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Abstract: The current document presents an update of the persuasive and personalization elements (proposed and described in D5.1) implemented in the MAMEM system (see D5.2), based on an analysis of the implications for persuasive design stemming from Phase I trials and an additional lab study. The lab study showed that the MAMEM system's persuasive and personalization design elements improve user effectiveness on social inclusion tasks, and that perceived ease of use of the MAMEM training software could be improved. Based on these findings, the current report presents updates, ameliorations and extensions of the user profiles and personas, the requirements for personalization, and the requirements for the persuasive design (as they were described in D5.1) to be incorporated into the MAMEM system in the Phase II trials to further improve user acceptance (evaluations) and use (performance) of the MAMEM system.

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Executive Summary

The current document presents an update of the persuasive and personalization elements (proposed and described in D5.1) implemented in the MAMEM system (see D5.2), based on an analysis of the implications for persuasive design stemming from Phase I trials and an additional lab study. The main conclusion of the Phase I trials is that patients were able to effectively use the MAMEM system (including the persuasive and personalization elements), and that they could use it as well (in performance and evaluations) as users in the healthy control group for social inclusion tasks. Also, results showed that participants were very positive about the persuasive and personalization elements. For example, participant self-reports showed that these elements contributed to the fun and enjoyment of MAMEM usage. However, these persuasive and personalization design elements did not seem to make a difference in participant's acceptance (ease of use, perceived usefulness etc.) and use (performance) of the MAMEM system. The main reason for the persuasive design to not further increase probably is the very high motivation of all participants, and the limited time of using the MAMEM system, in which the internal motivation of the participants did not decrease.

In the current report, we present a lab study that specifically tested the influence of the persuasive and personalization design strategies incorporated into the MAMEM system on participants' system evaluation (perceived ease of use and perceived usefulness), and on participants' task performance. In this experiment, participants (N = 72) were trained to use the MAMEM system with either the full persuasive training software, or with the limited persuasive version. Next, participants performed two internet search tasks. Results showed that participants trained with the full persuasive training software evaluated the perceived ease of use right after finishing the training tasks as lower compared to participants who were trained with the limited persuasive training software. Also, the former group of participants needed more time to finish the training tasks. This suggested that the full persuasive version of the training software is cognitively more demanding (e.g., more elaborate) than the limited version. Right after completing the dictated tasks, however, this

(negative) difference in perceived ease of use disappeared. Also, as expected, the healthy individuals in the current lab study perceived the usefulness of the MAMEM system for themselves to be very limited (as they can use the traditional solutions of mouse and keyboard). More importantly, results also showed that the persuasive design elements in the MAMEM system lead to increased performance (with respect to accuracy) both for the training tasks and for the two dictated tasks.

Therefore, the main conclusion of the Phase I field trials (see D6.4 [2]) is confirmed by the main conclusion of the lab study: the persuasive and personalization design elements of the MAMEM system are effective for improving user's effectiveness in using the computer system for social inclusion tasks. Also, based on these findings, we conclude that the perceived ease of use of the training software could (although not mandatorily) be improved. For this, the included persuasive and personalization design principles could be screened for elements that take unnecessary time or might otherwise lower perception of ease of use. Still, we argue that not too much should be changed in the persuasive and personalization design, because of the more important advantages these design elements show to have for the performance of users of the MAMEM system.

Based on these findings, the current document presents updates, ameliorations and extensions of the user profiles and personas, the requirements for personalization, and the requirements for the persuasive design (as they were described in D5.1) to be incorporated into the MAMEM system in the Phase II trials.

In sum, the current report concludes that the persuasive personalized design elements improve user performance accuracy, and proposes improvements of the persuasive and personalization design elements of the MAMEM system to improve user acceptance (evaluations) and use (performance).

Abbreviations and Acronyms

AD	Assistive Devices
DBS	Deep Brain Stimulation
EEG	Electroencephalography
NMD	Neuromuscular Diseases
PD	Parkinson's Disease
SCI	Spinal Cord Injury
SUS	Standard User Satisfaction questionnaire
ADL	Activities of daily living
SMA	Spinal Muscular Atrophy

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Chapter **Contents**

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1 Introduction

After the first feasibility study (field trials Phase 1) and also a lab study have been completed, the current document presents an update of the proposed persuasive and personalization strategies as they were presented in D5.1. That is, core to the MAMEM technology is the understanding that the adoption of assistive technology is not merely an issue of technological excellence but also relates to the particularities and the motivational context of the user. Therefore, in D5.1, the three user groups were described using user profiles and personas. These user models were based on descriptions of relevant characteristics such as (dis-)abilities, interaction behavior, emotions, intentions, social abilities and social network, extend to which training is needed, and sensitivity to persuasive strategies. These models and personas were and are used within the MAMEM project as input for various WP's and tasks to help the team members to recognize the real users of MAMEM.

Equally important as describing users (in models and personas), D5.1 also contained a description of the possible and relevant persuasive design principles to influence those users (e.g., increase adherence to therapy/exercises, increase trust in the interface). Finally, D5.1 presented a strategy for selecting the persuasive design strategies for effectively stimulating the target behavior of accepting and using the MAMEM system, in order to increase their social participation.

For both the training software and the actual use situation of the MAMEM system (browsing the web), D5.1 then proposed a selection of persuasive and personalization strategies. Thereby, the persuasive design has been divided into two sets, in line with the pilot trials protocol for Phase I and II trials, with two different main objectives: user acceptance (focus of Phase I) and engagement and social inclusion behavior (focus of Phase II trials).

In D5.2, the proposed persuasive design principles and personalization components were implemented into the actual design of the MAMEM system. That is, D5.2 presented mock-ups for the design of the MAMEM training software, as well as an initial implementation for

the prototype interface applications that will be used during the pre-test studies to train the user to accept and use the MAMEM system. This deliverable also proposed and incorporated training cycles (of interface use) necessary for optimizing user acceptation and behavior change. These training cycles were what the training software consisted of.

The goal of the current deliverable is to provide an update of the contents of D5.1 based on the user evaluations of the MAMEM system that have taken place within the MAMEM project. Based on this update (mainly of the persuasive design proposals and the personalization of persuasion of D5.1), but also on the evaluations of the feasibility study (field trials Phase I, as described in D6.4 [2]), the initial design of the prototype interfaces (the training software used in the Phase 1 trials) can be adapted for the next field trials: Phase II field trials. That is, based on the current report, the next version of the MAMEM system will be developed (in D5.3). That is, D5.3 will use the current conclusions about effectiveness of the persuasive design, personalization, both for stimulating training (the focus of the Phase I trials) and also for stimulating social inclusion behavior (the goal of the Phase II trials), combined with the evaluations of the Phase I field study (as described in D6.4 [2]).

So, the current report will update the user profiles and personas and (most importantly) the selection of persuasion and personalization strategies presented in D5.1, based on the following two user evaluations.

That is, firstly, at the three clinical sites a feasibility study has been performed: the Phase I trials of the MAMEM system. The evaluation of these trials is described in D6.4 [2]. The core goal of this feasibility study was to test whether users from the three patient groups could use the MAMEM system, identify usability issues, technology issues, and assess whether they can be effectively trained to use the MAMEM system and after such training perform a series of web tasks. Below, we will report the main conclusions of D6.4 [2], and discuss the implications they have for the persuasive design and personalization of the MAMEM system.

Secondly, we studied in a lab study specifically the influence of the persuasive and personalization design. That is, the selection of persuasive and personalization strategies made in D5.1 was based on a close review of the scientific literature showing what the more effective (and most fitting and relevant) persuasive strategies are. Also, based on the Intervention Mapping approach, we developed a selection system for selecting those persuasive and personalization strategies that best fit within a larger intervention aimed at influencing the current target behavior (acceptance and use of the MAMEM system, and after that, social inclusion behavior).

To more specifically investigate the effects of this selection of persuasive strategies and personalization as proposed in D5.1 (based on literature review and extensive intervention development strategy) and implemented in D5.2, we performed a lab study. In this lab study, we compared the effects of being trained with a version of the MAMEM system training software that include all of these persuasive strategies and personalization to the effects of being trained with a version of the MAMEM system training software from which most of those elements were removed.

1.1 The evaluation of the Phase I field trials

Earlier, the MAMEM project conducted Phase I field trials. These field trials were designed to evaluate the first version of the MAMEM system with actual users in a controlled environment. The specific purpose was to investigate the feasibility and usability of the MAMEM system and the propensity of the participants exposed to it, to adopt it. A sample of 34 participants (18 able-bodied participants and 16 patients) was trained to use MAMEM in a half-day training session supervised by experimenters. The patient sample included 6 PD patients, 4 participants with SCI and 6 participants suffering from NMD. All had physical disabilities limiting the use of digital devices. In this field trial, participants were trained in using the MAMEM system (using the training software), and then performed four dictated tasks that aimed at social inclusion (e.g., writing an email, posting a picture).

Results of this first feasibility study represent the first evidence that the MAMEM system can be used effectively by patients, that patients can use it as effectively as healthy users, and that the MAMEM system will allow patients to successfully perform social inclusion aimed tasks. More specifically, during these clinical trials, most patients (and also healthy users) expressed strong interest in trying this innovative technology using their mind and eyes. All participants were (with the exception of two participants who dropped out for medical reasons) able to learn to use the device in the basic, intermediate and advanced training tasks, while also showing improvement in the use of the device after practicing in more tasks. Results show that patients learned to use the MAMEM system similarly to able bodied participants. All patients were able to successfully carry out dictated tasks (composing and sending e-mail, posting on social media, watching a video and uploading a photo) defined as important for social inclusion. Their performance on these tasks (with respect to time and accuracy) was not different from able bodied participants. Importantly, the current findings point out that with the MAMEM system, their physical disability tends to not be a hindrance in the use of a computer for social inclusion tasks. Finally, the patients in the sample tended to express satisfaction and interest in using the device, despite some technical difficulties (e.g., repeated necessity of eye tracker recalibration).

Important for the current report, the Phase I field trials also investigated (qualitatively) the feasibility of the persuasive and personalized design of the MAMEM system training software. That is, the persuasive design and personalization elements of the training software (as developed and described in D5.2) were included in these field trials: Half of the participants were exposed to the persuasive design elements by training them on how to use the MAMEM system with the (original) version of training software that included all persuasive and personalization elements (as described in D5.2), whereas other participants were trained with a version of the training software from which most of these elements had been removed (but that still retained a potential influence on behavior as it contained the same structure and training cycles).

Results of the Phase I field trials show that participants were very positive about the persuasive and personalization elements. For example, participants' self-reports showed that these elements added to the fun and enjoyment of MAMEM usage. However, these persuasive and personalization design elements did not seem to make a difference in participants' acceptance and use (performance) of the MAMEM system. That is, both with respect to acceptance variables (ease of use, perceived usefulness etc.) and performance variables (speed and accuracy, learning speed), Phase I trials showed comparable findings for participants trained with the two versions of the training software.

Importantly, as described in D6.4 [2], there are several very clear reasons for this absence of differences in acceptance and use between users trained with the persuasive and personalized training software and the other users. First of all, all participants in the Phase I field trials showed to have very high motivation for accepting and using the MAMEM system. Also, these participants only used the MAMEM system for a very limited amount of time (only 3 to 4 hours), which apparently was brief enough to not cause deteriorations of motivation. This indicates that) the persuasive and personalized design could not increase motivation even further. Relatedly, in the Phase I field trials an experimenter needed to be present in the room to assist the participant. Still, the presence of the experimenter might have had a stimulating effect on the motivation of the participant. However, the persuasion design elements will be especially relevant in the Phase II part of the trials which will last for a month in participants' homes, and in which users have to use the system without the presence of an experimenter.

Another potential reason for the absence of clear differences between user acceptance and performance caused by the persuasive and personalized design of the training software is the lack of statistical power of the Phase I field trials. That is, these field trials were set up as a feasibility study and had inherent limitations in using larger numbers of patients as participants.

Therefore, next, we will report the lab study we performed to gather quantitative and more focused evidence for the (potential) effectiveness of the selected (in D5.2) persuasive design strategies and personalization.

