing Test (CDT) is a measure of dementia severity. Clients are asked to mark in the hours and then draw in the hands to indicate a particular time (for example quarter to two). The CDT assesses frontal and temporo-parietal functioning.

#### ***Administrate the GDS***

The Geriatric Depression Scale (GDS) is a 30-item self-report assessment used to identify depression in the elderly.

Therefore, it taps the affective and behavioral symptoms of depression and excludes most symptoms that may be confused with somatic disease or dementia. The 15-item version takes about 5–7 minutes to complete.

#### ***Hand out questionnaires***

As one of the final steps, the research member of PLAYTIME handed out a questionnaire to the informal caregiver, the B-ADL. The total time needed to complete the questionnaires was approximately be 20 minutes. The data from the B-ADL was used to tailor the content of the social-emotional training module to the needs of the PWD and his or her informal caregiver.

### **4.4.3 Phase 3 Introduction (Home visit II)**

Approximately, four weeks after the first home visit, the healthcare professional of GGZ and the researcher of PLAYTIME visited the PWD and his or her informal caregiver at home to demonstrate and explained how PLAYTIME works at a Tablet PC and address any remaining questions. Each PWD and his or her informal caregiver received individual support to fit the use of PLAYTIME to their own situation and preferences, based on the results of the personal interview, the MoveMonitor and MoveTest. Study participants started testing PLAYTIME at their home (and/or during group gatherings) for a period of ten weeks. Contact information of the healthcare professional of GGZ was provided to study participants in case questions arise or problems occur.

### **4.4.4 Phase 4 Testing**

For the testing period of ten weeks, study participants were asked to test and experiment with the beta prototype of PLAYTIME at home (or during at least five group gatherings). During gameplay at home, frequency of use, duration of use per time log, number of correct and wrong answers, solution time, emotion measurements and eye tracking data, was automatically recorded by the software of the beta prototype of PLAYTIME. The informal caregiver was asked

to support the PWD whenever necessary. The group gatherings for testing the beta prototype of PLAYTIME have been held at and facilitated by study participants' daytime activity center. Each group gathering consisted of 3 to 9 PWD and average 60 minutes in time. The healthcare professional of GGZ supported the group leaders of the daytime activity centers by demonstrating and explaining how PLAYTIME works at a Tablet PC, and advising how best to deploy PLAYTIME in a group. The group leaders received contact information of the healthcare professional of GGZ in case any questions arise or problems occur.

The testing period of the study participants who test the beta prototype of PLAYTIME **during group gatherings** looked basically as followed:

- (1) The PWD was asked to play every week at least one theme of the cognitive training module
- (2) The PWD was asked to play every week at least one scenario of the social-emotional training module
- (3) The PWD was asked to play every week at least one theme of the attention training module
- (4) The PWD was asked to attend at least five group gatherings to test the mat and the cognitive and social-emotional training module of PLAYTIME

The informal caregivers was asked to play at least one scenario of the social-emotional training module.

In Austria, the group training was accompanied by M.A.S. dementia trainers from SVDL Deutschlandsberg.

The testing period of study participants who test the beta prototype of PLAYTIME individually at home basically looked as followed:

- (1) The PWD was asked to play every week at least one theme of the cognitive training module
- (2) The PWD was asked to play every week at least one scenario of the social-emotional training module
- (3) The PWD was asked to play every week at least one theme of the attention training module
- (4) The informal caregivers was asked to play at least one scenario of the social-emotional training module

The individual training was accompanied by M.A.S. dementia trainers from SVDL Deutschlandsberg every 14 days. Here, SERES and MiRA were primarily accompanied. In addition, questions and difficulties that arose could be discussed and with the personal contact, as a social intervention, the motivation of the participants could be improved.

#### **4.4.5 Phase 5 Mid-term evaluation (Home visit III)**

During the fifth testing week, the healthcare professional of GGZ and the researcher of PLAYTIME visited the PWD and his or her informal caregiver at home, or at the group location. The main purposes of this home visit was:

- (1) To address queries/problems related to testing the beta prototype of PLAYTIME
- (2) To explain the MoveMonitor

- (3) To administer the Montreal Cognitive Assessment (MoCA) [27]
- (4) To conduct a mid-term evaluation interview
- (5) To schedule an appointment for the fourth home visit.

Below, some of these main purposes will be further described

#### ***Explain the MoveMonitor***

See page 9 for a detailed description.

#### ***Administrate the MoCA***

During home visit III, the healthcare professional of GGZ devoted particular attention to the administration of the MoCA to PWD. The MoCA assesses eight cognitive domains through several tasks and was administered to investigate whether eye movement features collected by the attention training module can predict the degree of specific functional impairments, such as, explicit memory, visual perception and executive functions. The total administration time of the MoCA is approximately 10 to 12 minutes. As repeated testing of the MoCA increases risks for practice effects [28], the MoCA was administered once in this study.

*In Austria the MoCA was not administrated at the Home visit III.*

#### ***Conduct a mid-term evaluation interview***

To evaluate the beta prototype of PLAYTIME, a mid-term evaluation interview was conducted with both the PWD and the informal caregiver. The interview deployed a semi-structured format with some open-ended questions on (1) the experiences of PWD and their informal caregivers in general, (2) the difficulties that arose when playing PLAYTIME, (3) the implementation of PLAYTIME in daily life, and (4) the motivation of PWD and their informal caregivers to continue with PLAYTIME. Examples of questions are: 'Which trainings module did you use most? Why?', 'Did you experience any problems when testing the multimodal training module?' and 'Did the feedback of the MoveMonitor and MoveTest motivate you to continue with PLAYTIME?'. The interviews took at average 30 minutes in time and was audio-recorded for the convenience of transcribing with the group gatherings.

### **4.4.6 Phase 6 Final evaluation (Home visit IV)**

After ten weeks, the healthcare professional of GGZ and the researcher of PLAYTIME visited the PWD and his or her informal caregiver for the last time at home. The main purposes of this last home visit are:

- (1) To collect the Tablet PC
- (2) To administer the CDR and perform the MoveTest
- (3) To conduct a final evaluation interview
- (4) To administer the MoCA (only in Austria)

Below, some of these main purposes will be further described.

#### ***Administer the CDR and perform the MoveTest***

See page 8 for a detailed description. Data of the CDR and MoveTest will be used to evaluate

the cognitive and physical status of PWD.

