Improving Medication Adherence in the Elderly Using a Medication Management System

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Preface

This thesis marks the final chapter in the book called ‘University’. It is time for a new chapter in a new book, time to dip my toes in the water of opportunity, adventure, and the business world. With a Bachelor degree Business Communication & Digital Media and a Master degree Human Aspects of Information Technology and my second Masters programme Business Communication & Digital Media in my pocket I am confident that I am ready to embark this ship and go on this journey.

I want to thank both of my thesis supervisors, Prof. Dr. E.O. Postma and Dr. J.P.M. Lacroix for their constructive feedback and guidance during my thesis. I have much appreciation for the opportunity they gave me to pitch my ideas and the given advice. I also want to thank Dr. M.M. van Zaanen for his review of my thesis and his comments. Furthermore, this thesis would not have been able without Philips Research that gave me the opportunity to carry out my graduation project at their offices in Eindhoven, Evalan for providing me with the medication dispensers and of course all of my participants. I appreciate all help and kind words.

I want to thank my parents and sister for their unconditional support and advice during my study. And a shout out to Michiel en Rieno for giving me the occasional cheer, even though I am a bit disappointed that I did not see any real pom-poms.
Abstract

One out of ten elderly ends up in the hospital because of medication non-adherence. This puts a large strain on health care facilities. In this study we present a platform for developing a Medication Management System to improve the medication adherence in elderly. The Medication Management System is evaluated in a pilot experiment. Two types of interfaces are examined: a textual interface and an interface featuring an Embodied Conversational Agent. The results of the pilot experiment suggest that the Medication Management System with an embodied conversational agent has a positive influence on the medication adherence in elderly. We conclude that a Medication Management System can have a positive influence on medication adherence, especially the interface featuring an Embodied Conversational Agent and provide suggestions for future research on this topic.
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1 Introduction

The world’s population is ageing rapidly and there is an ever increasing demand for health care. Governments spend a great amount of money each year on delivering adequate health care to their inhabitants. A great share of this money is needlessly spent due to hospital admissions that could be prevented. The New England Healthcare Institute (NEHI) estimated that $290 billion in avoidable medical spending is generated annually by people not taking their medication, suboptimal prescribing, drug administration and diagnosis (New England Healthcare Institute, 2009). A great share of this money, $100 billion, is due to medication non-adherence which leads to excess hospitalizations. Not only unnecessary health care costs are under discussion here but also the decrease of health care productivity.

It is a commonly known fact that people prefer to recuperate and grow old at their own homes instead of being reliant on a hospital or a nursing home. Hareven states that older people prefer to maintain independent households as long as possible (as cited in Pollack, 2005, p. 9). The safe environment of their own homes may accelerate their healing process and allows them to maintain their daily routine. By following treatment in their own homes, elderly experience less anxiety than when the treatment is followed elsewhere.

The great amount of money that is spent on medical care could be reduced by eliminating unnecessary hospital and nursing home admissions. Key to reducing these admissions is improving the life expectancy of an individual as well as their health by taking prescribed medication (Sokol, Kimberly, McGuigan, Verbrugge, & Epstein, 2005; Balkrishnan, Rajagopalan, Camacho, Huston, Murray, & Anderson, 2003). A condition for improvement in health and life expectancy is that the prescribed medication has to be taken in the correct manner. In the context of this thesis ‘correct manner’ is defined as taking the medication at the appropriate time. Throughout the thesis the correct intake of medication will be defined as ‘adherence’. Horne, Barber, Elliott, & Morgan (2005) define adherence ‘as the extent to which the patient’s behaviour matches the prescriber’s recommendations’. Patients that adhere to their medication regiment will improve their health more than non diligent patients (Gallagher, Viscoli, & Horwitz, 1993). Nevertheless, adhering to a medication regiment seems to be increasingly difficult for some population groups.
1.1 Elderly and Medication Adherence

The population group that suffers most from a lack of medication adherence are the elderly (Hammarlund, Ostrom, & Kethley, 1985; Pirmohamed, James, & Meakin, 2004; Leendertse, 2010; Bedell, Jabbour, & Goldberg, 2000). This is because non-adherence is less easily detected and harder to resolve in elderly than in younger people. One out of ten elderly ends up in the hospital (Nananda, Fanale, & Kronholm, 1990) and 25% of the elderly end up in nursing homes (Strandberg, 1984) due to medication non-adherence which puts a strain on health care resources. In 2008 the global population aged 65 and over was estimated to be around 506 million which is about 7 percent of the world’s population. By 2040 this group is projected to be as big as 1.3 billion which accounts for 14 percent of the total world population (Kinsella & Wan, 2009). With the growth of the group of people aged 65 and over and the decrease of health care staff the problem of medication non-adherence has to be resolved.

Before turning to ways of improving medicine adherence, the reasons for non-adherence have to be explored. The World Health Organization (WHO) has determined five factors that affect adherence:

1. Social and economic factors (e.g. illiteracy, high cost of medication, unstable living conditions, long distance from treatment centre);
2. Health care team and system-related factors (e.g. patient-provider relationship, overworked health care providers, weak capacity of the system to educate patients and provide follow-up);
3. Condition-related factors (e.g. severity of symptoms, levels of disability such as physical, psychological, social and vocational);
4. Therapy-related factors (e.g. complexity of medical regimen, duration of treatment, availability of medical support to deal with side-effects); and
5. Patient-related factors (e.g. forgetfulness, low motivation, lack of self-perceived need for treatment, low treatment expectations, hopelessness and negative feelings, anxiety over the complexity of the drug regimen).

The main causes for non-adherence with the elderly are the degrading health and their cognitive decline which correspond to factors 3, 4, and 5.
Many risks are involved with the poor adherence of medication (National Council on Patient Information and Education, 2007) such as progression in the disease, disease complications, reduced functional abilities, a lower quality of life, increased physician office visits, hospitalisations, nursing home admissions and premature death. The WHO (2003) states that medication non-adherence leads to more intense relapses (Weiden, 2002), increased risk of dependence on the medicine (Bush, Spector, & Rabin, 1984), increased risk of abstinence and rebound effect (Demyttenaere & Haddad, 2000; Kaplan, 1997), increased risk of developing resistance to therapies (Gallego et al., 2001; Wahl & Nowak, 2000; Paterson et al., 2000; Yach, 1988; Bell & Yach, 1988), increased risk of toxicity with over-use of medicines which is particularly true for elderly patients and increased likelihood of accidents because many medications need to be taken in conjunction with lifestyle changes, for example no driving with certain medication. Interventions are needed to prevent occurrence of these risks involved with non-adherence.

Research has shown that there are several good outcomes associated with good medication adherence (WHO, 2003) such as the improved health status of patients, improvements in and the preservation of the quality of life of patients and economic benefits by generated savings with the reduced use of costly health care resources. Also, the improved health status enables the patient to stay independent at their own homes.

By using Behaviour Change Motivation (BCM) techniques, i.e. pervasive methods for activating and motivating people to change their behaviour, the non-adherence of medication and its risks can be influenced positively (Miller & Rollnick, 2002). A study by Lorig et al. (1999) showed that an intervention such as an adherence program could improve the health-related behaviour and health status of a patient. Also the number of hospitalisations and days of hospitalisation decreased and therefore also health care costs decreased due to an intervention. Haynes (2001) states that the increase of the effectiveness of adherence interventions has much more impact on the health of a population than improvements in specific medical treatments.

One of the aforementioned BCM techniques is the method of Motivational Interviewing (MI) and has been used in previous research (Channon, Smith, & Gregory, 2003; Burke, Arkowitz, & Menchola, 2003; Kemp, Hayward, Applewhaite, Everitt, & David, 1996) to change the undesirable behaviour of patients. MI can be defined as “a client-centred, directive method for
enhancing intrinsic motivation to change by exploring and resolving ambivalence.” (Miller & Rollnick, 2002). Motivational Interviewing will be discussed in depth in Chapter 2.3.

To improve adherence in elderly, in the study presented in this thesis the method of MI has been combined with a virtual coach in the form of an embodied conversational agent. The patient is presented with the virtual agent on a digital platform such as a computer at their own home. This agent will combine MI techniques with a digital platform to help the patient with adhering to their prescribed medication treatment.