2 Lab study

In addition to studying the feasibility of the MAMEM system in the Phase I fields trials, we also performed a lab study to investigate specifically the effects of the persuasive design and personalization elements in the MAMEM training software on two crucial outcomes: system evaluation and task performance (as described in D5.2, Chapter 4). To assess system evaluation, we focused on the two most important determinants of technology acceptance (in line with the Technology Acceptance model, [1]): perceived ease of use and perceived usefulness. To assess task performance, we assessed the time participants needed to complete a task, and the accuracy which they completed it with.

In contrast to the Phase I field trials – which were a quantitative feasibility study that explored whether patients and healthy people could use the MAMEM technology, and what (technical, usability, etc.) issues arose during usage - , the current study had a very specific focus: . The primary goal was to test the influence of the persuasive and personalization design strategies incorporated into the MAMEM system on participants' system evaluation (perceived ease of use and perceived usefulness), and on participants' task performance.

To test this research question, in this lab study we trained participants to use the MAMEM system with one of two versions of the training software. One group of participants was trained with the version of the training software used in the Phase I field trials, which had all persuasive and personalization strategies incorporated (Full Persuasive version). The other group of participants was trained to use the MAMEM system with a version from which most persuasive and personalization design strategies had been removed (Limited Persuasive version). To create the Limited Persuasive version of the training software, we removed (as far as possible) all persuasive, gaming and personalization elements from the software (for an overview, see Appendix A). For example, only in the Full Persuasive version, participants' first name was used as a persuasive, personalized design strategy. Also, only in the Full Persuasive version, participants received feedback and rewards on their accomplishments, . However, the basic structure of the tasks, the training cycles, remained

intact. That is, the training consisted of a very well-thought series of tasks: the training cycles, and structural elements of the games also remained. These had been developed in D5.2 such that they train participants to first learn specific, more basic skills for using the MAMEM system (i.e., the basic training tasks), then train them to learn skills of intermediate complexity and level (the intermediate tasks), and then several more advanced skills (the advanced tasks). These training cycles follow a specific order, building on the skills learned in the previous task, and leading to being able to use the most important features of the MAMEM system. Thereby, after the training, all participants should be able to use the MAMEM system, and all participants in our lab study were instructed to perform two tasks using the system (i.e., doing a web search task, and a Youtube task—the dictated tasks). They had to complete these two dictated tasks using the MAMEM technology, for which they had to use the GazeTheWeb internet browser which they controlled with their eyes. So, both groups of participants were trained in a comparable way (same training cycles and training tasks), except that the persuasive and personalization design strategies had been removed for the second group. Also, both groups of participants performed the same two dictated tasks.

Right after finishing the training tasks, all participants answered questions to assess their perceived ease of use levels, and right after finishing the dictated tasks, participants answered questions to again assess their perceived ease of use and also perceived usefulness of the whole MAMEM system was measured. Performance (completion time and task accuracy) was measured both during the training task and during the dictated tasks.

The main goal of the current lab study was to provide evidence for the effectiveness of the persuasive and personalization strategies. Earlier research on the effectiveness of persuasive strategies (e.g., [3]), and also research of human motivation in general (e.g., [4], [5]), shows that persuasive strategies and other motivational sensitivities (e.g., personalized persuasion) are effective for humans in general as they often are built on psychological mechanisms core to the human species. Also, the Phase I field trials provide qualitative evidence for the feasibility and effectiveness of the MAMEM system. The current lab study added to those

qualitative findings (see D6.4 [2]) a study that allows quantitative analyses of one specific building block of the MAMEM technology (the persuasive personalized design). For such a quantitative analysis, large statistical power was needed, that cannot be provided within samples of our patient groups. That is, our patient groups are all heavily inflicted (e.g., very high spinal cord injury) and, for various reasons, from these patient groups not enough participants can be drawn for adequate statistical power. Therefore, the current lab study used as participants a (large) sample of younger adults (university students).

Based on the scientific literature providing evidence for the effectiveness of the incorporated persuasive and personalization strategies, and argumentation presented in D5.1, we expected that participants who are trained with Full Persuasive version of the software would evaluate the MAMEM system better (higher perceived ease of use, higher perceived usefulness), and would show better task performance (both on time and accuracy, for both the training tasks, and also the dictated tasks).

2.1 Methods

2.1.1 Participants and design

Seventy-two participants participated in this study, mainly students from Eindhoven University of Technology (TU/e). Of these, 43 were males and 29 were females, and participants were between 18 and 57 years old (M = 24.52, SD = 6.56). Participation was voluntary and compensated either with five euros, seven euros or with course credits, depending on a participant's association to the TU/e. All participants signed an informed consent form and were allocated randomly to one of two conditions: About half of the participants (N = 38) were trained using the Full Persuasive version of the training software, and the other half of the participants (N = 34) were trained using the Limited Persuasive version of the training software.

2.1.2 Materials

In the current experiment, participants were seated in a cubicle of the psychological lab at the Human-Technology Interaction research group at Eindhoven University of Technology. In

each cubicle, an identical setup of equipment was used. That is, participants were seated behind a desk on which a computer system (standard PC) was located next to a 17" LCD screen. Mouse and keyboard of the system had been put behind the computer screen such that the participant could not use them during the experiment. Below the computer screen a Tobii Eyex eye tracker (see Figure 1) was affixed, to allow the system to register participants' eye gaze direction.

***Figure 1**. Tobii Eyex eye tracker.*

Identical to the Phase I trials, participants used the GazeTheWeb browser for completing the training tasks and dictated tasks (see screenshot in Figure 2).

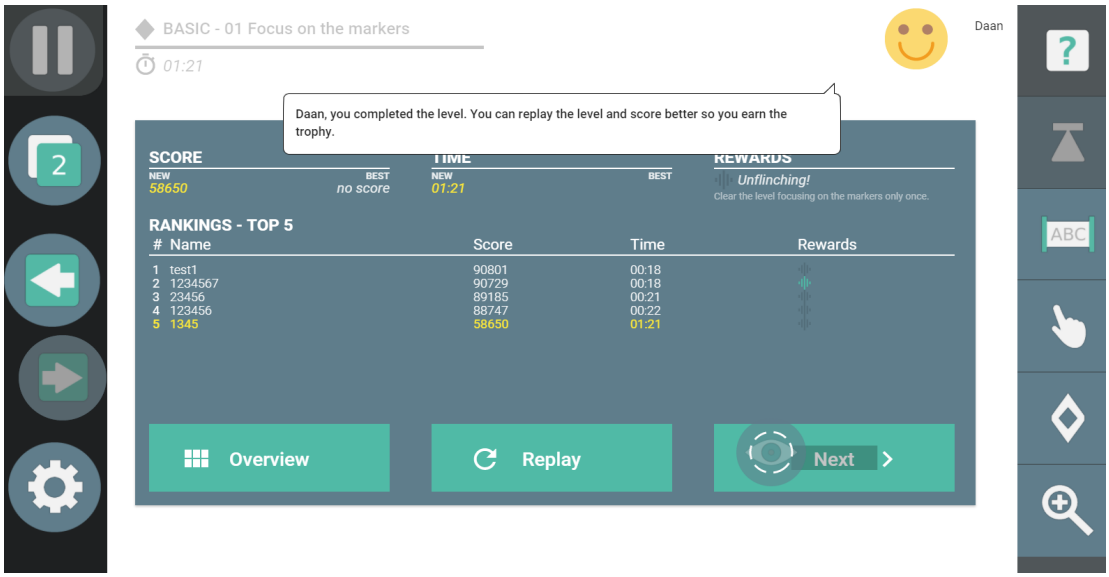


***Figure 2**: The GazeTheWeb browser displaying one of the training tasks.*

To give participants instructions to help them go through the current study, a paper booklet was used containing also the questionnaires for assessing user evaluations of the system.

Using this booklet, participants were welcomed to the study, and guided through the procedure. After introductions and general instructions, this booklet asked participants to

complete the MAMEM training software package. Training exercises were identical to the training exercises used in the MAMEM Phase I trials.

This booklet also contained the instructions for the two dictated tasks. That is, (as the first dictated task) the booklet asked participants to do "a Google search and see if you can find out who made the famous painting called 'The Son of a Man'." Participants were asked to write down their answer in the booklet. Next (as the second dictated task), participants were asked to go "to Youtube, search for 'melon catapult' and watch the first video in the search results." Participants were then asked to write down what went wrong in the video.

Using the questionnaires in the booklet, we assessed system evaluation (perceived usefulness and perceived ease of use), and task performance. To assess *system evaluation*, participants were asked to answer a series of questions assessing perceived usefulness and perceived ease of use twice: once right after the training tasks and once right after the dictated tasks. All questions had to be answered on a seven-point Likert scale, and consisted of statements to which participants could indicate their agreement (1 – strongly disagree, to 7 – strongly agree). Identical to the MAMEM phase I trials, the questions used to assess perceived ease of use and perceived usefulness constructs were based on previously published scales, taken from the TAM3-model [14]. The questions were slightly adapted to match the current research. Scale reliability was evaluated using Cronbach's α, and turned out to be good (α = 0.81 for perceived ease of use, α = 0.79 for perceived usefulness).

Task performance (on time and on accuracy) was assessed both for the training tasks and for the dictated tasks. To assess task performance (on time) during the training tasks, the time in seconds was measured that passed between a participant starting the training tasks, and ending the training tasks. To assess task performance (on accuracy) during the training tasks, for each participant for each of the 9 training tasks a *relative accuracy score* was calculated. That is, for each training task, we calculated a relative accuracy score by dividing the participant's accuracy score on that task by the highest score (of one of the participants). That is, even though the theoretical maximum accuracy score per definition was 100% (e.g., hitting all target objects 100% of the time), the highest score (by one of the participants)

usually was lower. So, for example, on the first training task (basic level task 1) the best person scored 35,71% accuracy. For a particular participant who scored 9.62% accuracy on that task, the relative accuracy score would be 9.62/35.71 = 27%. Thereby, we created an accuracy score that is comparable between the 9 tasks, even though these tasks have different difficulty levels (i.e., different high scores).

To assess task performance (with respect to time) for the dictated tasks, the time was measured that a participant needed to complete each of the two dictated tasks (the google search task and the Youtube video task). Also, to assess task performance (with respect to accuracy), for each of the two dictated tasks a control question was posed (see description above) to assess whether the participant had completed the task correctly.

In the current experiment, half of the participants were trained using the Full Persuasive version of the MAMEM training software, which included all persuasive design elements and personalization. These elements are extensively described and justified for in D5.2. In the table of Appendix A, we present an overview of these strategies, making clear how they were incorporated into the Full Persuasive version of the training software, and how they were removed and not included in the Limited Persuasive version of the training software which the other half of the participants was trained with.

2.1.3 Procedure

After arriving to the lab, participants were welcomed and asked to fill in the informed consent form (see Appendix B), and demographical information. After a general introduction by the experiment leader, the participant was guided to the cubicle. On the computer system in the cubicle, the GazeTheWeb browser was already opened and the appropriate version (persuasive design versus non-persuasive design) of the training software was started.

First, the experiment leader started the calibration procedure to enable the Tobii Eyex trackers. For this, the standard Tobii Eyex calibration software was used.

Next, the experiment leader gave the participant the instruction booklet, and left the cubicle. As described in the materials section above, in the booklet participants were given all instructions for the experiment, and also the booklet contained the questionnaires and related instructions. Participants were instructed to open their cubicle door and ask for help when they got stuck during the experiment (the experiment leader was present in the common room right outside of the cubicle). After completing the instructions booklet, the participant was asked to return the booklet to the experiment leader who then debriefed, thanked and rewarded the participant.

2.2 Results

To evaluate the findings of this lab study, we (quantitatively) test our hypotheses concerning the effect of the personalized gamified persuasive design on user's evaluation of the MAMEM system, and on their performance. Also, we present the results (qualitatively) to evaluate the MAMEM system usage in a general way, identical to the way the Phase I trials were (qualitatively) evaluated in D6.4 [2].