#### ***Conduct a final evaluation interview***

During home visit IV, the healthcare professional of GGZ and the researcher of PLAYTIME conducted a final evaluation interview with both the informal caregiver and the PWD, or with the health care professional of the group sessions. The interview deployed a semi-structured format with several open-ended questions focusing on the evaluation of the beta prototype of PLAYTIME with respect to (1) implementation, (2) usability, acceptability, feasibility and appropriateness and (3) users' motivation. Example questions are: 'What were your experiences with the social-emotional training module of PLAYTIME?', 'If you look at the last five testing weeks, how long and how often did you use the attention training of PLAYTIME at home?' and 'Would you like to use PLAYTIME again? Why (not)?'. Next to this, PWD and their informal caregivers were asked to motivate their answers to the self-constructed evaluation questionnaire. The final evaluation interview will average 30 minutes in time.

#### ***Administrate the MoCA***

See page 13.

## **4.5 Outcome measures**

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### **4.5.1 Usability and Acceptability**

Usability was measured by open questions like "what did you think about the usability of using DTN and SERES". "What would you like to improve in the use of the PLAYTIME apps", etc. Acceptability was measured for instance by "what did you think about the PLAYTIME games". "What exercises did you like or dislike". Answers of each participant are collected, analyzed and described in the result section. By the evaluation the perspectives of both the person with dementia and their caregiver were included in the interview.

### **4.5.2 Appropriateness and Feasibility**

For appropriateness, questions were asked about the level of exercises within DTN. Also was registered how many participants changed to a different difficulty level and how many times this was done. SERES was evaluated by asking if the scenarios fit their daily lives and it provides data about which topics are most selected to play. Data of both the person with dementia and their caregiver were included in the interview. The feasibility of PLAYTIME for everyday use at home was evaluated by data about the frequency of use and duration period. Participants were also asked to give a grade to the PLAYTIME apps from 0(bad) to 10 (excellent).

### **4.5.3 Motion parameters**

During the main field study, two different measurement methods were used to gain insight in the movement parameters of the subjects. Physical performance under controlled conditions ('what you can do') was assessed using a MoveTest. Specifically, the Short Physical Performance Battery (Guralnik et al., 1994) (SPPB) was used as this provides sub-scores for a subjects' balance, gait and repeated sit-to-stand capabilities (all sub-scores range from 0 (not able to perform) to 4 (top quartile compared to peers)) and a total score for overall performance (0-12

scale, summation of the sub-scores). Next to the sub-scores of the SPPB, the MoveTest also provides durations of the separate tests. Physical activity in daily life ('what you actually do') was assessed using a MoveMonitor. Classification algorithms classify different bouts of activity (walking, stair walking, cycling, shuffling, sitting, standing, lying and non-wearing). Of these bouts, the number and durations (mean and total) are used as outcome parameters in PLAYTIME. Additionally, for the walking bouts, steps will be calculated (total amount and amount normalized to 24 hours).

#### **4.5.4 Affective slider**

The emotional status of the participants was measured with the affective slider. Participants were asked to fill out the affective slider at the start and end of playing each game. The affective slider contained two questions;

- 1) How active do you feel ; slide between calm and exited
- 2) How is your experience; slide between pleasant and unpleasant

Results were stored in the central database of PLAYTIME.

## **4.6 Data analysis**

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### **4.6.1 Reflective interviews and field notes**

In the Netherlands, the reflective interviews with the group participants were audio-recorded and verbatim transcribed. A systematic theoretical coding analysis of the Dutch transcripts was carried out by applying the three steps method described by Ritchie and Lewis (2013): (1) data management, (2) descriptive accounts, and (3) explanatory accounts. Using the software package Atlas.ti (version 7.5.3), text segments were compared and contrasted, and classified into categories based on a priori codes derived from the literature. Emergent sub-codes were then developed based on patterns within each concepts and which were relevant to the literature. For the individual evaluations the questionnaires were filled in with the participant and their caregivers. All answers for each questions where combined and related to the specific objective.

## 5 Results

### 5.1 Qualitative results individual game

#### 5.1.1 Multimodal training module (DTN)

Participants that have also participated in the first field study do see improvement in the usability. The login is not necessary anymore, the language is automatically corrected. Also it's easier to select one level in the background. The choice for a lever for the person with dementia is reduced to a minimum what makes it easier to use. Main issue in the usability for DTN remains the touch screen of the Samsung Tablet. Many participants struggle with the delay in reaction time of the Tablets, and do not correctly use (or forget) the touch pen. The cover of the Tablet made it difficult to find the on/ off button and the sound buttons.

In the midterm evaluation of the qualitative survey in Austria, 11 out of 13 respondents stated that they had no difficulties in using the Tablet. Only one person stated that they had difficulties in using it. At the end of the main field test, the majority of respondents also stated that they had no difficulties (although it should be noted that other terminal devices were used in Austria). Most people could work independently with the DTN. Some needed help from their relatives.

The choices of themes are fitting to the target group and there is for everyone something that will interest them. It would however suggested that they could see which themes are already played, that is hard to remember for a person with dementia.

In Austria, 22 topics in 4 levels of difficulty were available for the participants to choose from. According to their interests, participants could choose their preferred topics. Until the midterm evaluation the participants saw 11 topics, the other 11 topics were made available to them after the midterm evaluation.

The different exercises (puzzles, riddles, fill in, mathematics, etc.) are mostly well received. Participants appreciate the variation in the training exercises and do think the amount of variation is enough. There is no exercise that could marked as favorite of all participants. The individual answers variate and all type of exercises are mentioned as favorite. There are however some suggestions to make some of the exercises more adaptable for the player with dementia. The size of the puzzles are somewhat small, and it's not always clear which piece was selected. If a piece is not correctly placed it is not possible to see. For the memory exercise also the size of the memory tiles is recommended to be larger. Another suggestion that was mentioned several times, is that the pieces turn back after a few seconds, when the wrong match was made. Now you have to select a third tile before the wrong match turns back. This is annoying and confusing, the person with dementia cannot always solve the exercise. Looking for the five differences it is also too small to see for the target group without reading glasses. Fill in the letters should be all on one line and one word instead of two, so that an open space is not a possibility to fill in. The math exercises are too easy for almost every participant. The reactions to the physical exercises variate, some found it their favorite, while others found them

a bit boring without sound, or way too easy. Spoken instructions and a background music could be helpful. The informal caregivers suggested to select a level for each individual exercise instead of one difficulty level for all exercises. Participants also suggest that it would be nice to have a reward at the end of a theme, for example a sound or a picture, this could increase the feeling of success

### **5.1.2 Social-emotional game module (SERES Dementia™)**

The most discussed topics about the usability of SERES were: 1) Application was hard to find, 2) WiFi problems and 3) Login issues. For the first point participants said that for SERES another tile was used on the start screen, this was somewhat confusing, there were four tiles in total (DTN, MOVE, SERES, MIRA). Therefore, some participants did not play SERES as they could not find the application on the Tablet PC. Others did not play SERES because of Wi-Fi problems, an off-line version should be helpful. Most reported issue was however the login problems. A person with dementia cannot remember their login code in the instruction manual. Also a few caregivers had trouble with normal and capital letters in the login code. Then there was the issue if you had to press register or log in. In the Netherlands this resulted in a lot of participants that did not use the SERES game.