1.2 The Rising use of Technology in Healthcare

Technological innovations are able to help people to stay active and increase their quality of life and life expectancy. Especially elderly benefit from techniques that help them to stay active and enable them to grow old at their own homes instead of a nursing home or other care facility. These technologies enhance the quality of the life of elderly but also reduce the workload of care takers.

The research field that concerns itself with innovations in technology to simplify the life of elderly is ‘gerontechnology’. Gerontechnology is “the study of technology and ageing for ensuring an optimal technological environment of all ageing and old people up to a high age” (Bouma, 1992). Gerontechnology concerns itself with technological innovations to improve the health, mobility, communication, leisure and environment of elderly people, with the purpose of allowing them to remain living independently at their own homes. This research field helps us deal with problems that our ageing population faces such as the reliance on nursing homes and other care facilities, the decline in physical and mental health of the elderly, and also the non-adherence of prescribed medication treatments. In recent years, research has lead to several inventions to support the population group aged 65 and above and help them cope with changes in their physical capabilities and their cognitive decline.

Bouma, Fozard, Bouwhuis, & Taipale (2007) provide a matrix (Table 1) in which a selection of relevant developments for gerontechnology are displayed. These developments are able to make a contribution to the life of the ageing population. We explain five of these developments (to give an overview of recent developments in the field of gerontechnology) because of their relevance to improving the quality of life of the elderly and the relevance to our study which incorporated some of the key concepts of these developments.
Domotics is the automation of the home in which several house functions such as central heating, lighting and alarms are automated to improve the quality of life in the living space. By using technological advancements such as sensors, the task of regulating these functions by the elderly themselves is not necessary. These automations can be as simple as the opening and closing of windows and setting the alarm at predefined times. Another example is the Smart Home at the University of Florida, an assistive environment in the form of a house, designed for the elderly (Davis, 2003). This house provides the latest in computer and sensor technology for the purpose of assisting in the daily needs of elderly.

Biorobotics is the field of research regarding the development of a robot that emulates living organisms. Robots like the vacuum cleaner that automatically vacuums your house have been around for quite some time. Biorobotics are targeted to the social well-being of the elderly. These robots respond to the users’ handling such as stroking in the case of a robotic pet. These robots can give the personal affection that is often much needed by elders. An example is the seal robot Paro (Figure 1) that was developed for therapeutic applications (Wada, Shibata, Saito, & Tanie, 2004).

<table>
<thead>
<tr>
<th>Physiology Nutrition</th>
<th>Preventive nutrition</th>
<th>Experimental houses</th>
<th>Situated learning</th>
<th>Telecare</th>
<th>Biometrics Resource sharing</th>
<th>Individual differences</th>
<th>User participation Inclusive design Standardisation</th>
<th>Care management innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychology Social psychology</td>
<td>Experimental houses</td>
<td>Domestic</td>
<td>Temporal discount &amp; benefits</td>
<td>Technology acceptance</td>
<td>Persuasive technology</td>
<td>Domestic</td>
<td>Navigation tools</td>
<td>Technology acceptance</td>
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<td>Sociology Demography</td>
<td>Technology generation (protocols)</td>
<td>Technology generation (protocols)</td>
<td>Technology generation (user interface)</td>
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<td>Medicine Rehabilitation</td>
<td>Perceptual implants</td>
<td>Perceptual implants</td>
<td>Modelling restrictions Telecare</td>
<td>Biometrics Resource sharing</td>
<td>Self medication Telecare</td>
<td>Care management innovation</td>
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Telecare offers remote care and enables people to remain independent at their own homes. For example, there is a service in which the elder is checked up on every morning by calling them and asking how they feel and if there are any problems. Other examples of remote care are the necklace with an alarm button which should be pressed in case of a fall (Philips LifeLine), and the Philips pill dispenser (Figure 2) in which the family member or care taker is notified when the elder forgets to take their medication.


Telemedicine overlaps with the field of telecare but is more focused on providing health care at a distance by eliminating distance barriers. Mobile techniques are used to provide acute care when needed and the transmission of medical information is possible. An example is video communication through which instructions can be given.

Self-medication encompasses the self-administering of medication. Memory aids such as audio alarms can be combined with the intake of medication.

Also, the increasing usage of mobile phones provides a new field for gerontechnology. Mobile innovations make the delivery of self care apps on your phone possible. Examples are applications in which the user can measure their heart rate or keeping a food diary for medical purposes.

In this study techniques from Gerontechnology: telecare and self-medication, have been used to come up with a Medication Management System to support the elderly with their medication regimen. These developments have been paired with the research field of Embodied Conversational Agents (ECA). An ECA is a computer-generated character with a human-like appearance and will be discussed in depth in Chapter 2.2.

1.3 **The Goal of our Study**

In our study both behaviour change techniques and assistive technology have been combined to design, build and to validate a novel Medication Management System. The purpose is to alleviate current problems in medication adherence and to present a method for improving the medication adherence in elderly. This technology aims to assist elderly in living independently and maintain a good health and good quality of life, as well as increase their life expectancy.

Our study intends to alleviate the strain on health care sources and therefore reduce the costs that are involved with unnecessary health care facility admissions. Also, with this system health care productivity could be increased. The most important purpose is to develop a way to increase the life expectancy, quality of life and the health of the elderly and to decrease the emotional burden of the possible admission into a nursing home.
1.4 Research questions

The research questions addressed in our study are:

• How should an effective Medication Management System be designed?

Which leads to the following sub research questions:

• What is the effectiveness of the Medication Management System?
  • Which version is more effective? How do the agent and text based interface compare?
  • Do the elderly users prefer the agent based or text based interface?

These questions will be addressed by giving an overview of our design and by analysing the data from the experiments.

1.5 Outline of the thesis

In Chapter 2 a theoretical background is given with a description of the Philips LifeLine Project (2.1) and an explanation of Embodied Conversational Agents (2.2) and Motivational Interviewing (2.3). Chapter 3 will describe the design process of the Medication Management System and the differences between the text and conversational agent versions (3.2.2). In Chapter 4 the methods for researching the research questions are discussed as well as the different stages of the research with the MMS. Chapter 5 will provide the results of the research. Chapter 6 provides the discussion. Chapter 7 presents the conclusions that followed this research and recommendations for future work.
2 Theoretical Background

Here, we will provide an explanation of the Philips Lifeline Project and a theoretical background on Embodied Conversational Agents and Motivational Interviewing.

2.1 Philips Lifeline Project

As stated earlier in our thesis, one out of ten hospital admissions amongst elderly is caused by non-adherence of their prescribed medication treatment (Nananda, Fanale, & Kronholm, 1990). Philips interpreted this data as a clear message that there was a demand for health care facilities that support people with the intake of their medication. Their ambition is to offer solutions that can cater to the whole health care chain: a) prevention, b) diagnosis, c) intervention and d) after care at the homes of the patients. With the acquisition of Lifeline Systems, Inc. in 2006, Philips fulfills the demand of health care facilities and expands their role on the growing market for personal health care and put focus on elderly that want to live independently longer and want to have their health and lifestyle under their own control. One of the products that belongs to the Philips Lifeline Project is the Philips Medication Dispensing Service called the MD.2.

The MD.2 is an example of a pill dispenser that is able to help people to maintain their medication schedule. When it is time to take their medication the MD.2 alerts the patient by an audio alarm. If a patient forgets to take a medication dose, the dispenser sends an alert to the contact person of the patient. This way the contact person, a family member or care taker, can check up on the patient and be sure that the medication is taken. In Figure 3, an overview of the several steps taken while using the MD.2 can be found.
The LifeLine website (http://www.lifelinesys.com/) states that the Philips Medication Dispensing Service has been proven to deliver a 98.6% in-home dispensing adherence level among monitored subscribers. According to the Lifeline website this particular medication dispensing service can help seniors take their medication on schedule, reduce the risk of unplanned hospitalisations and unnecessary medical complications related to incorrect medication use and let the elder remain independent at their own home. Also, the MD.2 serves caregivers by helping them support elderly from a distance. It can help reduce the risk of accidental over or under dosing when no one is there to help. Our research should be regarded as a possible extension to the MD.2. The internship in service of this research has been executed at the headquarters of Philips Research in Eindhoven, The Netherlands.