Overall, most importantly, results of the lab study suggested that the Full Persuasive version of the training software has a positive impact on user performance (leading to better accuracy both in the training and dictated tasks). At the same time, results of the lab study suggested that the Full Persuasive version of the training software has a negative impact on perceived ease of use right after completing the training tasks. This disadvantage disappears in the ease of use judgments right after finishing the dictated tasks. This finding (described in more detail in the next paragraph) was unexpected, but is in line with the finding (also presented below) that participants needed more time to complete the Full Persuasive version of the training software. As we will explain below, this finding suggests that the Full Persuasive training software needs more time and more attention, and is generally more complex than the Limited Persuasive training software.

In short, these findings show the persuasive, personalized design of the training tasks is effective for improving performance, and will help us (see Section 3 -- Implications for

requirements update, and section 4 -- Discussion) to improve user's evaluation of the MAMEM system, while retaining effectiveness.

2.2.1 System evaluation hypotheses

Participants evaluated the perceived ease of use of the MAMEM system twice: once right after completing the training tasks, and once after completing the two dictated tasks. Overall, results provided no evidence that participants who were trained using the Full Persuasive version of the training software evaluated the MAMEM system as more easy to use than participants who were trained using the Limited Persuasive version.

On the contrary, results showed that in their evaluations *right after completing the training tasks*, participants who were trained using the Full Persuasive training software evaluated the perceived ease of use of the MAMEM system *more negatively* (M = 3.66, SD = 1.30) than participants who were trained using the Limited Persuasive version (M = 4.35, SD = 1.19), $F(1, 70) = 5.45$, $p = 0.021$, *Cohen's d* = -0.552.

Still, results provided no evidence that *directly after completing the two dictated tasks*, participants who were trained using the Full Persuasive training software evaluated the perceived ease of use of the MAMEM system more positive or more negative than participants who were trained using the Limited Persuasive training software, $F(1, 72) = 0.74$, $p = 0.39$ (average M = 4.54, SD = 1.3).

Perceived usefulness of the MAMEM system was assessed only once: after participants completed the two dictated tasks. Again, results provided no evidence that participants who were trained using the Full Persuasive training software perceived the usefulness of the MAMEM system more positive or more negative than participants who were trained using the Limited Persuasive training software, $F(1, 72) = 1.11$, $p = 0.30$, average evaluation M = 1.34 (on a scale from 1 to 7), SD = 1.21.

2.2.2 Task performance

2.2.2.1 Task performance for training tasks

In line with the finding that participants trained using the Full Persuasive training software perceived the MAMEM system to be less easy to use, results also showed that these participants needed more time to complete the training tasks. That is, as for the one performance variable of time, results showed that participants trained using the Full Persuasive training software took more time to complete the training tasks (*M* = 650.49 sec, *SD* = 228.00) than participants trained using the Limited Persuasive training software (*M* = 508.03, *SD* = 182.11), t-test: *p* = 0.016, rank test: *p* = 0.009, *Cohen's d* = -0.620.

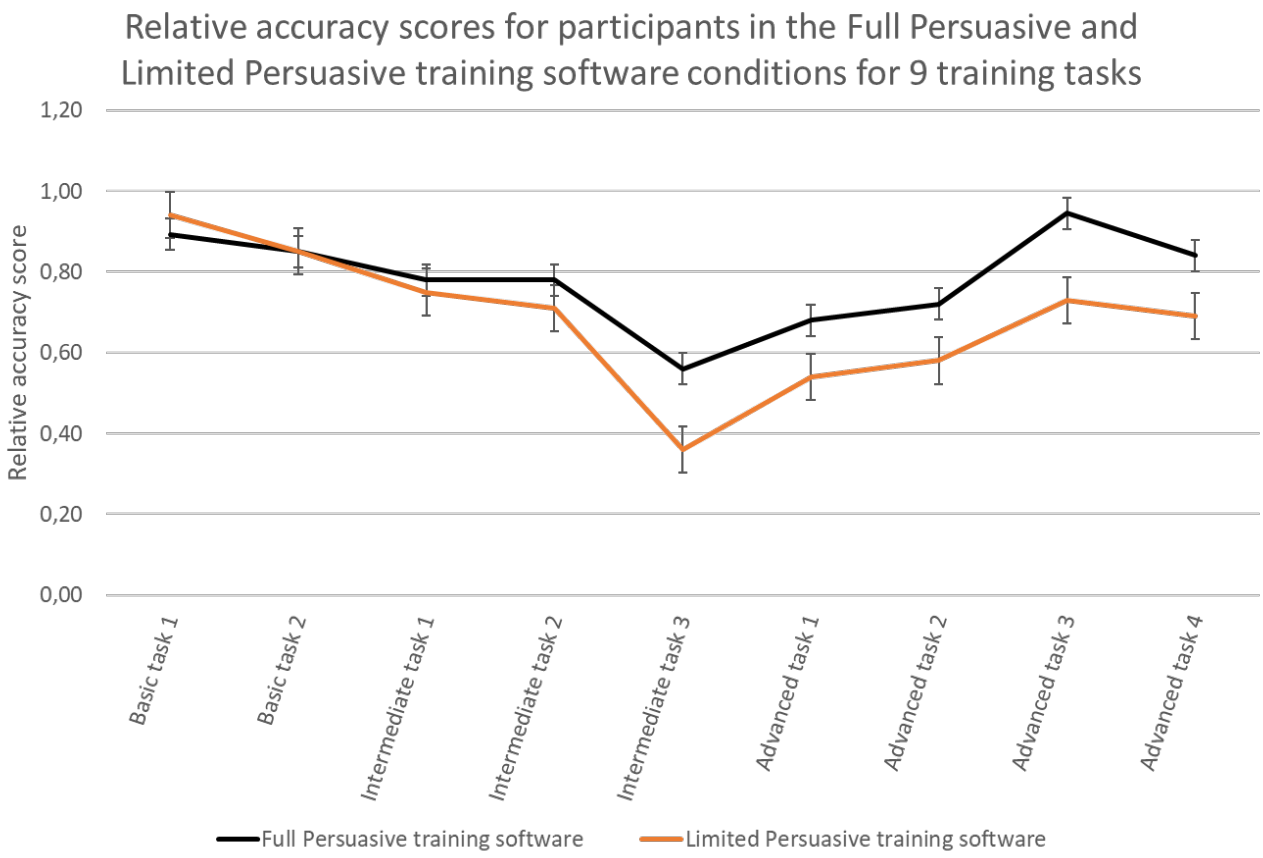
Importantly, results also showed that participants trained using the Full Persuasive training software had higher (relative) accuracy scores on the training tasks. That is, participants trained using the Full Persuasive training software had higher relative accuracy scores than participants trained using the Limited Persuasive training software, *F* = 3.42, *p* = .07. Moreover, results also provided evidence that this effect (increased accuracy for the persuasive design condition) became larger for the *later* training tasks, indicated by an interaction of training task condition x task, *F* = 4.20, *p* < .01. In other words, being trained with the Full Persuasive training software lead to increased accuracy, especially for the training tasks at the end of the training. More specifically, Graph 1 shows the relative accuracy scores for participants trained with and without the persuasive design elements included in the training software for the nine training tasks.

Furthermore, on basic training tasks 1 and 2, participants practiced repeatedly the same subtask. That, on basic training task 1 (Focus on the markers), participant had to focus their gaze on a rectangle repeatedly, and in basic training task 2 (Whack a mole), participants had to scan rectangles (for their color to change) and then focus on the changing one. Both these tasks were repeated (by the training software) until the training software measured no (large) improvement anymore.

Because for basic training task 1 and 2 we had available repeated measures of precisely the same task, we could analyze participants progress within each of these two tasks. Results of these two analyses presented no evidence that participants in the Full Persuasive condition

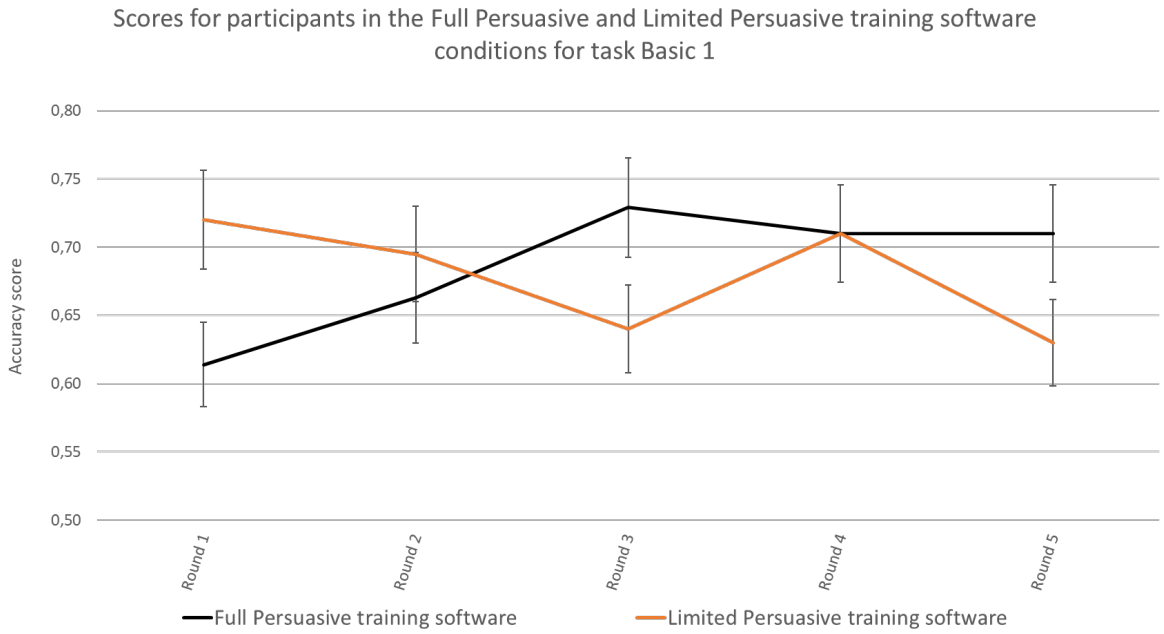
had higher accuracy scores than participants in the Limited Persuasive condition, neither for basic task 1 nor for basic task 2, $F < 1$.

Graph 1. Relative accuracy scores on the training tasks



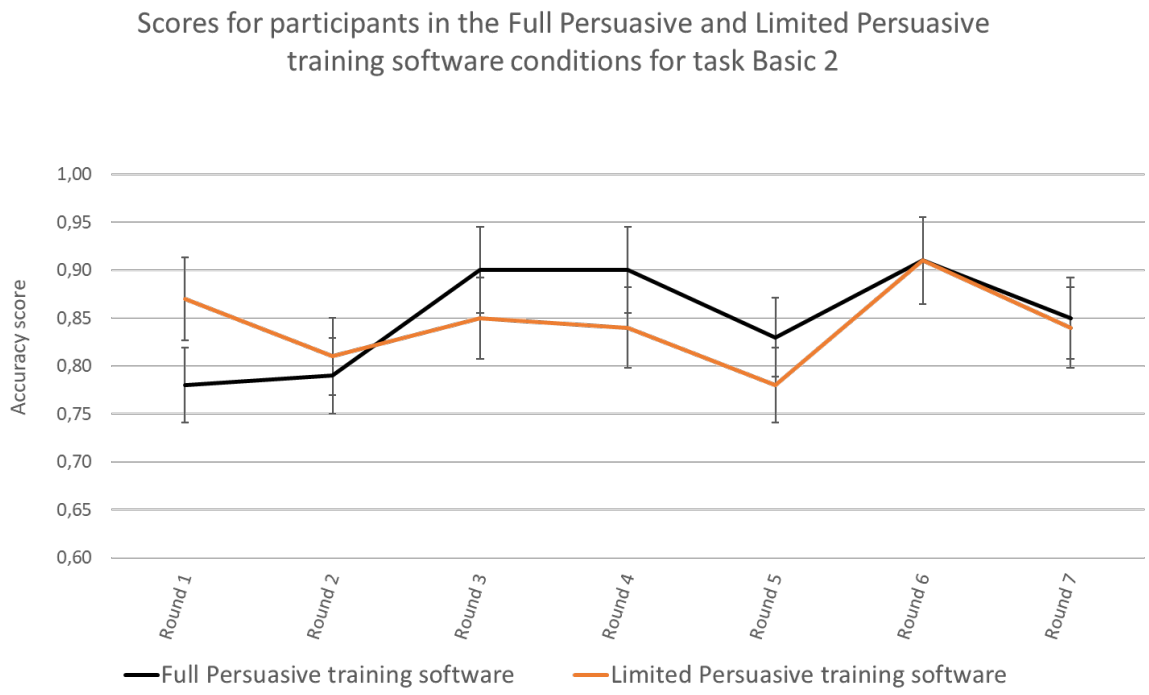
As can be seen from Graphs 2 and 3, average accuracy scores of participants on basic training task 1 and 2 show a comparable pattern: Subtask accuracy scores for participants trained with the Full Persuasive were somewhat higher than subtask accuracy scores for participants trained with the Limited Persuasive version. Specific contrast analyses confirm that for the middle subtasks, participants trained with the Full Persuasive training software had higher accuracy scores (M = .76, SD = .13) than participants in the Limited Persuasive condition (M = .72, SD = .18), F (1, 68) = 4.05, $p < .05$.