A similar picture was also emerging in Austria. The use of SERES proved to be very difficult. The requirement to enter registration data should be reconsidered and automated. Connection problems and a resulting loss of motivation to play SERES were also observed by the trainers. With the support of the M.A.S. trainer it was possible to ensure that SERES were explained and played at least every two weeks.

Participants that have played the SERES app found that the game could have potential, but does need some adjustments to meet its potential. All participants found that the scenarios are not fitting to their day to day life, most thought that it were nice scenarios but for a further stage of dementia. It would be better to have scenarios for an earlier stage of dementia that would be better fitting for the target group that plays DTN. Even better would be to select a level according your personal needs. A few participants found it very confusing that they were male in one scenario and female in another. It would be better to select if you are male or female. The amount of text, and the audio is an improvement with respect to the first version but according the players it could still be a little less. Furthermore, some words for example "stressed" is seen as a preview for the future and therefore is confronting.

In Austria there were problems of understanding due to the translation. Expressions were used which are not common in the language use. Participants also stated that the use of the many different names is confusing. They suggested that instead of using names, wife, father, sister ... to better understand the situations. They also presented a lot of text on a screen. The information from one screen to the other could not be remembered and so the M.A.S. trainers had the part to explain and make the situations understandable again and again. Of the respondents (9 statements) one person stated that he/she found SERES helpful, another one found it childish, 4 persons stated that SERES was okay. One person said that SERES was not for older people, one person said that it was overstraining and would not help.

Feedback on your choices is great, it gives the opportunity to learn something. However this should be contained in to one screen. Now it is way too much according to all participants. They

cannot react on that many screens with information and it feels more like a course instead of a game. Players would rather see one screen with one thumb and then a suggestion how to improve their coping. Now it is received by some of the players as patronizing and childish.

The overall usability of the app is fine, it is not difficult to understand that you just have to use the arrow to continue. It would be better if the system has a shorter reaction time. Also the confirm button after you make a choice should be removed according to the players. Furthermore, the screen should not turn black if you are reading, this now happens to soon. The option "Resume game" is of no use to a person with dementia. This should be removed as an option in their module.

To provide knowledge about their overall feelings about DTN and SERES, we ask every participant to score PLAYTIME's apps DTN and SERES, from 1 (being insufficient) till 10 (being excellent). Table 5 illustrates all grades.

*Table 2. Scores provided to PLAYTIME's apps*

Score	DTN (N)	SERES (N)
3	1	1
4	0	1
5	1	1
6	1	0
7	6	1
8	2	0

## 5.2 Qualitative results group game

The group version of the PLAYTIME game was tested for a period of 10 weeks on three different locations for day activities centers for people with dementia. One group in the Catherina Hospital Geriatrics and the game was tested by the focus group meetings of Innovate Dementia by GGzE where people with dementia, informal and formal caregivers gather to test products for the target group. Materials that were used for the group sessions were two tablets (one for the cognitive game and one for the physical exercises), a game math, five cones and one dice.

### ***Group session Dementia Tablet (DTN)***

Initial reactions of the group games were positive, groups are enthusiastic to participate in the main field study. The look and feel appeals to participants, even as the variety of the game. One



group leader mentioned that it was great that it's a game where interaction is stimulated and happened.

After a few weeks of testing, there were lots of ideas for improvement, and also some things that had to be changed to keep players motivated for use after the test periods.

The themes are found nice to do, however the group game puts all exercises of all the themes together. Group leaders mention that it makes it confusing for their participants. Also you cannot play Christmas at the good time of the year. It would be much better if you can select a theme as a group and play just that topic.

Another barrier is that all players have to play at the same level. So for one participant it is far too easy, whereas another is struggling to finish most of the exercises. Almost every group leader suggested that it would be great if you could select difficulty levels for each individual. Then it would be more motivating for our group.

The music sing a long, and the physical exercises are mentioned as most favorite to play. It would be nice to get more pictures in the game, so you can also talk about remembering those things and that is easier to do with a photo. When you have to name words with a certain letter, for example name cities with the letter k. the system should not give a letter like the x or y.

The play mat was nice to see, looks good. However three groups played longer they stopped using the mat. Reason for this was that lots of people with dementia are in a later stage of their dementia. Throw the dice, move the cone, see what you have to do, and then an exercise is too hard for them. Just the exercises seems enough for these groups. Furthermore it was difficult for participants to remember which color they are. The other two groups (Hospital and Innovate Dementia) liked the idea of the mat, because it is more recognized as a game for the target group. The mat should have a clear assignment on each box, instead of boxes were you can choose your assignment. This is too difficult for most of the participants. (See appendix 1.1 for the visual of the mat used in the group sessions)

From a technical point of view, to keep everybody active at the same time, the use of a big screen is very important. Otherwise it does not feel as a group game, if one person is looking at the tablet. Also a second tablet for the physical exercises is not usable. In the Netherlands, it was not possible to play the app on a large screen, because of each group has its own connection issues. Also the physical exercises were not possible to play it in one application.

In Austria these problems were overcome because they use the same screen for each groups sessions and the exercise movies in German were integrated in DTN.

In Austria the group game was designed somewhat differently. To be able to activate the individual in the group as well, no theme was used in the group. The type of practice could be selected. Depending on whether the task suited the participating person (biography), the M.A.S. trainer could choose whether the exercise was suitable for the person or whether another exercise should be given. The group session was started with a common song and individually adapted to the participants according to their daily condition. The group was very well received and the participants enjoyed it very much.

The frequency of use depends on the individual groups. One group played PLAYTIME once or twice every week, another group played once every two weeks.