2.2 **Embodied Conversational Agents**

As stated in a study by Jakobson (1960) to maintain a relational tone between individuals, social dialogue can be used even when no explicit task is being performed (as cited in Bickmore & Picard, 2005, p. 10). Merely conducting social dialogue tends to establish a relationship between two interlocutors. Bickmore & Picard (2005) came to the conclusion that this is also true for the use of many computer applications. Simply engaging a user and keeping them engaged, even when no task is being performed, will help to establish a bond with the system. A study by Klein, Moon, & Picard (2002) showed that when a computer system appears to be human-like and expresses empathy it can influence the mental state of a user much like a human could do, or in the case of
this thesis, like a health care professional would do. Klein et. al (2002) showed that appropriate use of empathy can alleviate negative emotional states such as frustration. In this study we implemented this knowledge in the form of an Embodied Conversational Agent (ECA).

An ECA (see Figure 4) is a computer-generated character with a human-like appearance and interactive behaviours (Schulman & Bickmore, 2009). With the emergence of 3D graphics we are now able to create very human-like 3D characters. Information is conveyed to human users by multiple modalities such as voice and hand gestures (Cassell, 2001). Previous studies have shown that ECA’s are able to influence behaviour (Bickmore, Caruso, Clough-Gorr, & Heeren, 2005; Bickmore, 2003; Klein et al., 2002). The behaviour of people that are non-adherent to a medication regimen needs to be changed and therefore those non-adherent people have to be influenced to do so. To support people and motivate people to adhere to their medicine regiment face-to-face communication with a health care professional is needed. These face-to-face appointments are a costly and time consuming manner. ECA’s enable face-to-face communication and could alleviate the health care professional a great deal. Also, as stated earlier, ECA’s encompass the ability to influence behaviour. An extra advantage that an ECA provides is that behaviour changing communication can take place at the surroundings of the home of the patient.

Empathy for the patient provided by the health care professional has been widely acknowledged as being an important prerequisite for the establishment of a therapeutic relationship between the health care professional and the patient (Horvath & Symonds, 1991; Becker & Maiman, 1975; Francis, Korsch, & Morris, 1969). Empathy for a patient expressed by a physician plays a significant role in prescription compliance, and a lack of empathy for a patient is the single
most frequent source of complaints. (Frankel, as cited in Bickmore & Fernando, 2009). ECA’s can play a significant role in maintaining the long-term adherence to disease treatment regimens. When equipped with certain motivational techniques from health care, such as Motivational Interviewing, ECA’s are able to persuade a patient to adhere to their prescribed medication regimen.

2.3 **Motivational Interviewing**

To change behaviour people need to be motivated to make changes. Different reasons exist for a person to not follow their prescribed medication regimen. Key is to have the patient in question look at their problem as something that is able to be solved, by themselves (self-efficacy) and with external help. To achieve motivation to change behaviour, the theory of Motivational Interviewing (MI) is used. As mentioned in Chapter 1.1, MI can be defined as “a client-centred, directive method for enhancing, intrinsic motivation to change by exploring and resolving ambivalence.” (Miller & Rollnick, 2002). In an earlier study by Rollnick & Miller (1999) MI is described as a directive, client-centred counselling style for eliciting behaviour change by helping clients explore and resolve ambivalence. MI can persuade a person to follow their medication regimen and to live more healthy, this will benefit them directly but also in the long run.

Several studies have related the use of MI with positive outcomes in various health-related behaviours, such as smoking, exercise, alcohol abuse and drug addiction (Brodie, Inoue, & Shaw, 2008; Rollnick, Butler, & Scott, 1997; Burke, Arkowitz, & Menchola, 2003). These findings suggest that MI can indeed have a positive influence on health-related behaviour and therefore also medication adherence in patients. A study by Ogedegbe et al. (2008) proved the positive influence Motivational Interviewing can have on medication adherence levels in patients over time compared to patients that did not receive care with the use of MI, in which there was a significant decline in adherence. Studies by Diorio et al. (2008) and Safren et al. (2001) have shown that the direct implementation of Motivational Interviewing can have a positive outcome regarding medication adherence.

Miller (1983) stated that a counsellor could use empathic listening to minimise resistance and increase motivation for change. This motivation to change should be elicited from people, not being imposed on them. Five key principles of MI are used to explore the personal goals and values of the patient and their perspective on the problem and to elicit motivation to change. In our research we used three of these principles (Rollnick & Allison, 2004):
1. The principle of express empathy is recognising the feelings of a patient and can be realised by reflective listening. Reflective listening involves summarising statements of the patient and gives the patient the feeling that he or she is understood.

2. The principle of support self-efficacy is developing a sense within the patient that they are able to cope with specific situations. The emphasis is on eliciting self-motivating statements instead of imposing it from without. The counsellor is still allowed to make suggestions for achievable goals as long as the patient is encouraged to take charge of their own decision making.

3. The principle of develop discrepancy is recognising a conflict in behaviour or opinions by exploring the patient’s personal values and aspirations for the future. By inviting the patient to make explicit the costs of their current behaviour and the change they want to accomplish they will recognise the discrepancy in their current behaviour and proposed behaviour. This discrepancy can be a motivation to change.

The conversational agent takes over the role of the health care professional and the previous mentioned principles should be translated into the medication intervention between the conversational agent and the user of the MMS. The agent should express empathy, elicit self-motivating statements within the patient during the conversation and develop discrepancy with the patient with the goal of developing a motivation to change. Aside from the conversations with the agent, the development of an action plan for the patient could give extra support with achieving goals. This action plan should include several goals which were identified by the patient to motivate them to achieve their personal goal.
3 Design of a Medication Management System

In this Chapter, we present the Medication Management System (MMS) that was designed with the use of several computer software programs. Written guides were part of the MMS and printed out to guide users during the experiments. The goal of the MMS is to enable the assessment of the medication management of independently living elderly and to improve their medication management. To be able to research different factors that could influence the medication intake of elderly, different versions of the system were designed with specific personas in mind which will be discussed in Chapter 3.1. In the following sections the design of the Medication Management System will be discussed.

3.1 Personas

The MSS was designed with so-called personas in mind. A persona is a fictional person that captures the most important aspects of the users in a user group. It is a precise description of the user we are developing for and the things this person wishes to accomplish (Cooper, 2004) and puts a face to the user that serves as a design target (Pruitt & Adlin, 2010).

Questions that were raised while developing a persona for the design of the medication management system were: 1) what kind of tasks will the users be trying to accomplish in the design, 2) what are their goals and their experience level in the subject domain and 3) their experience level with computers in general. For the user group of elderly people the following two personas were used:
Name: Ben, male  
Age: 70

Physically active, likes to go for a walk, lives with a partner (independently) and has a social life.

Goal: To stay healthy (with the use of medication), not being too reliant on anyone else and to keep a fairly active life.

Health: A light case of arthritis in his hands, less acute vision – wears glasses.

Technology savviness: Not much experience with computers, but does use them for online banking from time to time. Understands the key functions of a computer.

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Name: Rose, female  
Age: 75

Not physically active because of her age and health, lives alone and has a help come in every day to help with household tasks such as making dinner and taking a bath, does not have many social contacts but does not want to live in a care home. Her children visit her on the weekends.

Goal: To stay healthy (with the use of medication) and live independently for as long as possible.

Health: Suffers from arthritis, is bound to a wheelchair, less acute vision – wears glasses.

Technology savviness: Does not have experience with modern technology such as computers and is a little nervous about them. Uses a telephone with big buttons because of her bad sight and trembling hands.
3.2 Design of the Medication Management System

The Medication Management System is compiled of a software part and a written guides part. The software part contains the computerised programme as it is delivered on the laptop to a user. The written guides are the textual manuals that accompany the software part and guide the user during the medication management intervention.

To research the impact of different uses of media on the intake of medication, two variables were used in the software design: 1) a text variable and 2) an embodied conversational agent variable. These variables lead to two different designs of the MMS: a text version and a conversational agent version, see Figure 5. Both of these versions were accompanied by written guides.

![Figure 5. Overview of the Medication Management System](image)

The MMS was designed for use on a laptop, which was available during the experiments. Both of the versions of the MMS were designed with the notion that the design should be straightforward for the user and that there should be a minimum of visual distraction in the design. The system was developed using the software programme Adobe Flash Catalyst 5.
The following sections will give an in-depth discussion of the different versions of the software part of the MMS. First, a short introduction to both of the versions will be given which will be followed by an in-depth explanation of the content and topics handled in the MMS.