Graph 2. Subtask accuracy scores for participants in the Full Persuasive and Limited Persuasive training software conditions for task Basic 1



Thereby, these results suggest that performance (on task accuracy) of participants trained with the Full Persuasive training software was better than participants trained with the Limited Persuasive version, especially on the training tasks later on in the training cycle, and especially for the middle subtasks within one of the two basic tasks.

Graph 3. Subtask accuracy scores for participants in the Full Persuasive and Limited Persuasive training software conditions for task Basic 2



2.2.2.2 Task performance for dictated tasks

Results provided no evidence that being trained with the Full Persuasive training software caused participants to finish the two training tasks faster than being trained with the Limited Persuasive training software, $F < 1$.

Importantly, results showed that the persuasive design of the training software influenced the accuracy of participants for the two dictated task. That is, results showed that participants trained using Full Persuasive training software had a higher accuracy score (M = 0.98, SD = .08) than participants trained using the Limited Persuasive training software (who had an average accuracy score of M = 0.88 SD = .28), $F(1, 70) = 4.95$, $p = .03$.

2.2.3 Qualitative -- General MAMEM system evaluation

A crucial element of developing the MAMEM technology, is evaluation of user acceptance and usage of the MAMEM system. In D6.4 [2], three sets of evaluation parameters were proposed. In Table 1 below, we evaluate these evaluation parameters based on the results of the current lab study.

Table 1. Qualitative Evaluation Parameters

PRE USAGE STAGE	
Receptivity	Definition: To what extent the individual was to be eager to learn to the device and to be positive with regards to adopting it for personal use at home.
	Evaluation: The individuals in our lab study were paid and healthy participants, so their motivation to learn about the MAMEM system was based on different determinants than the patients of the Phase I field study. Still, many participants indicated great interest in the technology
DEVICE USAGE STAGE	
Ease of learning	Definition: Whether and to what extent did each of the participants experience MAMEM as easy to learn, as observed by the experimenters and reported by the participants in their self-reports.
	Evaluation: All participants in the lab study evaluated the ease of use of the MAMEM technology to be positive, as indicated by all scores on perceived ease of use being above the middle of the (1 -- low to 7 -- high) scale of ease of use. Many participants reported also directly to the experiment leaders that they experienced the system easy

	to learn.
Competence in learning the device	Definition: To what extent was each of the participants able to fully and completely learn how to use MAMEM so as to carry out specific digital tasks (as evidenced by monitored data and observed by the experimenters and reported by the participants).
	Evaluation: All participants were able to learn how to use the system quickly, and all participants were able to successfully complete the training tasks and perform the training tasks relatively accurately.
Competence in using the device	Definition: How much and to what extent were the participants able to competently carry out specified digital tasks (according to [1], the expectation to do well using a new technology has been shown to be the stronger predictor of the intention to use it).
	Evaluation: All participants were able to use the MAMEM system effectively, as indicated by all participants successfully performing the dictated tasks (accuracy > 90%).
Enjoyment and fun	Definition: To what extent was the usage of MAMEM pleasurable and fun for the participants in the study (described as “hedonic motivation” by [15].
	Evaluation: Participants expressed (in direct communication to the experiment leaders) themselves very positively about the MAMEM system, indicating they liked participating in the study and had enjoyed playing the games.

POST USAGE OF THE DEVICE	
Potential for independent use	Definition: To what extent do the patients involved in the study believe that they could use the device on their own, without external help and support?
	Evaluation: All participants in our lab study indicated very low perceived usefulness judgments (1.64 on a scale from 1 to 7) clearly indicating that they understood to have better alternatives for themselves.

2.3 Conclusion and Discussion

To study the effects on system evaluation and task performance, the current study investigated the effects of training participants with two different versions of the MAMEM training software: a version with all persuasive design elements included, and a version of the training software from which most persuasive design and personalization was removed. After being trained how to use the MAMEM system with one of these two versions of the training software, participants in the current study performed two dictated tasks: a Google search task and a Youtube task. Overall, the results of this lab study confirm and extend the results of the Phase I trials (as described in D6.4 [2]).

First of all, the current lab study investigated participants' evaluations of the MAMEM system. When assessing ease of use evaluations right after completion of the training tasks, results show that the Full Persuasive training software leads to more negative evaluations of the MAMEM system. That is, results showed that in their evaluations *right after completing the training tasks*, participants who were trained using the Full Persuasive training software evaluated the perceived ease of use of the MAMEM system *more negatively* than participants who were trained using the Limited Persuasive training software. Explanations for this difference may be related to the core consequence of including persuasive design elements: playing the games in the version of the software needed more time (as results

also showed), more game elements needed to be understood, and, basically, the tasks within this version of the software were more elaborate (including the persuasive design elements, like feedback, personalization, gaming elements) than the tasks in the Limited Persuasive training software. Thereby, we argue that causing a somewhat lower evaluation on ease of use judgments is not easily avoided when including persuasive design elements (compared to software in which those elements are not present).

Importantly, results could not provide evidence for a difference in ease of use judgments for the two versions of the software, right after the dictated tasks had been completed. This suggests that the detrimental effects on ease of use caused by the extra task elements in the persuasive design version had disappeared, and any disadvantage for ease of use judgments caused by the persuasive design elements had dissipated.

Finally, results could also not provide evidence that participants trained with the persuasive design version of the training software evaluated the MAMEM system as more useful than participants trained with the other version. Importantly, results show that the explanation for this is a 'floor effect': all (healthy) participants of our study seem to have evaluated the potential usefulness for themselves of this MAMEM technology to be very low (in both training software conditions), probably simply because they have much more useful alternatives available (i.e., the mouse and keyboard).

Thereby, these results help understand the lack of (qualitative) differences found in the Phase I trials (as described in D6.4 [2]) on evaluations of the Full Persuasive training software as compared to the Limited Persuasive training software. The current results suggested that there may not be an advantage (for ease of use judgments) of including persuasive design elements but rather that ease of judgments are negatively influenced, although such more negative ease of use judgments also easily diminish when using the system.

More importantly, the current results help understand how the persuasive design elements help increase user performance. That is, first of all, our analyses show that users trained with the Full Persuasive training software needed more time for completing the training tasks.

This finding is closely related to the lower ease of use scores found for this version of the MAMEM system: doing more (as more was included) costs more time, and thereby the whole set of tasks was less easy to complete. Still, using it for a longer time period also seems to have led to more training and better performance.

Indeed, crucially, the current results also showed the advantages of including the persuasive design elements in the MAMEM system for a very important performance outcome: accuracy. That is results showed both that participants trained with Full Persuasive training software performed the training tasks better (more accurate) and, perhaps even more importantly, performed the two dictated tasks better (more accurate). As the core goal of the MAMEM system is increasing social inclusion activities users perform, this finding provides evidence for the effectiveness of the persuasive design included in the MAMEM training software for increasing such outcome behavior.

In sum, the current lab study gives rise to the following conclusions about first of all MAMEM system evaluation, and, secondly, task performance within the MAMEM system.

First of all, different from what we expected, including the persuasive and personalization design principles into the MAMEM training software did not lead to more positive MAMEM system evaluations, as compared to not including these elements. The Full Persuasive version of the training software was perceived to be less easy to use, and, relatedly, participants needed more time to complete these training tasks. Crucially, we argue that this finding does not mean that these design features should be removed from the MAMEM system. Rather, we argue that the comparison made in the current lab study (between the two versions of the training software) was rather specific.

That is, importantly, also the version of the MAMEM training software from which the persuasive and personalization design principles were removed, still consisted of skills training included in appropriate and effective training cycles. So, the comparison made in the current lab studies (in hindsight) can be regarded as one between a rather elaborate (with persuasive and personalization included) version of the same skills training, versus a

shorter version of the same skills training (with persuasive and personalization elements removed). Many reasons for these lower perceived ease of use judgments can be identified: the increased extensiveness of the tasks (with the persuasive and personalization elements included), the longer time that was needed to complete them (e.g., for reading the feedback messages, or the social comparison tables), and also the potential additional usability issues in these additional task elements (e.g., difficulty of reading personalized feedback message). These characteristics of the persuasive and personalization design may have given rise to cognitive overload (and consequently lower perceived ease of use).

Finally, we conclude that the perceived ease of use of the training software could (although not necessarily) be improved. For this, the included persuasive and personalization design principles could be screened for elements that take unnecessary time or might otherwise lower perceptions of ease of use. Still, we argue that not too much should be changed in the persuasive and personalization design, because of the more important advantages these design elements show to have for the performance of users of the MAMEM system.

Second, and more importantly, we conclude that the persuasive and personalized design of the MAMEM system is effective in influencing user performance. The accuracy of users trained with the persuasive personalized version of the training software improved (as compared to users trained with the Limited Persuasive version) both on the training tasks themselves (as found in the lab study) as well as on the dictated tasks (as found in the lab study and suggested by the results of Phase I.

3. Implications for persuasive design requirements update

Based on the outcomes of the Phase I field trials (see D6.4 [2]) and the lab study reported in this deliverable (on the persuasive and personalization design strategies specifically), the current document presents updates and extensions of the contents of D5.1. That is, (section 3.1) the user profiles and personas, (section 3.2) the requirements for personalization (section 3.3), the requirements for the persuasive design as were described in D5.1 can be ameliorated based on these findings. Overall, the main conclusion of the Phase I field trials (see D6.4 [2]) is confirmed by the main conclusion of the lab study: the persuasive and personalization design elements of the MAMEM system can be effective for improving acceptance (motivation etc.) and use (performance, especially in accuracy) and thereby improve users effectiveness in using the computer system for social inclusion tasks. Thereby, the findings of these two user studies have great value to improve the persuasive and personalization design elements of the MAMEM system (as described in D5.1).

3.1 Implication for user profiles and personas

In both the Phase I field trials and also the lab study reported in this document, indications were found that the complexity of the MAMEM training task (especially the version including the persuasive and personalization design principles) contained a lot of cognitive tasks to be performed by the user (e.g., process feedback, play and understand task and game elements etc.). Even though evidence was found that performance improved (i.e., better accuracy), the abundance of additional tasks may have negative effects. For example, the user evaluations of the MAMEM system may be negatively influenced by this cognitive overload.

Deliverable 5.1 described user profiles and personas for the 3 cohorts (SCI, PD and NMD patients) that were derived from extensive literature review as well as from focus groups with clinical specialists and questionnaire analysis from the patients of the 3 cohorts (see D6.1 and D6.2).