### **Group session SERES**

The SERES group game was not played at every location, mainly due to a lack of time. After playing DTN no much time is left. Furthermore, DTN is easier to start playing. Another reason for not playing SERES is that the group leader needs some time to lead the game correctly and did found that preparation time. One tablet had issues with the Wi-Fi connection and therefore cannot play SERES.

Groups that did use SERES are in general positive about the game, one group said, this is unique there is nothing like this available right now. This could be our favorite part of the PLAYTIME suite. Also mentioned by the group leaders is that is a nice tool to start conversations that otherwise will not be happen. Participants seems to like these conversations and the recognition in each other's experience.

Some group leaders found the text too much and sometimes confronting, therefore they read it to their group in an adjusted version. It is suggested that words like "dementia" should be changed to "sometimes troubles remembering", this is easier to accept for the target group. Another barrier is that if you have to read three options, and one participant react on that the next participants do not remember the options anymore. Suggestion is to made one line with options. One group leader said, I just asked, what would you do? And selected the answer that came closed.

The scenarios did fit the day to day lives of the participants, they could relate and it gave enough to talk about. However, the feedback is way too much. You don't have time to discuss all that information. The group already discusses why everybody makes those choices and that is for a group enough. One screen with a suggestion to see if that fits or discuss further would be enough.

Almost all groups' leaders mentioned the fact that it are two different games and not fitting to play as one. Target group is also somewhat different, SERES challenges you to reflect on your own situation, whereas DTN does not require that and is more a cognitive trainings module.

Every group was asked to score the DTN part and the SERES part of the PLAYTIME group game including the materials (Table 2).

*Table 3. Grading scores of the groups for Dementia Tablet New and SERES.*

Group	DTN	SERES
1 (day treatment facility)	7	7
2 (day treatment facility)	7	-
3 (hospital geriatric ward)	7,5	-
4 (day treatment facility)	7	-
5 (focus group innovate dementia)	7	6

### **Person with dementia version: Module engagement overview**

11 and 29 Dutch and Austrian PwD users played greater than one module (3x scenarios) of SERES Dementia, respectively. Austrian users played, on average, more modules than Netherlands users. The range of modules played was 1-6 in both Austria and the Netherlands. 3 Dutch users played 6 modules, whereas only 1 Austrian user played this many.

Module 10 was played the most (17 times) followed closely by module 1 (16 times). The range of playing frequencies was 3 (modules 6 and 8) to 17 (module 10).

*Table 4. SERES Dementia, person with dementia playing overview. \* per unique user.*

	Netherlands	Austria	Total
Users with >1 module played	11	19	30
# modules played (min-max)*	29 (1-6)	54 (1-6)	83
Avg modules played per user	2.6	2.8	2.8

*Table 5. Detailed SERES Dementia modules played breakdown; \*total occasions played; \*\*variance from Table 4 due to users playing same module multiple times.*

Modules	Modules played*
1	16
2	10
3	10
4	6
5	6
6	3
7	6
8	3
9	11
10	17
<b>Grand Total</b>	<b>88**</b>

Of 83 modules played by PwD, 50% were mainly related to cognitive impairments. The number of available modules focused on behaviour, cognition, function, and social are 4, 3, 1, and 2, respectively.

#### ***Person with dementia version: Likert-style feedback***

At the end of each module, several Likert-style questions were asked to collect perspectives on individual feedback at the topic level (within SERES Dementia rather than between SERES Dementia vs DTN). The averages per module are displayed in Figure 3. This feedback can be used to improve SERES Dementia, as certain modules were rated better than others in e.g.

recognizability or applicability of advice. The applicability of advice was rated the highest, followed closely by the establishing good relationships and helping deal with challenges.

Modules 1, 2, and 3 were given the highest rating with an average of 4.0, 4.2, and 4.5 across responses. Whereas module 6 was the lowest, rated at 2.7.

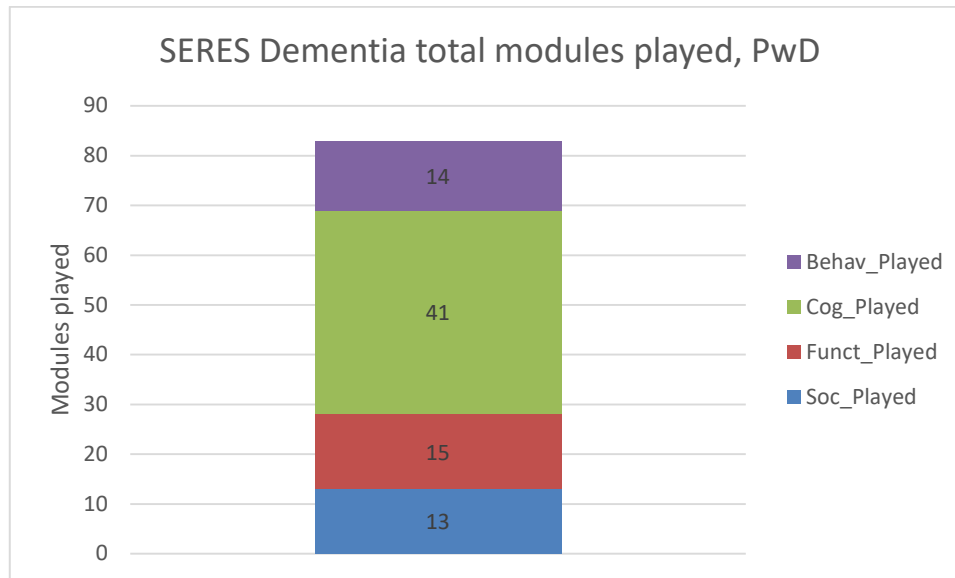


Figure 2. Overview of SERES modules played by PwD users, per type.