### 3.2.1 Text and Conversational Agent Versions

#### Text Version

The text version of the Medication Management System was designed with the idea that the use of it should be straightforward for the user. Therefore, the design has a focus on the use of text and not too many other visual counterparts were incorporated. This way it was clear for the elderly users which buttons they should click on to progress in the software system. For an example of a screen of the text version see Figure 6.

![Figure 6. Example of layout text version](image)

#### Conversational Agent Version

The conversational agent (for an explanation of a conversational agent see Chapter 2.2) version is based on text with a visual and auditory counterpart in the form of a talking and moving embodied conversational agent. The agent was designed with the help of software programme Smith Micro’s eFrontier Poser 8. The choice of a female conversational agent was made because the voice of the female researcher was used as the voice of the conversational agent.

The design has been made straightforward without too much detail to make it easily comprehensible for the elderly user. Only necessary visualisations such as buttons and the conversational agent are presented to the user. When someone achieved a certain goal, for example
taking their medication in time for the past two weeks, the conversational agent would smile. For an example of a screen of the conversational agent version used during the reminder segment, see Figure 7.

Figure 7. Example of layout conversational agent version

3.2.2 **Intake and Reminder Segments**

Both the text version and the conversational agent consist of two elements: the *intake* segment and the *reminder* segment. During the intake segment the user will answer questions and develop a personal action plan. During the reminder segment the user is reminded to take their medication.

*Intake segment*

The *intake* segment is composed of a total of 19 screens in which the user is ‘lead’ through the program with the help of an accompanied guide: The Diary (see Figure 8). By following the instructions on the screen they will proceed in the MMS by using the diary and conclude with constructing a personal action plan for their personal medication management goals. The complete guide and examples of the screens of the intake segment can be found in appendix A and is elaborated on in the next section.
The content of the intake segment

As stated earlier, the content of the intake segment for both the text version and the conversational agent version correspond to a large extent with each other and therefore also the ideas of discussing certain subjects. The conversational agent version was more social than the text version with statements such as ‘Good job!’ and having a sad expression on her face when someone forgot to take their medication. The author has chosen to give a description of the identical parts of both versions.

For the development of the diary and the dialogue on screen that was used during the intake segment, several Motivational Interviewing techniques linked to principles defined by Rollnick & Allison, 2004 were used (see Chapter 2.3):

The principle of expressing sympathy can be achieved by reflective listening. Reflective listening has been achieved in this design by summarising statements from the patient such as ‘Good. You say you have taken your medication in time for the past few weeks.’ or ‘You say that you did not take all your medication for the last few weeks’. When the conversational agent utters summarising statements, the patient will feel as if they are understood and that someone is listening and interested in what they are saying.

The principle of supporting self-efficacy can be achieved by trying to elicit affirmations from the patient. To achieve this, questions that were asked are for example ‘Why is it important for you to take your medication in time?’ or by asking how they achieved taken their medication in time in earlier times.

The principle of developing discrepancy can be achieved by exploring the personal values and future aspirations of the patient. In this design we achieved this by asking ‘In what way do you want
to improve regarding your medication adherence’ or ‘What kind of reward do you want to give yourself when you achieve your goal’.

Overall, open-ended questions can be used in a certain way that the patient ends up with providing motivational statements to change their behaviour. For example, asking what the reason was for not changing their behaviour could give them a negative feeling. Instead, asking how they could improve their medication intake puts a much more positive vibe to the question which leads to a positive answer and eventually a motivation to change.

The questions that have been asked during the intake segment reflected on the time period the patient took their medication without help from a medication aid. In short: their life without the intervention of the Medication Management System. The answers that were given by the participants were used to develop an action plan for their medication intake. It depended on the answer of the participant to which next question the system would proceed. A complete overview of the questions asked during the intake segment can be found in Appendix B. In this overview also the different options of proceeding to the next question during the intake segment are shown by question A and question B.

When all of the questions were answered, the Action Plan was filled with the previous given answers. This Action Plan was a part of the diary and was used to remind the participant about their goals during the experiments. This Action Plan comes including a list of questions for the participant to ask themselves during the development of the Action Plan. This list was composed of questions that gave examples of answers and tips in case the participant did not know how to answer a question. See Appendix C for the Action Plan.

The intake segment was aimed at 1) making the participant familiar with the agent, 2) the normalisation of non-adherence of medication, 3) gathering information about medication adherence, 4) exploration of the problem and 5) gathering information about how and in what way the patient takes their medication.

**Reminder segment**

The *reminder* segment plays the role of reminding the patient to take their medication in time. It consists of an audio alarm that goes off at set times, followed by several screens in which the patient is greeted and asked to take their medication, as well as look over their personal Action Plan. After the user has taken his or her medication, the reminder segment screen
automatically closes. The design of the first screen is adjusted, depending on the time of day (morning or evening) the patient has to take their medication. For example: when the medication intake moment takes place in the morning, a picture of sunrise is shown. For intake moments in the evening, a sunset is shown.

**Figure 9. Overview of the Reminder Segment**

**REMINDER SEGMENT**

<table>
<thead>
<tr>
<th>When:</th>
<th>At set medication intake times during the 2 experimental weeks using the text or conversational agent version</th>
</tr>
</thead>
<tbody>
<tr>
<td>What:</td>
<td>Alarm goes of and reminds patient to take their medication</td>
</tr>
<tr>
<td>Goal:</td>
<td>1. Reminding patient to take their medication in time</td>
</tr>
<tr>
<td></td>
<td>2. Reminding patient to look at their personal action plan</td>
</tr>
</tbody>
</table>

**Figure 10. Example of morning intake layout of the text version**

### 3.3 Alarm

The audio alarm that was developed, was made with the use of computer software called Apple Logic. It was kept in mind that the users, even the ones with less hearing, should be able to hear the alarm when it would go off. Therefore, the use of high frequency tones (e.g. above 8 kHz) was prohibited.
4 Research Methods

The experimental design is discussed in this chapter. This chapter will describe the participants in the experiment, the setting of the experiment, the materials used, the design of the experiment and the procedure.

4.1 Participants

Approximately a hundred individuals were contacted to participate in this experiment. From these contacted persons, thirteen participants were recruited for the actual experiment. One of the participants did not follow the instructions given by the researcher correctly so the data corresponding to this participant was not used for the evaluation of this study. The data of twelve of the participants was used to evaluate the research questions of which four were male (\(M \text{ age} = 72.5, SD = 8.2\)) and eight were female (\(M \text{ age} = 70.9, SD = 6.9\)). The participants ranged in age from 65 to 85 and all lived independently\(^1\) with their spouse, family, a friend or on their own. This group of participants consisted of generally active adults, not limited by physical impairments and with no big problems relating to their medication intake. Due to difficulties with finding elderly that had medication adherence problems (elderly living in care homes are generally known as the biggest group with medication adherence problems but fall under the responsibility of the care home) we choose to conduct the experiment with a group of elderly that had minor problems with medication intake.

All of the participants had to take medication for their health problems. The level of dependence on their medication varied between the participants. Some of the participants had to take medications for heart problems and had to take their medication at strict times for their physical wellbeing. Participants were recruited via person-to-person contact and via via and were compensated with a gift certificate of €25 upon completion of the study.

The efficiency of most medication is positively influenced by taking it at a particular set time for every medication intake moment. A side note that has to be taken in account is that this depends on the particular medicine and if the patient is on other medicine regimens. This fact was presented to and acknowledged by the participants and they indicated to prefer to take the medicine at a set time. However, because of their age they sometimes forgot to take their medication and needed help with taking their medication at the correct time.

\(^1\) Independently means that they were not living at a care home or dependent on a caregiver.
Four participants had to take their medicine once a day (33%). Eight of the participants had to take their medicine twice a day (67%). The intake moments were situated in the morning or in the evening or both. All of the participants indicated that in the past they did at least once forgot to take their medication.

All the participants participated on a voluntary basis and gave permission for the use of the experimental data for research and educational purposes by signing the consent form before the tests were started. The participants were randomly assigned to groups A and B and participated in both MMS versions.

4.2 Experimental Setting

The experiments, including the questionnaires and interviews, were carried out at the participants’ homes. This was to ensure a familiar setting for the participants and to make certain there was the least of influence on their medication intake. A prerequisite of the experiment was that it had to interfere as little as possible with the daily lives of the participants.