In short, the user profiles for each cohort covered the following 6 areas:

- Disease range and demographic characteristics
- Physical functioning
- Emotional functioning
- Motivational aspects
- Cognitive functioning
- Computer and assistive technology operation

Based on the user profiles, two personas were created per patient group, following the variable mapping approach, in order to find major variable patterns (see D5.2). In short, the personas included the following variables:

- Demographics
- Medical information
- Computer use information
- Goals and attitudes

The results of the field trials clearly show that the created user profiles cover most of the essential user attributes as is shown from the requirements that derived from these trials (presented in D6.4 [2]). For example, regarding the physical symptoms of PD, the user profile contained information about posture/loss of postural reflexes. As it was observed in the field trials, indeed, a PD user had difficulties in holding his body posture, leading to usability problems with the eye-tracking device. Another example that provides evidence for the rigor with which the profiles were created comes from the NMD patient groups. The NMD profile discusses the gradual mobility reduction of the NMD patients as a physical symptom and the consequences for psychosocial functioning. Specifically, in computer use part of the profile it is mentioned that use of computer validates their ability to think, respond and function well. Indeed, findings from field trials provided similar evidence: NMD users prefer to make use of any ability they have in using their hand as long as they have it. In conclusion, the derived

requirements based on the findings of the trials were all included in the profiles and personas.

However, one limitation is that although the cognitive functioning is included in the profiles, it was excluded from the personas, giving rise to more the psycho-social aspects rather than the cognitive aspects of an Assistive Technology (AT) use, like the MAMEM system. The reason for this was that the limited information in the literature regarding cognition (of these patient groups) and AT use, but also this was due to the fact that cognitive functioning was not included in the first MAMEM patient questionnaires. This lack of consideration of cognitive functioning might have been the reason for the decreased ease of use found in our lab study, which compared the Full Persuasive to the Limited Persuasive training software.

Based on this argumentation, the current document will provide an update of profiles per patient group, adding a focus on the aspect of cognitive functioning. This will mainly be useful for updating the persuasive design training, as well as the persuasive strategies included in Phase II.

One important note to be made is that the cognitive aspects to be taken into consideration in the following subsection pertain to both patients with muscular disorders as well as to healthy individuals, since one of the exclusion criteria of the MAMEM trials is that cognitive function of users has to be intact in order to be able to operate the MAMEM successfully. In fact, the Phase I field trials presented no evidence for statistical differences in responses between able-bodied and patients in variables in terms of system perceptions, beliefs, satisfaction and ease of use. So, although the personas we created in D5.1 can remain as they are, based on Phase I fields trials and the current lab study, we propose (below) an updated general cognitive user profile. These additions are relevant for all three patient groups (as well as healthy users), because all three patient groups have comparable mental characteristics in the sense that they might suffer from cognitive overload when tasks are too demanding (and the exclusion criterion of no cognitive deficits was used for all three patient groups).

3.2 Updated cognitive user profile

Based on the two user evaluation studies (Phase I field trial and the lab study), we present below an addition and update of cognitive user profiles (for all three patient groups). This update does not apply to patients with any cognitive deficits (i.e., memory or attention impairments).

It became evident in Phase I that participants need clear instructions about how to use MAMEM. This made clear that the MAMEM system is not readily intuitively figured out. Proper training and learning is very important in leading the user to a successful learning experience. Below we describe a user profile with a reference to cognitive aspects that will pave the way for a meaningful update of persuasive design training method, to be used in the home trials too (such a cognitive user profile is specifically tailored to the MAMEM patient groups and lies on the cognitive theory of multimedia learning (see also [16]):

- Cognitive overload: The MAMEM system is mainly used with the eyes. At the first learning steps, users learn both the functionalities of the system (i.e., different icons) as well as the interaction between them and the system. A potential problem to be considered from this learning situation is that the processing demands evoked by the learning task may exceed the processing capacity of the cognitive system, called cognitive overload.
- The split-attention effect is a learning effect with detrimental learning effects when cognitive load is high It is apparent when the same modality (e.g. visual) is used for various types of information within the same display. To learn from these materials, learners must split their attention between these materials to understand and use the materials provided.
- Limited capacity: users are limited in the amount of information that can be processed in each channel at one time.

- Active processing: Users are engaged in active learning by attending to relevant incoming information, organizing selected information into coherent mental representations and integrating mental representation with other knowledge.

This cognitive user profile extends the user profiles described in D5.1. That is, the cognitive characteristics of each of the three patient groups can now be evaluated and taken into account using also the new insights generated by these two evaluation studies.

In general, in D5.1 we saw that especially patients with muscular disorders might face difficulties with memory, attention and processing speed (both for PD and NMD patients). So, one general implication (at least for PD and NMD, but probably also for SCI patients) of the current findings is that any persuasive and personalization design elements should refrain from taxing memory, attention and / or processing speed.

Below, we present for each of the three patient groups the cognitive functioning element of their user profiles (as described in D5.1), and the implications the current findings have for these user profiles.

SCI Cognitive functioning

From D5.1: Cognitive function can be normal, but a substantial number of SCI patients have significant deficits in one or more cognitive domains: moderate attention and processing speed deficits, mild deficits in processing speed, executive processing difficulties, or moderate memory impairments.

Implications based on current evaluation studies: As described above, especially for these patients, the persuasive and personalization design should take into account cognitive limitations, and use more influencing strategies that demand less cognitive resources (both in memory as in processing speed).

PD Cognitive functioning:

From D5.1:

- Mild cognitive impairment (MCI) in PD individuals is associated with increasing age, disease duration and disease severity.
- The frequency of cognitive dysfunction is from 36% at the time of diagnosis to as high as 93% in more advanced stages of the disease.
- The most frequently encountered domains of cognitive dysfunction involve: executive functions, memory, visuospatial skills, attention, and mental processing speed.
- Preserved functions include basic attentional processes and many language abilities (particularly comprehension).

Implications based on current evaluation studies: Next to the importance of exclusion criteria (no cognitive impairments), the current evaluation studies also stress that for PD individuals cognitive overload caused by the abundance of persuasive and personalization strategies included may certainly occur. Therefore, also for these patients, limitations to necessity of memory and cognitive processing in the persuasive games are needed. Also, the games might also be limited in the extent to which they need visuospatial skills.

NMD Cognitive, learning and neurobehavioral functioning:

From D5.1:

- A substantial number of patients from the NMD population has a cognitive impairment.
- Cognitive skills do not deteriorate over time.
- Cognitive deficits documented in older children and adults mainly pertain to verbal skills.
- Vision-spatial skills, long term memory and abstract reasoning skills are not affected.
- NMD patients have been characterized as being easily frustrated, easily distracted, and have poor attention span.

Implications based on current evaluation studies: Next to limiting the strain on memory, processing speed, and visuo-spatial capabilities (needed for SCI and PD patients), for NMD

individuals the persuasive games need to be optimized for causing no or very limited frustration, and needing only a limited attention span.

3.3 Updated requirements for personalization

In general, the two evaluation studies showed favorable results as for the personalization strategies included in the design of the MAMEM training software. We propose two sets of updates to the requirements for the personalized persuasive design elements in the next version of the MAMEM training software.

First, the current two evaluation studies show that the personalization included is effective, but at the same also suggest that further limitations of the necessity of using memory, cognitive processing etc., might be helpful for optimizing the effectiveness of all persuasive strategies (also the personalization persuasive strategies). Therefore, we propose to check in this perspective all personalization now included in the training software. Using the participant's first name, for example, seems to be effective, but must be done only for a limited amount of times. Likewise, the personalized feedback messages might be effective, but should be limited in length and complexity.

Second, as mentioned by various participants in the Phase I field trials (see D6.4 [2]), the current MAMEM interfaces contained my possibilities for customization. That is, also the MAMEM training software contained personalized persuasive strategies (e.g., using the participants first name, and adapting feedback messages to the participant's age and gender), this personalization was done by the MAMEM system itself. An additional personalization strategy is to allow users of a system to customize it to their own preferences. That is participants might be allowed to set the background color of the interface, choose certain graphics, set other issues like response speed etc. Indeed, earlier research presented evidence for the effectiveness of customization as a persuasive strategy (see [13]).

3.4 Updated requirements for persuasive design

Finally, we will discuss the implications for the requirements for the persuasive design of the MAMEM training software of the two user evaluations (the Phase I field trials and the lab study reported in this document). Most importantly, as argued above, in both the Phase I field trials and also the lab study reported in this document, indications were found that the complexity of the MAMEM training task (that included the persuasive and personalization design principles) gave rise to cognitive overload. Indeed, in D5.1 we presented earlier scientific research that investigated the effectiveness of most of the persuasive and personalization principles *separately*. For example, based on research of social norm activation and related interventions (see [6]), D5.1 proposed to include various kinds of social norm activation interventions. And although some earlier studies have investigated combinations of a few persuasive strategies (see e.g., [7]), scientific research has not investigated the effects of combining larger numbers of persuasive strategies with one another. Indeed, dual process theories of persuasion (e.g., [8]) disentangle more elaborate, conscious and controlled mental processes (central processing) from less elaborate, more unconscious and less controlled (peripheral processing). Such theories (e.g., the Elaboration Likelihood Models [8]) would argue that presenting too many persuasive strategies that need to be processed through central processing will lead to overload, may lead to interferences between these persuasive strategies and diminish their effectiveness.

Now, although the current user evaluation study results suggested limited (Phase 1 trials) to negative (lab study) effects of the persuasive and personalized design principles on user evaluations of the MAMEM system, results also showed that the persuasive and personalized design was effective in stimulating performance improvement (on accuracy). Therefore, our main conclusion for updating the requirements for the persuasive design entails that only limited changes should be made, as the current design seemed to be effective on the most important variable: behavior change.

Still, changes in the persuasive and personalized design principles that improve user evaluations and leave unchanged (or even improve) the effectiveness of the MAMEM

training software for influencing behavior (performance accuracy) can provide a positive contribution. Therefore, we propose two kinds of improvements for the persuasive design principle requirements: Simplification (more peripheral cognitive influencing strategies), and more positive elements. That is, based on dual process theories of persuasion, as argued above, we propose to adapt some of the selected influencing strategies towards more peripheral processing: less elaborate, more unconscious and less controlled influencing strategies may lead to less cognitive load. Thereby, a set of influencing strategies that includes (next to already incorporated, more central influencing strategies) also more peripheral influencing strategies may have a more positive influence on user evaluations of the MAMEM system and lead to more positive perceptions of ease of use. In other words, we propose to include in the MAMEM system persuasive personalized design more ambient persuasive technology strategies (see [9]), that influence user behavior from the 'ambient' environment without the necessity of the conscious attention of the user. For example, we propose to replace factual feedback (e.g., presenting a score) with evaluated feedback (e.g., a color between red and green, or a flower in a particular state of opening up). That is, factual feedback needs more elaborate cognitive processing, whereas evaluated feedback already has been processed (evaluated) and causes less cognitive load for the user.

Also, we propose that negative evaluations within the persuasive principles may have influenced the perceived ease of use of the MAMEM system. Psychological research showed that negative associations may spread through what is known as the 'halo'-effect ([11]) to related judgments. Research findings by [10] showed that hedonistic elements of user interfaces (e.g., negative feedback) can influence (e.g., lower) ease of use perceptions. Still research ([12]) on the effectiveness of evaluative feedback showed that negative feedback can be more effective than positive feedback for changing user behavior. Therefore, we also propose to restrict the amount of negative evaluations in the persuasive and personalized, but not to abandon negative feedback.

Based on these analyses, we propose the following update of the requirements for persuasive design of the training tasks, as they were originally presented in D5.2. In Table 2 below, we present the original requirement (from D5.2), and the updated requirement.

Table 2. Updated requirements for persuasive design.