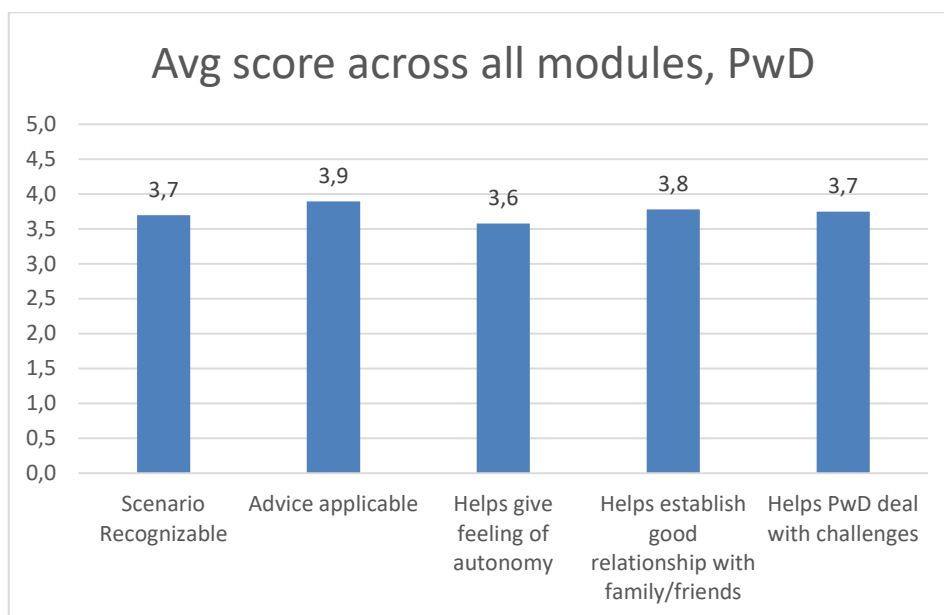


Figure 3. Likert scale scores for SERES Dementia, average across the 10 modules; 1=definitely do not agree ; 2= do not agree ; 3= neutral ; 4=agree ; 5= definitely agree.

Recognizability and applicability may depend on person with dementia location as all modules received better scores, on average, in Austria than in the Netherlands. Austrian participants also appreciated module 7 and 9, which both received ratings of 4.1 alongside modules 1, 2, 3 that were rated as 4.1, 4.2, 4.1, respectively.

Of the 90 possible answers (3 options per scenario with 30 scenarios over 10 modules), 78 (87%) were selected and 12 (13%) were not selected by any of the 30 users. Seven of the 12 answers not selected were from modules 5, 6, and 7. Modules 6 and 8 were played the least by only 3 participants each.

### ***Person with dementia version: Emotional data***

User interaction data (in-game emotional status) from SERES was intended to be linked with user data collected from the emotional slider (real-world emotional status). Although many data points were collected via the emotional slider, minimal data was realistic (non-default) and therefore usable. This limited data set was insufficient to connect with emotional data collected in SERES. However, in an independent assessment of emotional data, a perspective on in-game emotional status was collected. As this data was longitudinal in nature, few participants had sufficient data available over several weeks to offer a picture of how in-game emotional status was changing over time. Nevertheless, an example of this data is shown below, from one Austrian participant. This could have been compared to real-world emotional status data if not for the very limited dataset available.

In Figure 4, the selection of answers with positive (green smiley), neutral (yellow smiley), or negative (orange smiley) emotions is displayed. Although the emotional status seems to be quite variable over time, there are several periods of consistency, such as during W3 (positive emotion), W5 (negative emotion) and W7 (neutral). By comparing this with another measure of real-world emotional status – as, evidently, the emotional slider was not usable for PwD, one could evaluate how real-world emotional status is reflected in the emotional aspects of answers selected (behaviour & communication options) in the SERES. Further information on these aspects is reported in D3.4.2.

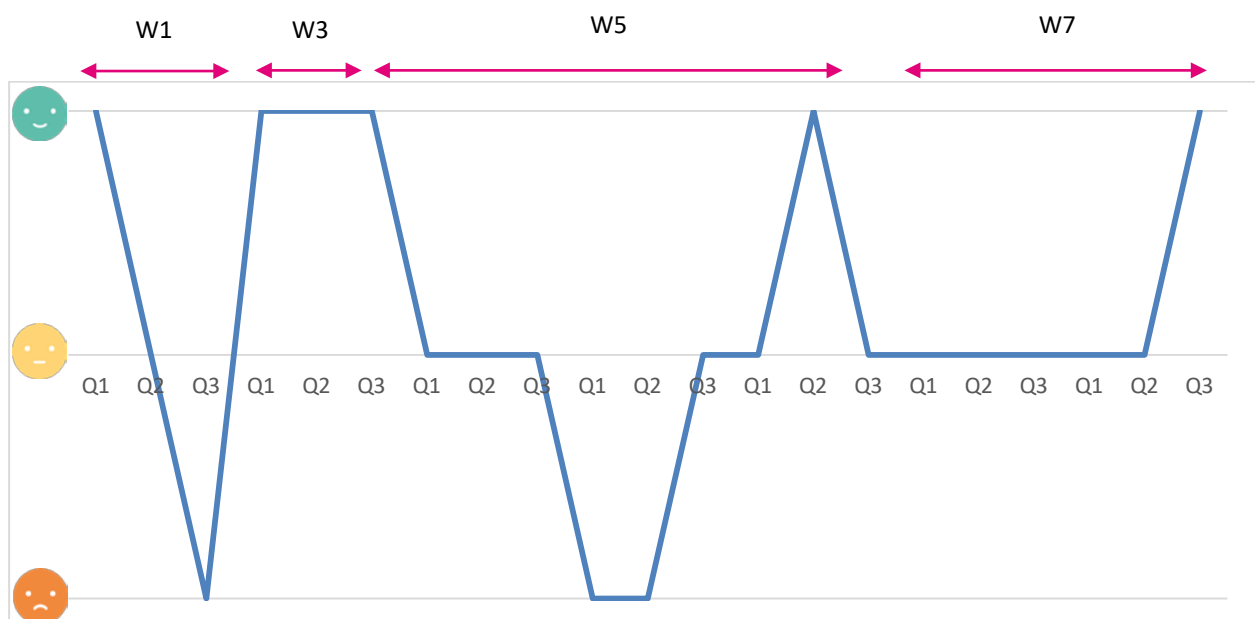


Figure 4. Example of in-game emotional status over time from single patient in Austria.

**Caregiver version: Module engagement overview**

Table 6. SERES Dementia, Family Caregiver playing overview

	Netherlands	Austria	Total
Users with >1 played	3	0	3
# modules played (min-max)	8 (1-4)	0	8
Avg modules played per user	2.7	0	8

3 Dutch family Cg users in the Netherlands played greater than one module (3x scenarios) of SERES Dementia. In contrast, no family Cgs played SERES Dementia in Austria. The range of modules played was 1-4 in the Netherlands. Of the three Cg users, the number of modules played was 1, 3, and 4 modules.