Before the experiment started the participants were asked to fill in a form in which they were asked to answer a few personalia questions, how many pills they had to take and when and five questions about their medication use and living conditions

4.3 Stages in the experiment

The experiment and data collection consisted of four stages (see Figure 11):

1) The exploratory pre-questionnaire and ‘no intervention’ weeks,

2) the medication management intervention text version concluding with a questionnaire,

3) the medication management intervention conversational agent version concluding with a questionnaire, and finally

4) an interview with the participant.
Figure 11. Experimental stages
The order of the medication management interventions depended on which the group (A or B) the participant belonged to. The discussion of the experimental design will be divided into the above mentioned stages, stage 2 and 3 will be combined.

### 4.3.1 Stage 1: Exploratory Questionnaire and No Intervention

This stage was composed of an exploratory questionnaire and two weeks of the use of a medication dispenser and no intervention by the MMS.

**Materials used**

An exploratory pre-questionnaire was conducted and offered on paper. The goal of this questionnaire was to explore the motivations for taking medication and the degree of self-efficacy of the participant. The questions asked in the pre-questionnaire can be found in Appendix D.

To be able to analyse their medication intake without intervention of the MMS compared to their medication intake with the MMS a medication dispenser was given to the participants. In this medication dispenser they could divide their medication for a week. Because of the frailty of the participants not every one used this dispenser for the storage of their pills. The handling of the dispenser, in particular the opening of the medication case within the dispenser, appeared to be difficult. Also, the medication dispenser had no option to divide the medication in a morning intake and an evening intake which was inconvenient for those participants that had two intake moments. The participants that did not use the dispenser for the storage of their medication did however open the dispenser at the times they had to take their medication. According to Maclaughlin (2005) no single method for gathering data is sufficiently reliable and accurate, therefore the participants also kept track of their own medication intake by filling in a medication planner. For each of the times they had to take their medication they would cross off if they took their medication, forgot it, did not take it because they were not at home or took it later that the actual time they had to take it.

**Design**

The exploratory pre-questionnaire consisted of five questions about their medication use. All of the questionnaires used during this study were in the Dutch language to make sure the participants understood the questions.

Topics that were discussed in the questionnaire were of the following: a) self-efficacy b) their motivation to take their medication and reasons for forgetting them.
a) Self-efficacy

The topic of self-efficacy was included in the pre-questionnaire to measure the confidence that someone had in being able to take their medication at the correct time. This topic was included to be able to investigate if their self-efficacy was of influence on taking their medication and if their self-efficacy was influenced by taking part in the experiment.

b) Motivations

The motivations or reasons of the participants for taking their medication were included to measure their willingness to take their medicine. For example, if a participant is not sure their medication is beneficial for their health this could influence their intake of their medication and therefore also the outcome of the experiment. Also, the different reasons for forgetting to take their medication were explored.

Procedure

The researcher asked the participants to answer the questionnaire at the familiar environment of their homes. The researcher was available for questions when something was not clear. This was done to make sure that there was as little as possible interference with the real life conditions. The remainder of the no intervention weeks the participants used the medication dispenser when it was time to take their medication.

Analysis

The data from the pre-questionnaire is used to evaluate if the participants were confident about taking their medication on time. Also, reasons for not taking medication were explored.

4.3.2 Stages 2 & 3: Medication Adherence

In these stages the MMS was introduced and the medication adherence of the participants was explored through the use of this MMS.

Materials used

For Stages 2 and 3 a computerised version of the Medication Management System presented in Chapter 3 was used. The system was offered through software on a Dell laptop with or without a computer mouse (whichever the participant preferred, the trackpad or mouse) to enable the use of
the software programme and was accompanied by the written guide. Because not all of the elderly were computer-savvy, instructions on how to use the laptop were given on paper. Besides this laptop the participants made use of a medication dispenser in which they could keep their medicine and keep track of their medicine intake (see stage 1 on the preceding page for an explanation about the medication dispenser). During the reminder segment the participants were able to use the Action Plan that was compiled during the intake segment. During these weeks the participants filled in their medication planner as they did in the previous weeks (see stage 1 for an detailed explanation of the medication planner) When an experiment week was concluded the participants were expected to fill in a questionnaire composed of questions about the past week.

**Design**

For a detailed description of the design choices for the MMS, see Chapter 3. The questionnaire that was conducted after each experimental week (text version or conversational agent version) was composed of nineteen questions about the participants’ self-efficacy, their impression of the MMS, (possible) improvements of their medication intake and their experience with computers. This questionnaire consisted of ten point scale questions in which the participant had the option to share in the degree they agreed or disagreed with the statement. The choice for scales was made to be able to measure the opinion and to compare answers for the different versions. Two closed questions were asked in which they had to answer with ‘yes’ or ‘no’ and the degree (four options) in which they were certain of the statement. For a detailed description of the questionnaire see Appendix E.

**Procedure**

The experiments were conducted at the homes of the participants to make sure that the experiment would be influenced as little as possible by a new environment. The researcher was present and available for questions at the introduction phase. Depending on the group the participant belonged to they would begin with the text version or the conversational agent version and the second week they would use the other version. At the beginning of the experimental week the intake segment would take place in which the participant was asked questions by the MMS which were used to develop a personal Action Plan. The participant noted down the answers to the dialogue on paper. During the experimental week the reminder segment would take place in which an audio reminder would go off at set times to remind the participant to take their medication. This audio reminder was then followed by a dialogue.
During their medication intake the participant opened the medication dispenser and the dispenser sent an alert to the server. The researcher would subsequently download the dispenser data from the server via an online website. Concluding each week of the different MMS versions a questionnaire was conducted on paper. The researcher was present if any questions should arise. The experiments were carried out with the use of a laptop that was situated in the living room or bedroom of the participant. Also, a medication dispenser was given to the participants that they kept near the computer or in the kitchen or bathroom were they normally would take their medicine.

Analysis

Within-group comparisons were evaluated with between no intervention and text and between no intervention and conversational agent. The dependent variable was medication adherence and the independent variable was the Medication Management System. We measured adherence as the deviation (expressed in seconds) from the required intake moment. Both of the no intervention weeks were independently tested against the two versions using a multiple comparison test for significant differences of the mean deviation times.

The data from the questionnaires have been used to evaluate if the participants were confident about taking their medication on time with the use of the MMS text or conversational agent version.

Our research questions were if the use of an MMS would be effective for improving the medication intake of elderly and if there was a difference between the text and conversational agent condition. Also the personal opinion of the participants if the MMS improved their medication intake were explored.

4.3.3 Stage 4: Interview

Stage 4 was a concluding stage in which the participants were asked their opinion on the MMS during an interview.

Materials used

With the consent of the participants a recording device was used to record the interviews. Paper was used to note particularly interesting statements.

Design
The interview started with a general question if they enjoyed the use of the MMS and thought it could help them. During the interview the participants were encouraged to come up with their own opinions, questions and other subjects that arose during the experiment.

**Procedure**

The interview was conducted at the homes of the participants. If something was not clear they could ask the researcher. Interviews were conducted with the participants about the MMS and both of the versions of the MMS to obtain qualitative feedback on the system and their experience with it. Overall impressions were positive.
5 Results

In this chapter the results of the analysis will be discussed to be able to answer the research questions. The first section presents the results of the exploratory questionnaire during Stage 1, section two will discuss the results from the medication management intervention for all of the conditions: no intervention week 1, no intervention week 2, text version intervention and conversational agent version intervention. Also, the results from the questionnaires will be discussed. The last section will discuss the results from the interview that was conducted with the participants.

Of the thirteen participants who started the study, twelve completed the study by following the instructions of the experiment. One participant did not follow up the instructions correctly so the data corresponding with this participant was not used for the data evaluation. Participants were randomly assigned to the two conditions and participated in all of the conditions.

Results from the exploratory questionnaire

Of all the participants, four of the participants were a bit sure that they were able to take their medication at the right times, six of them were sure and two were really sure. This was all without the intervention of a medication management system. The three reasons for not taking or forgetting to take their medication that occurred the most (in no particular order) were that the participant in question was not at home, they were too busy and forgot or had a change in their routine.