No.	Requirement D5.2	Updated requirement
1	System shows how a user is doing on a number of clear and quantifiable criteria	System shows how a user is doing on a number of clear criteria, *and this information is presented in an evaluated way.*
2	System shows users' status, progress and achievements	System shows users' status, progress and achievements on a special overview page. *To provide continuous, repeated progress feedback, the system shows a combined, evaluated variable*
3	System encourages or discourages user's behaviour with the use of praises or rewards and punishments (absence of rewards)	System encourages or discourages user's behaviour with the use of praises or rewards
4	System provides positive, evaluative feedback of user's performance	(no change) System provides positive, evaluative feedback of user's performance
5	System provides means for comparing performance with the that of other users	System provides *ambient* means for comparing performance with the that of other users

6	System provides a clear structure among the various levels and tasks	System provides a clear structure among the various levels and tasks, and presents this in a very simple way
7	System provides challenging (though attainable) assignments with clear short-term and long-term goals	System provides challenging (though attainable) assignments with clear short-term and long-term goals; *These assignments only need little amounts of conscious attention*
8	System provides assignments and levels which increase gradually in difficulty, following the training tasks	System provides assignments and levels which increase gradually in difficulty, following the training tasks, *without bothering the user with keeping track of sequences or progress*
9	System provides task instructions in a clear manner	idem.
10	System provides opportunities for the user to learn functionalities of the system and develops competences and skills	idem.
11	System provides suggestion for carrying out tasks during the system use process	System provides, *in an ambient way*, suggestion for carrying out tasks during the system use process
12	System provides opportunities for the	idem.

	training tasks to be fun	

3.5 Implications for the Phase II persuasive design strategies

In D5.1, we proposed a separate set of persuasive strategies to be included in the extended use situation of the Phase II trials. That is, in the second phase of the clinical trials of MAMEM, the participants will go over the same protocol as in the first phase, but this time in their home environments. The platform will be given to them for a fixed period in which they will be encouraged to use it. The core objective of the Phase II trials will be to assess the impact of the MAMEM system on multimedia management, authoring and sharing in less controlled settings. In this phase, social network activities (i.e., social media activities) and digital productivity (i.e., online courses taken).

Since the overall aim of the MAMEM project is to increase users' potential in social inclusion, strategies are needed, as motivators, for the users to continue using the system and stimulate their online social participation. The specific target of the persuasive and personalization strategies included in the Phase I training software was to stimulate acceptance and use (although use within the limited time frame of 3-4 hours). After comparable initial training (that may also be repeated over the weeks to improve performance), in the Phase II trials, participants will also (mainly) use the MAMEM system for actual and extensive web browsing (over a period of four weeks). In these web browsing activities, social inclusion related activities (e.g., using social media) will be stimulated through the persuasive elements of the MAMEM system. Thereby, the desired outcome of the second phase is different from that of the first phase and therefore, as described in D5.1, for the Phase II trials, we need additional persuasive design elements.

D5.1 presents (in detail) the following list of persuasive strategies that can be incorporated into the GazeTheWeb interface to stimulate social inclusion behavior:

- Reciprocation (responding likewise when receiving something)

- Consistency (showing consistency in attitudes and behaviors)
- Social validation (doing what others do)
- Theories of discrete emotions (people are sensitive to specific emotional appeals)

These persuasive strategies, as D5.1 proposed, will be included by including in the Phase II trial software the concept of 'hierarchical memberships' because in this persuasive design element the above mentioned persuasive strategies are combined. The core motivation strategy here is to introduce of a set of hierarchical memberships into the system. Users can be given different memberships based on to their levels of online activity. The more active a user, the higher their membership level.

Finally, D5.1 describes that indeed social activity indicators should be measured in Phase II to steer this persuasive design element of hierarchical group membership, and give user rewards, and also D5.1 describes a detailed example of how the selected persuasive strategy could be applied to the MAMEM system.

Based on the two evaluation studies the following implications can be identified for these proposal (in D5.1) for the persuasive design elements to be added to the Phase II trials.

In general, the two evaluation studies present evidence supporting that also these additional persuasive strategies will be effective. Even though these strategies were a part of the Phase I trials, or of the lab study, the proven effectiveness of the persuasive and personalization elements of the MAMEM training software makes it probable that also these additional strategies will add to the overall effectiveness of the MAMEM system for stimulating social inclusion behavior.

Also, it is important to limit in the implementation of these additional persuasive strategies (e.g., the hierarchical group membership) the extent to which they rely on and need user memory, processing capacity, visuo-spatial capacity and the extent to which they might cause frustration. The considerations presented above for the already included persuasive and personalization design elements should be used also to optimize the to be included Phase II persuasive design elements.

4 General Discussion

Based on the outcomes of the Phase I field trials and the lab study reported in this deliverable (on the persuasive and personalization design strategies specifically), the current document presented an update of the proposed persuasive and personalization strategies as they were proposed for inclusion in the MAMEM system in D5.1, and as they were included in the MAMEM training software (as described in D5.2). Overall, the main conclusion of the Phase I field trials and the lab study was that the included persuasive and personalization design elements are effective in improving user performance (that is, task accuracy)

For implementation of these requirements into the final version of the MAMEM training software to be used in the Phase II field trials, the updated requirements presented in Table 2 can be used. That is, during the creation of that new version of the software, the implementation of these persuasive design requirement in the Phase I training software as represented in the table of Appendix A needs to be adapted according to Table 2. Furthermore, the current report also presented advice on adapting the additional persuasive design elements needed for Phase II as they were described in D5.1.

The intervention mapping presented in D5.1 seems optimal for distilling what the behavioral steps should for users of the MAMEM technology. That is, participants were able to successfully complete the training cycle (as was shown in the Phase I field trials and also in the lab study), and after performing the training tasks, all participants could successfully complete the dictated tasks (again, in both studies).

Importantly, because the Phase II trials will allow the participant to use the MAMEM system for an extended period of time (four weeks), the effectiveness of the motivators included in the persuasive and personalized design elements (the ones included in Phase I, and also the additional ones presented for Phase II) will potentially strongly increase. That is, both in the Phase I field study but also in the lab study, the effectiveness of the persuasive and personalized design elements for increasing user acceptance and use was limited. Indeed, there are several very clear reasons for this limitation of differences in acceptance and use

between users trained with the persuasive and personalized training software and the other users. First of all, all participants (especially in the Phase I field trials, but also in the lab study) showed to have very high motivation to accept and use the MAMEM system. Also, these participants only used the MAMEM system for a very limited amount of time (only 3 to 4 hours in the Phase I field study, and 30 minutes in the lab study) that may have been very short for that high motivation to diminish. This makes clear that (as results show) the persuasive, personalized design could (but to a limited extend) increase motivation even further. However, the persuasion design elements will be especially relevant in the Phase II part of the trials which will last for a month in participants' homes. Internal motivation of the user may be lost or diminish within that time frame, and the persuasive and personalization design elements will be much more important and have the possibility of increasing or retaining motivation for accepting the system and to keep on using it for social inclusion activity.

Based on the current report, the persuasive and personalized design principles can be further improved, and the persuasive and personalization design elements for the Phase II field trials can be developed.

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6 Appendices

Appendix A. The persuasive design elements in the two training software versions

As described in D5.2, the MAMEM training software includes a series of persuasive design elements, and personalization to make these persuasive design elements even more effective. In the table below, we present an overview of these strategies, making clear how they were incorporated into the one version of the training software, and how they were removed and not included in the other version of the training software.

MAMEM TRAINING PERSUASIVE DESIGN AND PERSONALIZATION			
PERSUASIVE STRATEGIES	**APPLICATION**	**FULL PERSUASIVE VERSION**	**LIMITED PERSUASIVE VERSION**
Evaluative Feedback at the end of each level (positive, neutral, negative)	Positive: 1. Evaluation 2. Praise	1. Provide evaluation at the end of each level to indicate that they reached the goal in the most effective way and that they can proceed to the next level. 2. Accompany this feedback in a form of a praise, both via	1. Minimal evaluative feedback. Provide information that the level has finished and the user can proceed to the next level. No information about his performance i.e., you did great).

		words (i.e., wow, great etc.) and via symbols (i.e., trophies, emoticons)	2. No praise
	Neutral: 1. Evaluation 2. suggestion	1. Provide evaluative feedback to indicate that they reached their goal in completing the level and that they can proceed further. No praise via words (i.e., wow, great etc.) or via images. 2. Provide suggestion: i.e., that the trophy has not be reached and the user can play again to take it (i.e., why don't you play again to make the trophy yours?)	1. Minimal evaluative feedback. Provide information that the level has finished and he can proceed to the next level (Same as in the positive category) 2. Minimal suggestion: only provide him with the option to play again or move forward (buttons at the bottom of the screen)
	Negative:	1. Provide evaluation that the level has not successfully completed. 2. Suggest to play again to finished the level and also to win the trophy (i.e., why don't	1. Minimal evaluative feedback. Provide evaluation that the level has not successfully completed. 2. Minimal suggestion:

	1. Evaluation, 2. Suggestion 3. Positive reinforcement	you play again to finish the level and make the trophy yours?) 3. Provide confidence that the user can be successful (reinforce them positively, i.e., you can do it).	only provide the user with the option to play again or go forward (buttons at the bottom of the screen) 3. no positive reinforcement
Factual feedback	Scoreboards (at the end of each level)	Show how players are doing in a number of quantifiable criteria (time, errors, points)	No factual feedback is provided at the end of each level
	Self-monitoring (during the gameplay)	System keeps track of user performance(i.e., time, error, points) which is on-screen and thus visible to the user while playing each level	System does not make visible the measurements of performance and the user cannot keep track of his performance, while playing.
Social	Comparative	Show player's ranking relative to the other players (social	No social comparison

Influence	feedback (leaderboards)	comparison/comparative evaluation)	
	Emoticons	Accompany the evaluative feedback with emoticons to reflect the content of feedback (positive, neutral, negative): 1. happy face 2. Neutral face 3. sad face	No emoticons at all
External rewards	Trophies	Trophies as rewards for great performance the end of each level	No rewards at all
Tailoring	Identification	When give feedback use the name of the user (i.e., great Job, George)	No names are mentioned
	Contextualization	Quiz game questions based group culture	Similarly, Quiz game questions based group culture
		Tailor feedback based on user	No tailoring (same, plain

	Feedback tailoring	performance Tailor feedback based on Users' gender and the age	text to all users)
Other game mechanics	Levels	Gameplay advances through different levels of increasing difficulty.	Levels remain the same
	Assignments (goal setting)	Shape gameplay by providing users with short-term goals (i.e., find the wizard)	Assignments are restructured per category. Basic tasks: remain the same Intermediate task: user does not provided with the goal (i.e., no introductory scenario) and is not congratulated by the wizard for being found. The rest remain the same Advanced task: no gameplay (no map at all). The user simply does

			the tasks according to the instructions
	score	User gets a summative performance score	No score is provided (no factual feedback)
	Instructions	Instructions of what the user should do (both for the game play and for the buttons)	Instructions remain more or less the same (i.e., we do not mention the trophies etc.).
	Liking	Visual graphics to increase the user fun	Limited visual graphics.

Appendix B. The informed consent form user in Lab Study 1.

Technische Universiteit Eindhoven University of Technology

Informed consent form

This document gives you information about the study “MAMEM1”. Before the study begins, it is important that you learn about the procedure followed in this study and that you give your informed consent for voluntary participation. Please read this document carefully.

Aim and benefit of the study

The aim of this study is to measure your evaluation and use of the MAMEM system. The MAMEM system uses a web browser that you can control with your eyes (by using an eye-tracker). This information is used to study how easy it is to use this technology.

This study is performed by HTI master students under the supervision of dr. Jaap Ham of the Human-Technology Interaction group.

Procedure

In this study, you will be asked to take place behind a computer system and will perform a short calibration task to allow the (TOBI eyeX) eye tracker to track your eyes. Tracking is done with cameras inside a rectangular bar right below the computer monitor, and is not in any way harmful for your eyes. After that, the experiment consists of two phases. In phase one you will be guided through a series of training tasks. In phase two you will be asked to perform two day-to-day computer use tasks (search and play a Youtube video, and do a websearch).

Risks

The study does not involve any risks or detrimental side effects.

Duration

The study will last approximately 25 minutes.

Participants

You were selected because you were registered as participant in the participant database of the Human Technology Interaction group of the Eindhoven University of Technology.