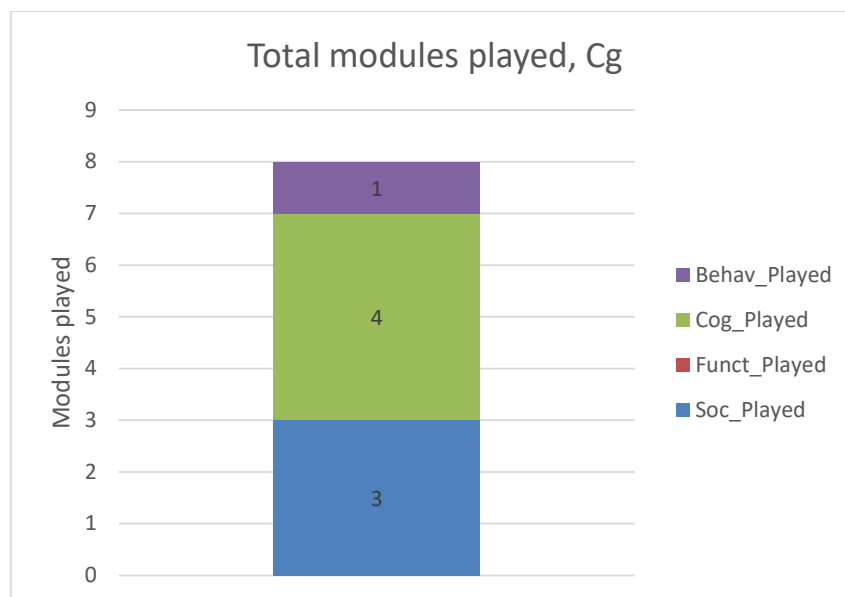


Figure 5. Overview of SERES modules played by Cg users, per type.

Of 8 modules played by Cgs, most were focused on social and cognitive challenges. The number of available modules focused on behaviour, cognition, function, and social are 4, 3, 1, 2, respectively.

**Caregiver version: Likert-style feedback**

Due to the limited number of family Cgs that played SERES, data is presented on two caregivers that played 3 and 4 modules, respectively. Both Cgs found the advice highly

applicable and whereas the Cg playing 3 modules didn't appreciate module 6, the other Cg agreed with each question (Figure 6).

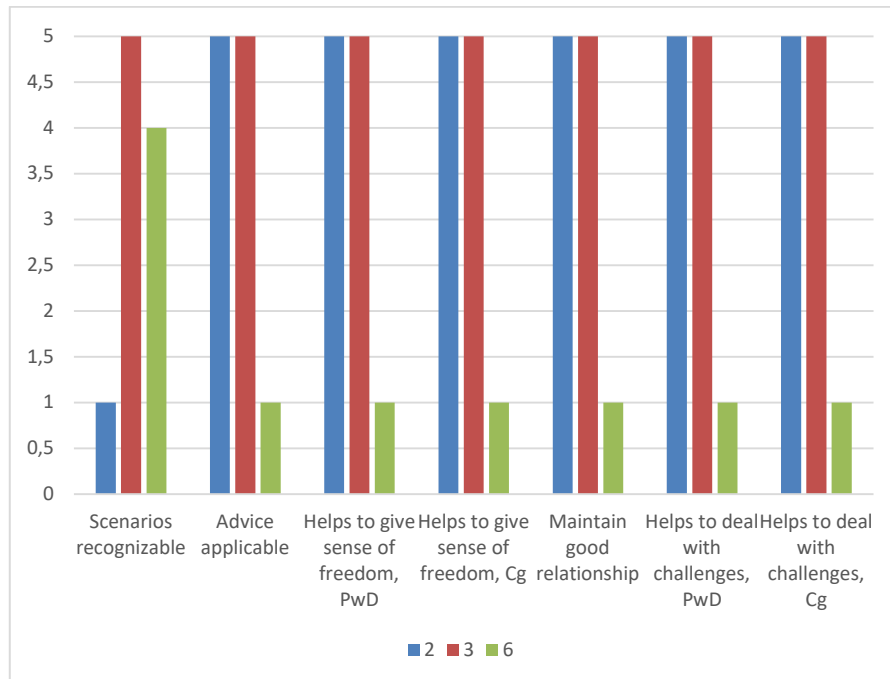


Figure 6. Likert scale Scores across three SERES Dementia modules played, single Cg. 1=definitely do not agree ; 2= do not agree ; 3= neutral ; 4=agree ; 5= definitely agree.

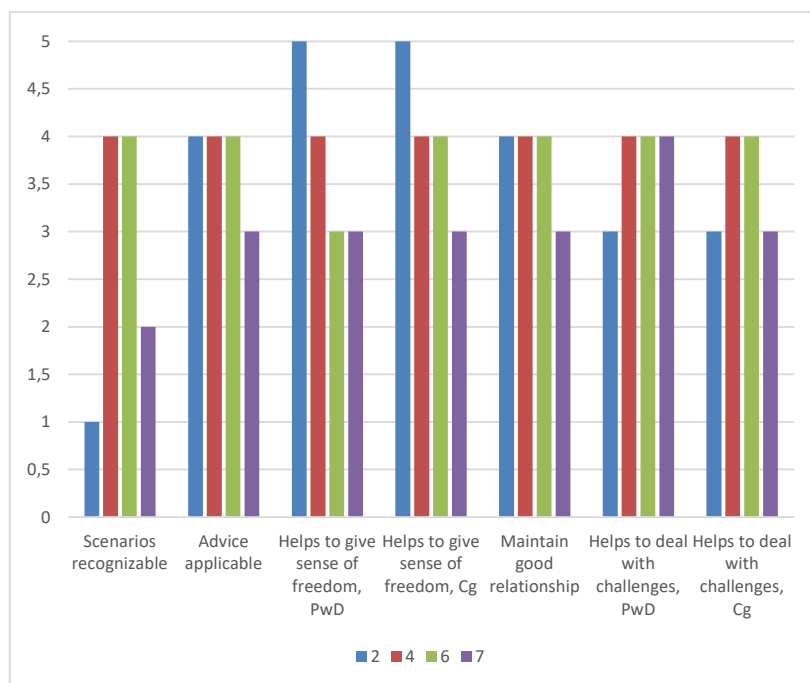


Figure 7. Likert scale scores across four SERES Dementia modules, single Cg. 1= definitely do not agree ; 2= do not agree ; 3= neutral ; 4= agree ; 5= definitely agree.

The first Dutch Cg found module 3 to be most recognizable followed by 6 and module 2 as not recognizable. However, this user found the advice applicable in modules 2 and 3 but not 6.