Results from the medication management intervention

The data appeared not to be normally distributed, therefore a Wilcoxon Rank Sum test was used to compare the deviations of the required medicine intake time (seconds) for the no intervention condition and text and conversational agent conditions. The results from the multiple comparison test combined with the Wilcoxon Rank Sum test showed a significant difference \( (p < 0.01) \) between the intake time for the second week of the no intervention condition \( (Mdn = 366) \) and the conversational agent version \( (Mdn = 193) \), only. The mean of the deviation of the required medicine intake for the no intervention condition for week two was 822 (seconds) and for the conversational agent condition 367 (seconds).
The questionnaires provided us with the opinions of the participants. Of all the participants, one of the participants was a *bit sure* they were able to take their medication at the right times with the text version of the MMS, five of them were *sure* and six were *really sure*. For the conversational agent eight of the participants were *sure* and four of them were *really sure*.

A ten points scale was used to measure if the participants thought their medication intake was improved by using the MMS. The users of the conversational agent version rated this version higher ($M = 7.8$, $SD = 2.04$) than the users of the text version ($M = 7.2$, $SD = 2.10$). Given the limited number of participants and the relatively large standard deviations, we cannot assess reliably if the difference in rating is significant.

**Results from the interviews with the participants**

All of the participants were positive about the medication management system. They found the program itself easy to use and clear to understand.
6 Discussion

Every year a great amount of money is spent on medical care that could be prevented by improving the medication intake of individuals (Sokol, Kimberly, McGuigan, Verbrugge, & Epstein, 2005; Balkrishnan, Rajagopalan, Camacho, Huston, Murray, & Anderson, 2003). Not only a reduction in health care costs is necessary but also the improvement of the health of the world population. Therefore, a medication management intervention is needed. To cater this need, a platform for developing a Medication Management System has been provided in this study. Several design factors have been provided that have to be taken into account while developing such a system. Examples of these design factors are the use of persona’s, the use of an embodied conversational agent with different modalities such as dialogues, video and speech, the use of text and the use of Motivational Interviewing for persuading users to follow the instructions of the MMS.

This study has several outcomes, namely the MMS itself and the results of the evaluation of the MMS. The outcomes clearly suggest that the use of an MMS has a positive influence on the medication intake of the elderly. Data analysis showed a significant effect for the conversational agent versus the second week of the no intervention condition. This can be interpreted in the following manner: by using the conversational agent version, the participant will take less time to take their medication. Also, the chance of forgetting medication decreases in comparison to when there was no intervention by the MMS. The conversational agent version improves the medication intake of the elderly and persuades them to take it on time. Data from the text version suggests a trend when using a MMS, medication adherence can be improved.

Data from the questionnaires and interviews are in line with the results from the quantitative analysis. Participants stated the conversational agent version as more effective than the text version. Overall, they were very enthusiastic about the intervention of a MMS to help them with their medication intake which could be concluded from the interviews.

The study had several limitations that should be kept in mind while interpreting the results. It should be noted that the total number of participants to this study was small. Because of this small research population, this study should be regarded as a pilot study. Also, the participants did not have any big problems with their medication intake beforehand. There were some problems with the
hardware such as the medication dispenser that did not record some of the intake occurrences. These data points were subsequently regarded as missing values. Regarding the design choices of the MMS, the size of the text used could be of influence. Different text sizes were used between the two versions because of the amount of space that was available. In the text version a bigger size text was used and in the conversational agent version smaller text because of the limited amount of space with the ECA next to it. This could be of possible influence on the perception of the users regarding the use of the system because of less vision in the elderly. This study should be regarded as a pilot study and further evaluations are needed on the use of a MMS.
Conclusion and future work

In our study we have made explicit the design of a Medication Management System to motivate people to take their medication at the correct times and evaluated this MMS with the use of an pilot experiment. To our knowing this is the first study in which a MMS has been developed with the use of Motivational Interviewing and an Embodied Conversational Agent for the improvement of medication adherence. We presented a platform for the design, development and the evaluation of such a medication management system to use in research.

The aim of this MMS is to improve the medication adherence of patients, specifically with the elderly. This population group is the most prone to medication non-adherence because it is less easily detected than in younger population groups. It is commonly known that the health of the elderly can be improved by the elderly taking their medication on time. Also, admissions to health care facilities can be reduced by improving medication adherence which leads to a decrease in the amount of money that each year is spent by governments on health care.

Analysis of the data showed that the use of a MMS can be of positive influence on the medication adherence in the elderly. Especially the use of an embodied conversational agent in combination with Motivational Interviewing presents the greatest improvements in the medication adherence of elderly. The opinion of the participants in this study is in line with these results and the participants preferred the conversational agent version over the text version. They prefer to use a MMS to help them with their medication management in every day life. Overall, the implication that can be derived from this study is that a MMS can be very helpful with adhering to a specific medication regimen. The study also showed that people are willing to engage in a dialogue with a computer system.

As stated earlier, given that this is a pilot study, further research is needed to evaluate the impact of a MMS with different conditions on medication adherence. There are several directions that this research could be advanced in future work. For example, the development of an intelligent agent that uses relational information given by the user during conversations. The area of natural language processing could be of specific help by developing a more intelligent agent. Interesting to research is how speech can be recognised and how information given by the user can be processed. The development of a conversational agent that can refer to prior conversations could be of
particular interest. By referring to prior given information the agent could build a relationship with the user. Regarding our research this could help with engaging the user to use the system and be even more motivated on a social level. Elderly are often lonely and having the idea of a friend which they could talk with could alleviate this feeling.

In the field of artificial intelligence future research could expand this MMS by having a embodied conversational agent that recognises human expressions and anticipates on that information by for example expressing empathy through facial expressions. A system that uses RFID tags could be very helpful to measure if the medication is actually taken.

A recommendation for commercial businesses while looking at recent developments in the mobile application business is to develop such a MMS for use on a tablet device or mobile device so that the system is mobile and the user can take it with them. This is particularly convenient for people that travel a lot and are dependent of their medication. This mobile application could then be used as some sort of buddy.

Overall it would be of interest to research if the use of a male or female embodied conversational agent could be of influence on medication adherence. To expand this idea even more, the effects should be measured for female participants and male participants. Also, different pitched voices could be used to see if this is of any influence on medication adherence.
References


Appendix A

Example screens from intake text version

---

**Mijn Medicatie Inname**

Deze applicatie gaat u helpen met het innemen van uw medicijnen.
Om een *persoonlijk actieplan* te maken, is het belangrijk om te weten hoe u met uw medicatie omgaat.

![Screen 1](image1.png)

**Mijn Medicatie Inname**

Hoeveel procent van uw medicatie heeft u ingenomen de *eerste twee weken* van dit onderzoek? Dit zijn de twee weken met de elektronische pillendoos.

- [ ] 0%, geen medicatie
- [ ] 25%, kwart medicatie
- [ ] 50%, helft medicatie
- [ ] 75%, bijna alle medicatie
- [ ] 100%, alle medicatie

---
Example screens from intake conversational agent version

1. Hallo, ik ben Anna. Aangenaam kennis met u te maken.
   
   - OPNIEUW
   - VERDER

2. Ik wil u graag helpen, met het innemen van uw medicijnen. Om een persoonlijk actieplan te maken, is het belangrijk dat ik weet hoe u met uw medicatie omgaat.
   
   - OPNIEUW
   - VERDER
Mijn Medicatie Inname

Vergeet niet om uw antwoorden op de vragen altijd eerst op te schrijven in de bijgeleverde diary voordat u verder gaat.

OPNIEUW

VERDER

Mijn Medicatie Inname

Hoeveel procent van uw medicatie heeft u ingenomen de twee weken dat u alleen gebruik maakte van de elektronische pillendoos?

OPNIEUW

- 0%, geen medicatie
- 25%, kwart medicatie
- 50%, helft medicatie
- 75%, bijna alle medicatie
- 100%, alle medicatie
U zegt dat u uw medicatie niet altijd heeft ingenomen de laatste twee weken. Wat is de voornaamste reden voor het niet altijd innemen van uw medicatie?

U kunt deze vraag beantwoorden in uw diary.

OPNIEUW
VERDER

Goed zo. We zijn al een heel stuk verder. Ik ga u nu nog een paar vragen stellen om zo uw persoonlijke actieplan compleet te maken. Mocht u moeite hebben met het beantwoorden van de vragen, maak dan gebruik van het hulpmiddel op pagina 4 van uw actieplan.

OPNIEUW
VERDER
Mijn Medicatie Inname

Op de dagen dat u _niet vergeet_ uw medicatie in te nemen, wat zorgt ervoor dat u het niet vergeet?