Voluntary

Your participation is completely voluntary. You can refuse to participate without giving any reasons and you can stop your participation at any time during the study. You can also withdraw your permission to use your data up to 24 hours after the study is finished. All this will have no negative consequences whatsoever.

Compensation

You will be paid 5 euros (€2.00 extra if you do not study or work at the TU/e or Fontys Eindhoven).

Confidentiality

All research conducted at the Human-Technology Interaction Group adheres to the Code of Ethics of the NIP (Nederlands Instituut voor Psychologen – Dutch Institute for Psychologists).

We will not be sharing personal information about you to anyone outside of the research team. No video or audio recordings are made that could identify you. The information that we collect from this study is used for writing scientific publications and will only be reported at group level. It will be completely anonymous and it cannot be traced back to you.

Further information

If you want more information about this study you can ask [student info].

If you have any complaints about this study, please contact the supervisor, dr. Jaap Ham (j.r.c.ham@tue.nl).

Certificate of Consent

I, (NAME)…….. have read and understood this consent form and have been given the opportunity to ask questions. I agree to voluntarily participate in this study carried out by the research group Human Technology Interaction of the Eindhoven University of Technology.

Participant's

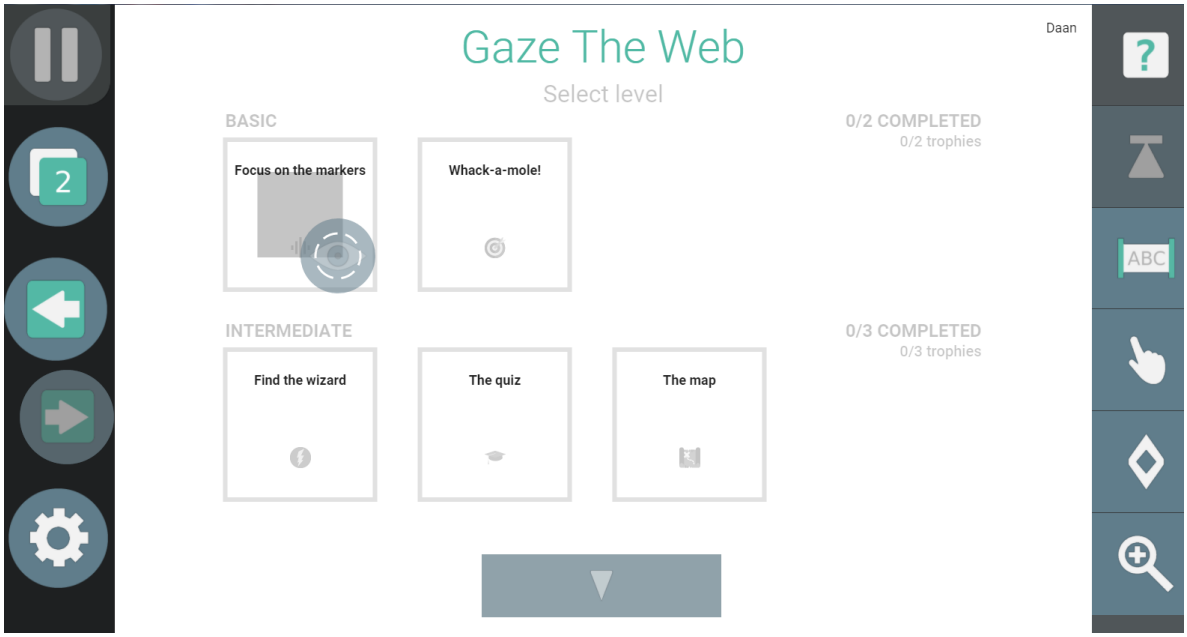
Signature Date

Appendix C. The instruction booklet for participants in Lab Study 1.

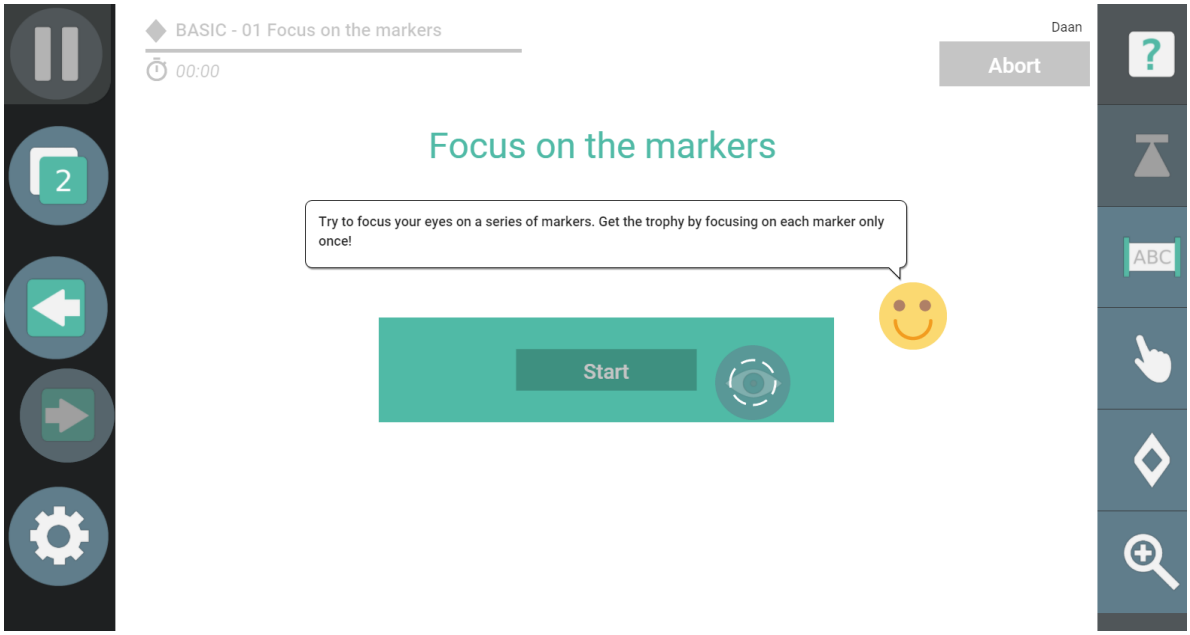
Dear participant,

Please carefully read and follow the instructions provided in this document. Instructions are accompanied by screenshots to help guide you through the procedure. Before reading in the manual, always **pause** the system using the pause button in the top left corner of the screen to prevent the eye tracker from tracking your eyes while you read and thereby performing unwanted actions. If you have any questions or encounter any problems, don't hesitate to ask the experiment leader for help.

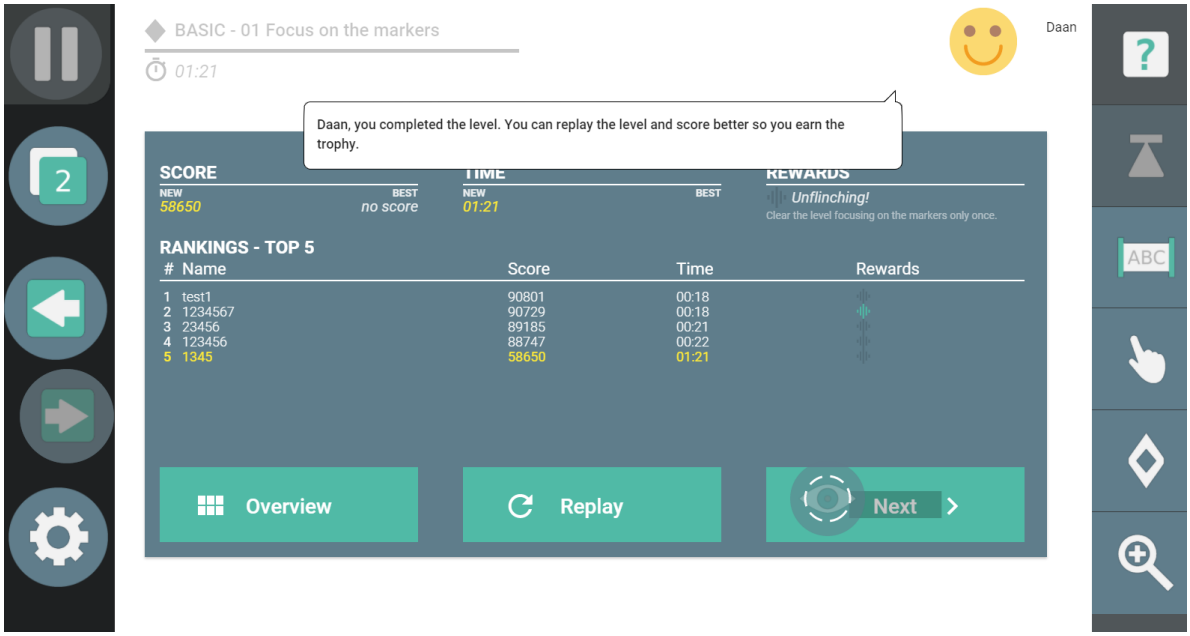
1. Start the first level of the basic training tasks by looking at the 'Focus on the markers' section.



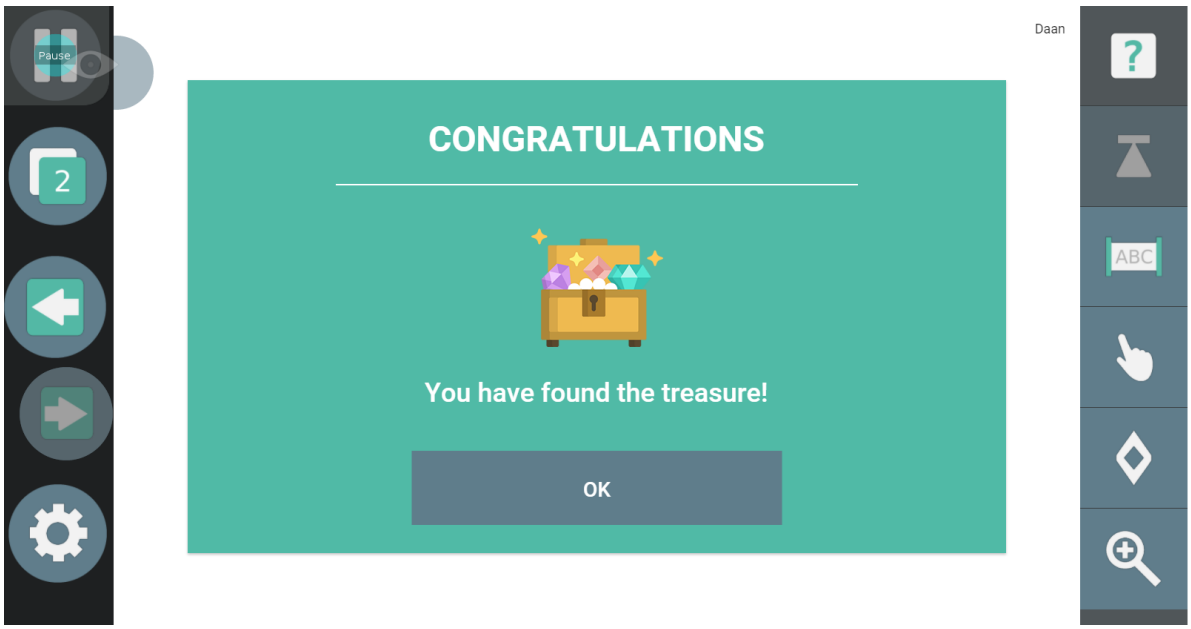
2. Read the instructions and select ‘Start’ when you are ready.



3. After completing the training task you may retry in order to improve your score by selecting ‘Replay’. When you are done, select ‘Next’ to proceed to the next level.



4. Continue completing tasks until you have finished the last task and reach the screen below.



5. Now please pause the system by selecting the pause button on the top left of your screen and turn the page to fill in the first questionnaire.

Questionnaire 1

For each statement, you can indicate whether you agree with that statement or not. You can indicate your agreement or disagreement by encircling the number that corresponds to your answer.