The second Dutch Cg found modules 4 and 6 to be more recognizable than 7 with module 2 not recognizable. This user also found the advice to be more applicable in modules 2, 4, and 6 rather than 7.

## 5.3 Assessment of cognitive state from measured data

A further relevant objective for the implementation of the main field study was to evaluate the data measured by the beta prototype of PLAYTIME in relation to the cognitive, social-emotional and physical status of PWD.

- **Key figures** of the analytics of the **cognitive status** and the indicative correlation of PLAYTIME play scores with dementia related ratings from standardized questionnaires are briefly presented here. Details are found in Deliverables D3.3.2/3.3.3 on gaze analytics from the application of MIRA component, and Deliverables D3.5.2/3.5.3 report on the results from DTN application as well as from a combined DTN-MIRA approach.
- Details of the results about the **physical status**, in the context of MOVE-based measurements, are found in Deliverables D4.3.2/4.3.3.
- Details of the results about the **socio-emotional status**, in the context of SERES-based measurements, are found in Deliverables D3.4.2/3.4.3.

### 5.3.1 Cognitive assessment from DTN exercise scores

For the evaluation of the DTN app N=8 users provided data each from about the time of intervention of 10 weeks. Users were measured to perform 39.5 exercise units per day.

**Correlations with statistical significance** ( $p < .05$ ) were particularly identified between, as follows,

- Game score (mean score) and **MoCA total score** ( $r = .754$ ;  $p = .038^*$ )
- Game score (mean score) and **Clock Drawing Test** ( $r = .788$ ;  $p = .036^*$ )
- Game score ("difference puzzle exercise" mean score) and **MoCA subscore "Visuospatial Executive"** ( $r = .836$ ;  $p = .016^*$ )
- Game score ("outsider played exercise" mean score) and **MoCA subscore "Abstraction"** ( $r = .784$ ;  $p = .036^*$ )
- Game score ("box finder exercise" mean score) and **MoCA subscore "Orientation"** ( $r = .781$ ;  $p = .030^*$ )

We conclude from these figures that even with a rather low number of users some underlying statistical dependencies between DTN game score and important neuropsychological assessment instruments have been identified. Since there is more than one single questionnaire (MoCA, CDT) affected it appears as if the correlations must be substantially related to the playful exercises. More studies with much more participants are needed in order to confirm this hypothesis but a **first positive indication** has been identified and points to promising facts to be explored and confirmed in the future.



### 5.3.2 Cognitive assessment from MIRA gaze interface play score

The data were captured from the main field study, receiving data from 15 elderly with M=81.7, S=4.6 years of age, 91.7% females, all diagnosed with Alzheimer's disease and mental state MMSE M=25.4, S=3.1, Montreal Cognitive Assessment (MoCA) score M=17.9, S=4.5 and Clinical Dementia Rating (CDR) M=1.0, S=0.7.

PwD used MIRA (see Figure 8, including video link) within 10 weeks M=6.2, S=4.1 times, they were introduced and assisted by trainers, some learned to play alone. During M=86.3% of playtime users were frontally centered and gaze was estimated. Table 7 depicts most important correlations between the MIRA outcome measures and dementia rating scores. Applying second order polynomial regression enabled to estimate MoCA scores from MIRA outcome scores with an error of M=2.6, S=1.9 MoCA points.

A video about the MIRA app and analytical results (Paletta et al., 2020) can be viewed at this [link](#).

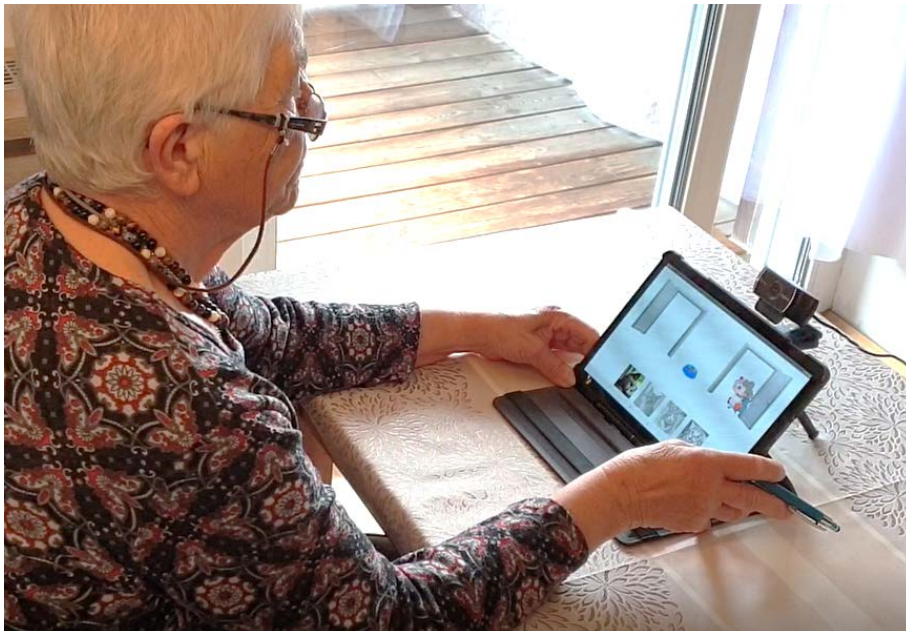


Figure 8. A person with Alzheimer's disease plays PLAYTIME component **MIRA**, a serious game version of the "anti-saccade" task. A video about the MIRA app and analytical results (Paletta et al., 2020) can be viewed at this [link](#).

Table 7 presents an overview on most relevant correlations between MIRA game score and neuropsychological assessments score as well as for executive function related scoring in the context of "activities of daily living" (ADL). Particularly high correlations are found<sup>2</sup> between

- Game score (mean score) and MoCA total score ( $r=.713^{**}$ )
- Game score (mean score) and MoCA subscore "Visuospatial Executive" ( $r=.729^{**}$ )
- Game score (mean score) and MoCA subscore "Language" ( $r=.711^{**}$ )

<sup>2</sup> **\*\*** represents p-value < .05, **\*\*\*** represents p-value < 0.01.

- Game score (mean score) and MoCA subscore "Naming" ( $r=.559^*$ )
- Game score (mean score) and B-ADL "Drink preparation" ( $r=-.608^*$ ),
- Game score (mean score) and B-ADL "Using the toilet" ( $r=-.589^*$ ),
- Game score (mean score) and B-ADL "Transferring" ( $r=-.586^*$ ),
- Game score (mean score) and CDR ( $r=-.695^{**}$ ),
- Game score (mean score) and CDT ( $r=.607^*$ )

Table 7. Statistically significant correlations (Spearman's Rho) between MIRA outcome measures and dementia rating scores.