OPNIEUW
VERDER

Mijn Medicatie Inname

Goedzo! We hebben nu uw persoonlijke actieplan gemaakt. Het lijkt mij _een goed idee_ als u af en toe het actieplan nog even doorneemt. Zo kunt u uw doel goed voor ogen houden.

OPNIEUW
EINDE

Druk de toetsen ALT - F4 tegelijkertijd in (dat zijn de toetsen met de rode sticker)
Deze applicatie gaat u helpen met het innemen van uw medicijnen. Om een persoonlijk actieplan te maken, is het belangrijk om te weten hoe u met uw medicatie omgaat. Druk op de knop ‘VERDER’

Vergeet niet om uw antwoorden op de vragen altijd eerst op te schrijven in de bijgeleverde diary. Druk op de knop ‘VERDER’

Hoeveel procent van uw medicatie heeft u ingenomen de eerste twee weken van dit onderzoek? Dit zijn de twee weken met de pillendoos.

- 0%, geen medicatie (ga naar vraag 4a)
- 25%, kwart medicatie (ga naar vraag 4a)
- 50%, helft medicatie (ga naar vraag 4a)
- 75%, bijna alle medicatie (ga naar vraag 4a)
- 100%, alle medicatie (ga naar vraag 4b)

U zegt dat u uw medicatie niet altijd heeft ingenomen de laatste twee weken. Wat is de voornaamste reden voor het niet altijd innemen van uw medicatie?

Ga door naar vraag 5
Goed zo. U bent geen enkele keer vergeten uw medicatie in te nemen de laatste twee weken.

Kunt u terugdenken aan een moment dat u wel vergeten bent uw medicatie in te nemen? Probeer daarna de vraag te beantwoorden.

Wat is de voornaamste reden van het vergeten in te nemen van uw medicatie?

Het is wellicht een goed idee om de redenen van het vergeten in te nemen van uw medicatie te bespreken met uw arts en vrienden en familie. Zij kunnen u ondersteuning bieden bij het innemen van uw medicatie.

Goed zo. U bent al een heel stuk verder. Er komen nu nog een paar vragen om uw persoonlijke actieplan compleet te maken. Mocht u moeite hebben met het beantwoorden van de vragen, maak dan gebruik van het hulpmiddel op pagina 4 van uw actieplan.

Druk op de knop ‘VERDER’
| 7 | Pakt u uw actieplan er even bij? |
|   | De eerste vraag is: |
|   | Waarom is het voor u persoonlijk belangrijk om uw medicijnen in te nemen? |
|   | Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN. |
| 8 | Wat wilt u verbeteren op het gebied van uw medicatie inname en is haalbaar? |
|   | Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN. |
| 9 | Wat is uw doel voor de komende week op het gebied van medicatie inname? |
|   | Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN. |
| 10 | Welke stappen gaat u ondernemen om uw doel te bereiken? |
|   | En wanneer gaat u deze stappen ondernemen? |
|   | Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN. |
| 11 | Welke factoren kunnen volgens u van negatieve invloed zijn op het bereiken van uw doel? |
|   | Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN. |
| 12 | Kunt u manieren bedenken om de invloed van deze factoren te verkleinen? |
| 13 | Op de dagen dat u niet vergeet uw medicatie in te nemen, wat zorgt ervoor dat u het niet vergeet? |
| 14 | Wanneer u vroeger iets belangrijks moest onthouden, hoe deed u dat dan? Bijvoorbeeld een ezelsbruggetje, het ergens opschrijven. Misschien kunt u deze methode ook gebruiken om uw medicatie niet te vergeten. |
| 15 | Wat voor beloning geeft u uzelf als u het net vastgestelde doel behaald heeft? |
Goed zo. Uw persoonlijke actieplan is nu gemaakt. Het is een goed idee om dit actieplan af en toe nog door te nemen, zo kunt u uw doel goed voor ogen houden.

Dit is het einde van de sessie. U kunt nu op het kruisje in de rechterbovenhoek klikken van het venster dat is afgebeeld op de laptop.
Hallo, ik ben Anna. Aangenaam kennis met u te maken.

Druk op de knop ‘VERDER’

Ik wil u graag helpen, met het innemen van uw medicijnen. Om een persoonlijk actieplan te maken, is het belangrijk dat ik weet hoe u met uw medicatie omgaat.

Druk op de knop ‘VERDER’

Vergeet niet om uw antwoorden op de vragen altijd eerst op te schrijven in de bijgeleverde diary.

Druk op de knop ‘VERDER’

Ik heb begrepen dat u wel eens vergeten bent uw medicijnen in te nemen.

Druk op de knop ‘VERDER’
Hoeveel procent van uw medicatie heeft u ingenomen de **twee** weken dat u alleen gebruik maakte van de elektronische pillendoos?

---

6a

U zegt dat u uw medicatie niet altijd heeft ingenomen de laatste twee weken. Wat is de **voornaamste reden** voor het niet altijd innemen van uw medicatie?

U kunt deze vraag beantwoorden in uw diary.

---

6b

Goedzo! U bent geen enkele keer vergeten uw medicatie in te nemen de laatste 2 weken!

Kunt u terugdenken aan een moment dat u wel vergeten bent uw medicatie in te nemen? Probeer daarna de vraag te beantwoorden.

Wat is de **voornaamste reden** van het vergeten in te nemen van uw medicatie?

---

7

Het is wellicht een goed idee om de redenen van het vergeten in te nemen van uw medicatie te bespreken met uw **arts** en **vrienden** en **familie**.

Zij kunnen u ondersteuning bieden bij het innemen van uw medicatie.

---

Ga door naar vraag 7

---

Druk op de knop ‘**VERDER**’
8 Druk op de knop ‘VERDER’

9 Pakt u uw actieplan er even bij?
   De eerste vraag is:
   Waarom is het voor u persoonlijk belangrijk om uw medicijnen in te nemen?

10 Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN.

11 Wat wilt u verbeteren op het gebied van uw medicatie inname en is haalbaar?

Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN.

11 Wat is uw doel voor de komende week op het gebied van medicatie inname?

Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN.
12. Welke stappen gaat u ondernemen om uw doel te bereiken?
   En wanneer gaat u deze stappen ondernemen?

13. Welke factoren kunnen volgens u van negatieve invloed zijn op het bereiken van uw doel?

14. Kunt u manieren bedenken om de invloed van deze factoren te verkleinen?

15. Op de dagen dat u niet vergeet uw medicatie in te nemen, wat zorgt ervoor dat u het niet vergeet?
Wanneer u vroeger iets belangrijks moest onthouden, hoe deed u dat dan? Bijvoorbeeld een ezelsbruggetje, het ergens opschrijven. Misschien kunt u deze methode ook gebruiken om uw medicatie niet te vergeten!

Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN.

Wat voor beloning geeft u uzelf als u het net vastgestelde doel behaald heeft?

Noteer het antwoord op deze vraag in uw persoonlijke ACTIEPLAN.

Goedzo! We hebben nu uw persoonlijke actieplan gemaakt. Het lijkt mij een goed idee als u af en toe het actieplan nog even doorneemt. Zo kunt u uw doel goed voor ogen houden.

Dit is het einde van de sessie. U kunt nu op het kruisje in de rechterbovenhoek klikken van het venster dat is afgebeeld op de laptop.
Appendix B

Questions asked for constructing the diary and the response of the MMS were the following:

1) How much of your medication did you take the two weeks prior to the use of the electronic medication box (in percentages)?
   a. You say you did not take all of your medication the last two weeks. What is the most common reason of you not taking your medication?
   b. Good job, you did not forget to take your medication in the previous two weeks. Could you think of a moment that you did forget your medication? What was the common reason for you to forget taking your medication?

It is maybe a good idea to discuss the reasons of forgetting your medication with your doctor and friends and family. They could support you with the management of your medication.

Good job, we have progressed a great deal.

Questions proposed to the participant with the goal of developing the personal action plan were the following:

2) Why is it important for me to take my medication?
3) In what way do I want to improve regarding my medication intake and is achievable?
4) My personal goal for the next weeks regarding my medication intake is..?
5) Which steps am I going to take to reach this goal and when (time period)?
6) When and with what activity do I want to connect these steps?
7) Which factors could be of negative influence on reaching my goal(s)?
8) My ways for diminishing the influence of these possible factors?
9) The days that I do not forget to take my medication, what makes sure that I do not forget to take them?
10) In former days, when I had to remember something important, how would I do that?
11) My reward if I reach my goal.
Appendix C
Example of an action plan.