		Strongly disagree	Moderately disagree	Somewhat disagree	Neutral (neither agree nor disagree)	Somewhat agree	Moderately agree	Strongly agree
1	The training provided information that motivated me to use the MAMEM system	1	2	3	4	5	6	7
2	The training helped me to see the usefulness of the MAMEM system	1	2	3	4	5	6	7
3	The training increased my intention to master the MAMEM system	1	2	3	4	5	6	7
4	The training showed me the value of using the MAMEM system in operating my	1	2	3	4	5	6	7

	computer							
5	My interaction with the MAMEM system was clear and understandable	1	2	3	4	5	6	7
6	My interaction with the MAMEM system did not require a lot of my mental effort.	1	2	3	4	5	6	7
7	I find it was easy to get the MAMEM system to do what I want it to do	1	2	3	4	5	6	7
8	Overall, I find the MAMEM system easy to use	1	2	3	4	5	6	7
9	The MAMEM system did not scare me at all	1	2	3	4	5	6	7
10	Operating the MAMEM system made me nervous	1	2	3	4	5	6	7

Please continue on the next page.

		Strongly disagree	Moderately disagree	Somewhat disagree	Neutral (neither agree nor disagree)	Somewhat agree	Moderately agree	Strongly agree
11	The MAMEM system made me feel uncomfortable	1	2	3	4	5	6	7
12	The MAMEM system made me feel uneasy	1	2	3	4	5	6	7
13	I find using the MAMEM system to be enjoyable	1	2	3	4	5	6	7
14	The actual process of using the MAMEM system was pleasant	1	2	3	4	5	6	7
15	I had fun using the MAMEM system	1	2	3	4	5	6	7
16	Assuming I were handicapped and had access to a MAMEM system, I intend to use it.	1	2	3	4	5	6	7
17	Given that I were	1	2	3	4	5	6	7

	handicapped and had access to a MAMEM system I predict that I would use it.							

The following questions ask you to indicate how you would characterize yourself when using computers in your daily life. Please indicate how much you agree or disagree with each trait on the list, on a scale from on 1 (strongly disagree) to 7 (strongly agree).

	When using a computer in daily life, I characterize myself as…	Strongly disagree	Moderately disagree	Somewhat disagree	Neutral (neither agree nor disagree)	Somewhat agree	Moderately agree	Strongly agree
18	…spontaneous	1	2	3	4	5	6	7
19	….creative	1	2	3	4	5	6	7
20	…playful	1	2	3	4	5	6	7
21	…unoriginal	1	2	3	4	5	6	7

Please continue on the next page.

The following questions pertain to how much help you think you would need to get something done using the MAMEM system

	I could complete a job using the MAMEM system…	Strongly disagree	Moderately disagree	Somewhat disagree	Neutral (neither agree nor disagree)	Somewhat agree	Moderately agree	Strongly agree
22	…if there was no one around to tell me what to do as I go.	1	2	3	4	5	6	7
23	…if I had just the built-in help facility for assistance	1	2	3	4	5	6	7
24	…if someone showed me how to do it first	1	2	3	4	5	6	7
25	…if I had used similar software packages before this one to do the same job	1	2	3	4	5	6	7

Please continue on the next page.

During the second part of the experiment you will perform two daily activities: making a web search and watching a YouTube video. The following questions are related to these activities. Please indicate whether you think you could use the MAMEM system yourself for these activities, on a scale from 1 to 7.

	I believe I have the ability to…	Strongly disagree	Moderately disagree	Somewhat disagree	Neutral (neither agree nor disagree)	Somewhat agree	Moderately agree	Strongly agree
26	…initiate a web search using the MAMEM system	1	2	3	4	5	6	7
27	…type a search term in the search engine using the MAMEM virtual keyboard	1	2	3	4	5	6	7
28	…scroll up and down on a webpage to find the information I want using the MAMEM system	1	2	3	4	5	6	7
29	…open a webpage /link using the MAMEM system	1	2	3	4	5	6	7
30	…play a video on YouTube	1	2	3	4	5	6	7
31	…edit a URL (e.g., youtube.com), to be directed to the page, using the	1	2	3	4	5	6	7

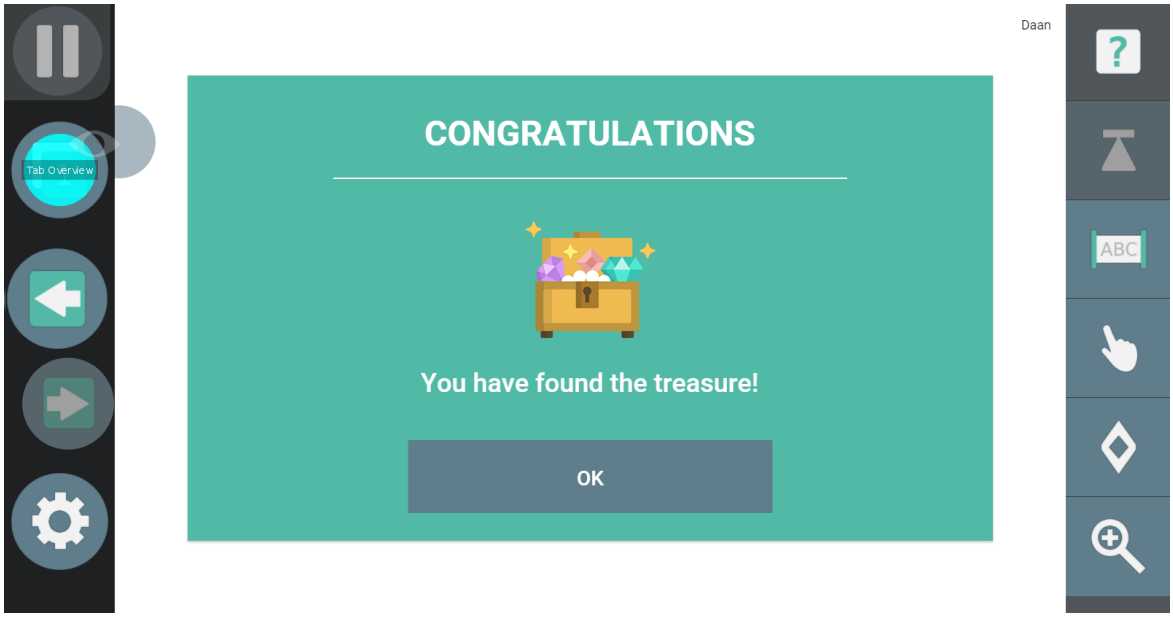
	MAMEM system							

Using the MAMEM system to perform computer activities (such as making web search and watching a YouTube video) will be:

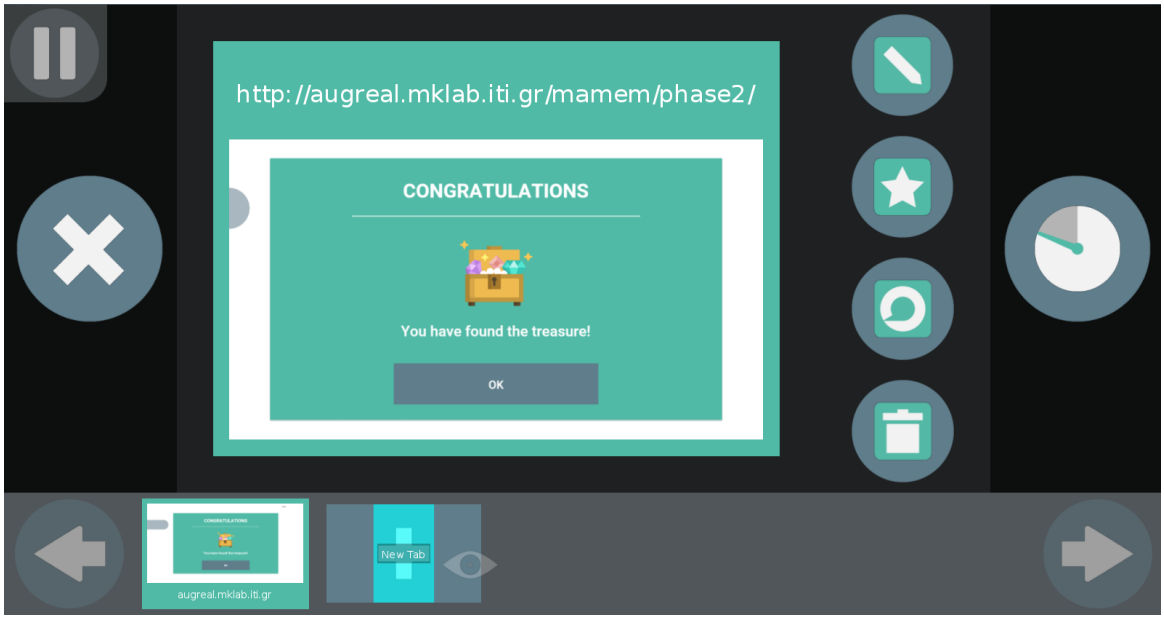
32	harmful	1	2	3	4	5	6	7	beneficial
33	pleasant	1	2	3	4	5	6	7	unpleasant
34	good	1	2	3	4	5	6	7	bad
35	worthless	1	2	3	4	5	6	7	valuable
36	enjoyable	1	2	3	4	5	6	7	unenjoyable

This was the end of the Questionnaire 1. Please check if you have missed any questions. If not, please continue by following the instructions on the next page.

6. Return to the computer screen, un-pause the system by selecting the pause button on the top left of your screen again and then select ‘Tab overview’ right below the pause button.



7. Open a new tab by selecting ‘New Tab’ (the large + icon on the bottom of the screen).



8. Do a Google search and see if you can find out who made the famous painting called 'The Son of a Man'. Please write down your answer here: ……..

9. Go to Youtube, search for 'melon catapult' and watch the first video in the search results. Please write down what goes wrong in the video: ……

10. Now please turn the page and fill in the second questionnaire.

Questionnaire 2

This questionnaire is about the second part of the experiment involving daily computer activities.

For each statement, please indicate whether you agree or disagree with that statement on a scale of 1 (strongly disagree) to 7 (strongly agree).

		Strongly disagree	Moderately disagree	Somewhat disagree	Neutral (neither agree nor disagree)	Somewhat agree	Moderately agree	Strongly agree
1	My interaction with the MAMEM system was clear and understandable	1	2	3	4	5	6	7
2	My interaction with the MAMEM system did not require a lot of my mental effort.	1	2	3	4	5	6	7
3	I find it was easy to get the MAMEM system to do what I want it to do	1	2	3	4	5	6	7
4	Overall, I find the MAMEM system easy to use	1	2	3	4	5	6	7
5	Imagine that your hands are dirty because you are cooking dinner. Would you find this system useful to google recipe	1	2	3	4	5	6	7

	information?							
6	Imagine that you are working on multiple monitors. Would you find this system useful to do a quick google search while typing text on the other monitor?	1	2	3	4	5	6	7
7	Imagine that you are suffering from pain in the shoulder and arm (RSI related). Would you find this system useful to do a google search?	1	2	3	4	5	6	7
8	Imagine that you are playing a video game on your game console. Would you find this system useful to find a youtube music video to play on the side while gaming?	1	2	3	4	5	6	7

Please indicate whether you think you could use the MAMEM system yourself for these activities, on a scale from 1 to 7.

	I believe I have the ability to…	Strongly disagree	Moderately disagree	Somewhat disagree	Neutral (neither agree nor disagree)	Somewhat agree	Moderately agree	Strongly agree
9	…initiate a web search using the MAMEM system	1	2	3	4	5	6	7
10	…type a search term in the search engine using the MAMEM virtual keyboard	1	2	3	4	5	6	7
11	…scroll up and down on a webpage to find the information I want using the MAMEM system	1	2	3	4	5	6	7
12	…open a webpage/link using the MAMEM system	1	2	3	4	5	6	7
13	…play a video on YouTube	1	2	3	4	5	6	7
14	…edit a URL (e.g., youtube.com), to be directed to the page, using the MAMEM system	1	2	3	4	5	6	7

Thank you for filling in the second questionnaire. **The experiment is now finished.** Please hand this document over to the experiment leader.