<i>MIRA parameter</i>	<i>dementia rating score</i>	<i>Spearman's Rho</i>
	<b>Clinical Dementia Rating (CDR)</b>	-.695**
	<b>Clock-Drawing Test (CDT)</b>	.607*
mean	<b>Montreal Cognitive</b>	.713**
MIRA	<b>Assessment (MoCA)</b>	
outcome	MoCA-1 <b>Visuospatial Executive</b>	.729**
score	MoCA-3 <b>Language</b>	.711**
	<b>Bristol Activities of Daily Living Scale (B-ADL): Drink preparation</b>	-.608*
	<b>Bristol Activities of Daily Living Scale (B-ADL): Transferring</b>	-.586*

We conclude from these results, firstly, that we have a rather small but valid study population (N=15) but still a good basis for a substantial first estimate. The correlation results, which are high in value ( $r > .6$ ), in particular, relating to the MoCA but also to the CDR are **very significant** ( $p\text{-value} < .01$ ). Furthermore, there are statistically significant correlations with MoCA, subscores, CDR, CDT and B-ADL which points to the strong hypothesis that the MIRA definitely captures fundamental statistics about the **cognitive status**, but even more, about **executive functions** that are in relation to the B-ADL scores.

## 6 Conclusion and Outlook

### 6.1 Summary and conclusions

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With regards to usability, a significant part of the people with dementia who tested PLAYTIME had some trouble with the touch screen. Their fingers did not have any effect on tapping the screen, and using the touch pen was often forgotten or took some time to get used to it. Furthermore, the reaction time is very slow. The usage of four logo's of the individual modules on the start screen turned out to be confusing. Especially because you only use two of them. The cover of the tablet made it difficult to find the on/ off button and the sound buttons. The SERES part of PLAYTIME has not been played by a lot of participants. This is mainly due Wifi troubles and login issues. People with dementia do not remember how to find these codes. Caregivers find it difficult. It was also mentioned that on the login screen you have two options after you fill in the codes, it is unclear which one to use. The screen turns black if you have to read the feedback, this make it difficult.

With regards to acceptability participants mentioned that the social part of PLAYTIME feels somewhat childish with the graphics. The physical exercises are too easy for most of the participants, there for more than the half of the players skipped these exercises. For a better acceptance of the physical exercises it would be suggested to add music and/or a voice over to guide you through the exercise. It is difficult to perform the exercise while keeping your eyes on the screen. Most of the exercises within the cognitive part of PLAYTIME where found nice to play, with enough diversity to keep it interesting and fun to do. Themes fits to the target group and selection based on your own preference is highly appreciated. It would be found helpful if you can see which themes you have already played. The social part (SERES) of PLAYTIME was not seen as a game but more as a course. Every participants mentioned that the amount of feedback is too much. The participants suggested one screen of feedback as a better solution.

The letters, puzzle pieces, and memory pictures within the cognitive part of PLAYTIME should be larger. Puzzles are found difficult by some participants because the background is not clear enough and it is sometimes hard to see if a piece is activated to move. Suggestions for improvement are a more visible background, a square around the tapped puzzle piece, and a notification if a piece is not correctly placed. For memory it is found confusing that the pieces after a wrong match stays open. They suggested to turn the wrong pieces after a few seconds. In the social game (SERES), participants could not always related there personal situation to the scenarios. It better fits to people in a more advanced stage of the dementia. A suggestion was to make a few gradations to improve the appropriateness of the game for each individual.

Look for the differences was not feasible for most of the participants. The differences were very small (especially in the most difficult levels) so it was not visible for most. The math exercises were too easy for most. For the social part (SERES) of PLAYTIME is would be much easier for the person with dementia if they could select if they are male or female, now this changes and they forget who they are in the story.

Participants find it more motivating if every exercise can be adjusted to a personal level. Now for instance the language exercises are too easy and the puzzles are too difficult. To keep motivated to play PLAYTIME almost every participant needs external motivation, mostly by the informal caregiver. It has been suggested to add a signal to remember the player that they can use the PLAYTIME tablet. Participants also suggest that it would be nice to have a reward at the end of a theme, for example a sound or a picture, this could increase the feeling of success. SERES needs to be a lot easier to get in to be motivated, now most participants stopped before getting far enough in the game, due to the login or Wi-Fi trouble.

The goal of the slider for measuring the emotional status is not understood. It appears to often and disturb the pleasure of playing the game. After some times of sliding the bars participants just press to confirm without sliding. It's also mentioned that it is not doable for a person with dementia to rate this for themselves and for a caregiver it's just a guess. The translation was not very good in Dutch. Suggested was to replace the sliders for emoticons so you can select out of a few, which one fits the most to your mood.

Finally, we have promising, good results regarding the indication of the game scores (MMA, MIRA) related to cognitive assessment, results which were already accepted for publication at the AAIC 2020. In the future we would like to make use of the other components, SERES and MOVE, as well, with larger population size in the study, in order to be able to draw conclusions about the interrelations between cognition, physical and socio-emotional performance. This project's main study was mainly targeted at usability-based investigations for the support of a market-launch of the central ICT-based activation app. Furthermore, we could receive first promising results in the direction of automated monitoring and assessment which points to promising further exploitation of these components in the future.

## 6.2 Outlook

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The goal of this project was to develop a serious game PLAYTIME by the use of a Living Lab method. Therefore, this main field study aims to evaluate the beta prototype of PLAYTIME in order to retrieve insights on its usability, feasibility, appropriateness, motivation and acceptability in real-life environments. Furthermore, it will evaluate the usability of the user feedback, in terms of physical performance, physical activity and emotional measurements, for determining personalized recommendations.

The results of this study provide insights about content and technical improvements. However, most participants appreciated PLAYTIME and were willing to play it for 10 weeks. These results are promising for the future, because PLAYTIME does have the ambition to develop further as a therapeutic tool in slowing down the dementia process by training their cognition, physical activities and social activities at the same time. Research about the relation between playing PLAYTIME and their performances in daily life is highly recommended. This study shows that PLAYTIME is a playful tool that fits to the needs of people with dementia and their informal caregivers.

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### Appendix 1: Example of the playground that used for group sessions of PLAYTIME