Mijn persoonlijke actieplan

Naam: ________________________

1. Waarom is het voor mij persoonlijk belangrijk om mijn medicijnen in te nemen?
   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________

2. Wat wil ik verbeteren op het gebied van mijn medicatie inname en is haalbaar:
   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________

3. Mijn doel voor de komende week op het gebied van mijn medicatieinname is:
   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________

4. Welke stappen ik ga ondernemen om dit doel te bereiken en wanneer:
   ______________________________________________________________________
   ______________________________________________________________________
   ______________________________________________________________________
<table>
<thead>
<tr>
<th>Doel</th>
<th>Welke stappen onderneem ik om dit doel te behalen</th>
<th>Wanneer en aan welke bezigheid koppel ik deze stappen</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Welke factoren kunnen van negatieve invloed zijn op het bereiken van dit doel:

__________________________________________________________

__________________________________________________________

__________________________________________________________

6. Mijn manieren om de invloed van deze mogelijke factoren te verkleinen:

__________________________________________________________

__________________________________________________________

__________________________________________________________

7. Op de dagen dat ik niet vergeet mijn medicatie in te nemen, wat zorgt ervoor dat ik het niet vergeet?

__________________________________________________________

__________________________________________________________

__________________________________________________________

8. Wanneer ik vroeger iets belangrijks moest onthouden, hoe deed ik dat dan?

__________________________________________________________

__________________________________________________________

__________________________________________________________

9. Beloning als ik mijn doel behaald heb:

__________________________________________________________

__________________________________________________________

__________________________________________________________
Hulpmiddel actieplan

De volgende vragen kunnen u helpen bij het beantwoorden van de actieplanvragen. Deze vragen kunnen u helpen om verder na te denken over de situatie.

- Wat is de situatie? Bijvoorbeeld: 'Ik vergeet mijn medicatie op tijd in te nemen.'

- Hoe voelt iets? Bijvoorbeeld: 'Ik vind het vervelend.' 'Ik ben teleurgesteld.'


- Wie heeft er invloed op/heeft er een rol in? Bijvoorbeeld: ‘Ik heb de meeste invloed op het op tijd innemen van mijn medicatie maar mijn partner probeert mij ook weleens te helpen.’

- Wat zorgt ervoor dat het voorkomt? Bijvoorbeeld: ‘Ik heb het erg druk.’

- Wat is het gevolg van de situatie? Bijvoorbeeld: 'Ik voel me lichamelijk en geestelijk slechter, ten eerste omdat mijn lichaam de medicijnen nodig heeft om goed te functioneren en geestelijk omdat ik teleurgesteld ben dat ik het vergeten ben.'
<table>
<thead>
<tr>
<th>ACTIEPLAN OVERZICHT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Waarom het voor mij belangrijk is mijn medicijnen in te nemen (vraag 1)</strong></td>
</tr>
<tr>
<td><strong>Doel komende week (vraag 3)</strong></td>
</tr>
<tr>
<td><strong>Stappen die ik ga ondernemen om dit doel te behalen (vraag 4)</strong></td>
</tr>
<tr>
<td><strong>Wanneer ga ik dit doen (tabel vraag 4)</strong></td>
</tr>
<tr>
<td><strong>Wat zorgt ervoor dat ik mijn medicatie niet vergeet in te nemen (vraag 7 &amp; 8)</strong></td>
</tr>
<tr>
<td><strong>Beloning voor mijzelf (vraag 9)</strong></td>
</tr>
</tbody>
</table>
Appendix D
Pre-questionnaire

1. Hoe zeker bent u:
   a) Dat u in staat bent om uw medicatie op de juiste tijden in te nemen?
      niet zeker / een beetje zeker / zeker / heel zeker
   b) Dat uw medicatie goed is voor uw gezondheid?
      niet zeker / een beetje zeker / zeker / heel zeker

2. In hoeverre herinnert uw omgeving (vrienden en familie) u eraan om uw medicijnen in te nemen?
   helemaal niet / af en toe / regelmatig / altijd

3. In hoeverre bent u tevreden met de medicijnen die uw arts voorgeschreven heeft?
   helemaal niet tevreden / een beetje tevreden / tevreden / heel erg tevreden

4. Welke van de volgende redenen komen overeen met de redenen dat u wel eens vergeten bent uw medicijnen in te nemen? Kruis de drie meest voorkomende aan en noteer de getallen 1 t/m 3 achter de reden, met 1 als meest voorkomende reden.
   - Ik was niet thuis
   - Druk met andere bezigheden
   - Teveel pillen die ik in moet nemen
   - Bang voor bijwerkingen
   - Een verandering in mijn dagelijkse routine
   - Anders..
## Appendix E

*Questionnaire about the experimental week.*

### 1. Hoe zeker bent u dat u in staat bent om met het computerprogramma dat u de afgelopen week getest heeft uw medicatie op de juiste tijden in te nemen?

Niet zeker | Een beetje zeker | Zeker | Heel zeker
--- | --- | --- | ---

### Vragenlijst week .., versie .. – Deze vragenlijst gaat alleen over de afgelopen week

2. Vindt u dat het juist innemen van uw medicatie de afgelopen week verbeterd is ten opzichte van uw medicatie inname voordat u met dit onderzoek meedeed?

ONEENS 1 2 3 4 5 6 7 8 9 10 EENS

3. Als u de afgelopen week vergelijkt met de eerste twee weken van het onderzoek met enkel de elektronische pillendoos, heeft u de afgelopen week uw medicatie dan vaker op dezelfde tijd ingenomen?

ONEENS 1 2 3 4 5 6 7 8 9 10 EENS

*De volgende vragen gaan over de communicatie met het Medicatie Inname computerprogramma en niet over het gebruik van de laptop of de elektronische pillendoos. Geef voor iedere stelling aan in hoeverre u het eens bent met de stelling.*

4. Ik ben tevreden over hoe eenvoudig het is om het Medicatie Inname programma te gebruiken.

ONEENS 1 2 3 4 5 6 7 8 9 10 EENS

COMMENTAAR:

5. Het programma was overzichtelijk en het was duidelijk wat de bedoeling was.

ONEENS 1 2 3 4 5 6 7 8 9 10 EENS

COMMENTAAR:

6. Het programma doet wat ik ervan verwacht had. (Bij commentaar kunt u beschrijven wat u er vooraf van verwacht had.)

ONEENS 1 2 3 4 5 6 7 8 9 10 EENS

COMMENTAAR:

7. Het programma motiveerde mij om mijn medicatie op tijd in te nemen.

ONEENS 1 2 3 4 5 6 7 8 9 10 EENS

COMMENTAAR:

8. Het programma helpt mij bij het op tijd innemen van mijn medicijnen.

ONEENS 1 2 3 4 5 6 7 8 9 10 EENS

COMMENTAAR:

*De volgende vragen gaan over de inhoud van het systeem, dus het actieplan dat gemaakt is en de dialogen die zich afspeelden op het scherm.*

---

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9. Het was voor mij duidelijk wat er met de vragen bedoeld werd bij het maken van mijn actieplan aan het begin van de week. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS
COMMENTAAR:

10. Ik vond het handig om een actieplan voor de week tot mijn beschikking te hebben. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS
COMMENTAAR:

11. Het actieplan bood mij ondersteuning bij het innemen van mijn medicatie gedurende de week. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS
COMMENTAAR:

12. Ik heb het actieplan in de loop van de week nog eens doorgekeken. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS
COMMENTAAR:

13. Het gebruik van het actieplan motiveerde mij om mijn medicatie op tijd in te nemen. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS
COMMENTAAR:

14. Het was voor mij duidelijk wat ik moest doen aan de hand van de instructies op het scherm tijdens mijn innamemomenten. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS
COMMENTAAR:

15. De dialogen van het programma zijn persoonlijk/sociaal. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS
COMMENTAAR:

De volgende vragen gaan over het gebruik van de laptop.

16. Ik heb zelf een computer thuis die ik regelmatig gebruik. 
JA/NEE

17. Het is voor mij makkelijk om met een computer om te gaan. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS

18. Ik was onzeker over het gebruik van de laptop tijdens het onderzoek. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS

19. Ik vond het vervelend om gebruik te maken van de laptop. 
ONEENS 1 2 3 4 5 6 7 8 9 10 EENS
COMMENTAAR: