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"How to develop physical activity programs for elderly to facilitate their motivation to follow physical activity recommendations?"

A Social Determination Theory – based approach

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Abstract

Background: A decline of functional ability is often associated with increasing age. To maintain physical functioning, physical activity is a solution. Despite the physical, social and mental health benefits that physical activity provides for elderly, many elderly do not act according to the recommended guideline.

Objective: The aim of the present study is to develop a prototype that facilitates the motivation to be physically active and to follow physical activity recommendations. Based on the literature, the self – determination theory (SDT) is identified as a suitable framework for the development of a physical activity program.

Method: The study was conducted in three phases. First, semi - structured interviews were held with 14 German elderly to get a better understanding of the determinants of physical activity behavior of the respondents and user requirements for the prototypes. Then, the information gathered from the first phase was translated into functional requirements of the prototype in combination with high SDT components in one prototype and low SDT components in another prototype. To evaluate the two prototypes, a usability study in a cross – over design with German 10 elderly was carried out.

Results: The system usability score for the prototypes were good and showed that the interface design is appreciated by the elderly in the sample. 9 from 10 respondents preferred the SDT (+) prototype over the SDT (–) prototype. Autonomy – supportive features like having multiple choices were evaluated extremely positively by the respondents. There were mixed results for the strategy of guilt – inducing language in the SDT (-) prototype. Some respondents pointed out that the guilt – inducing message about the risk of inactivity was perceived motivating, but only in combination with positive feedback. In this study, the competence component seemed to have the most decisive contribution. Practical guidance is one of the main factors to choose for the SDT (+) prototype. The feature of collecting stars is mainly positively valued and is described as a feature that enhances the interactivity of the program and the motivation use to use the program to be physically active. The results of this study showed that the relatedness – supportive strategy praise can be useful when developing a physical activity program.

Conclusion: This study provided a first approach on how a prototype could be built on SDT principles. This study showed that preferences were not always consistent with empirical evidence. The results could be a useful guideline to adapt the technology and to develop a physical activity program for elderly that meet their needs.

Samenvatting

Achtergrond: Een functionele achteruitgang is vaak geassocieerd met toenemende leeftijd. Om fysieke werking te ondersteunen is lichamelijke activiteit een oplossing. Ondanks de fysieke, sociale en mentale gezondheid, gaan ouderen niet de aanbevolen richtlijnen volgen.

Doel: Het doel van dit onderzoek was het ontwikkelen van een prototype dat de motivatie verhoogd om fysiek actief te zijn en adviezen met betrekking tot lichamelijke activiteiten te volgen. Volgens literatuur is de 'Self-determination theory (SDT)' een passende raamwerk voor de ontwikkeling van een lichamelijke activiteits program.

Methode: De studie was opgedeeld in drie verschillende fasen. Ten eerste worden semi - gestructureerde interviews met 14 Duitse ouderen afgenomen om een betere begrip van de determinanten van lichamelijke activiteit of van de gebruikers-behoefte voor de prototype te ontvangen. Daarna zijn de verzamelde resultaten uit de eerste fase vertaald naar functionele behoeften voor de prototype. In een prototype zijn SDT ondersteunende componenten verwerkt en in de andere zijn SDT niet-ondersteunende componenten verwerkt. Om de twee prototypen te evalueren wordt er een gebruikersevaluatie in een cross-over design met 10 Duitse ouderen afgenomen.

Resultaten:
De 'system usability score' voor beide prototypen waren goed. 9 van 10 respondenten gaven de voorkeur aan de SDT (+) prototype tegenover de SDT (-) prototype. Autonomie ondersteunende strategieën zoals het hebben van meerdere opties zijn positief geevalueerd door de respondenten. Er zijn niet eenduidige resultaten voor de strategie van schuld veroorzakende taalgebruik in de SDT (-) prototype. Enkele respondenten gaven aan dat de schuld veroorzakende boodschap over de risiken van lichamelijke inactiviteit motiverend waargenomen wordt maar alleen in combinatie met positieve feedback. In dit onderzoek heeft de competentie onderdeel de meest bepalende contributie. Praktijk ondersteuning is een van de hoofd factoren om voor de SDT (+) prototype te kiezen. De optie om sterren te verzamelen is meestal positief geevalueerd. Volgens de respondenten wordt de interactiviteit van het programma en de motivatie om het programma te gebruiken om lichamelijk actief te zijn verhoogd. Uit de resultaten kwam uit dat ook lof een nuttig strategie voor het ontwikkelen van een lichamelijke activiteitenprogramma is.

Conclusie: Deze studie levert een eerste benadering hoe een prototype ontwikkeld kan worden op basis van de SDT principes. Verder toont de studie aan dat de voorkeuren niet altijd overeenkomen met de empirisch bewijs. De resultaten kunnen een nuttige handleiding zijn om technologie aan te passen en een lichamelijke activiteitenprogramma te ontwikkelen dat aan de behoeften van de ouderen aansluit.

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Chapter 1: Introduction and aim of this study

1.1 Functional decline in elderly population & rising health care costs

The fastest growing age group of the western world population is elderly (> 65 years). In the Netherlands, 2.5 million of the population in 2010 was aged (above) 65 years and it is expected that in 2020 3.4 million of the population in Netherlands will be elderly (CBS, 2007). Elderly from this decade have a higher life expectancy compared to life expectancy of elderly in past decades (Moran, Cauwenberg, Hercky – Linnewiel, Cerin, Deforche & Plaut, 2014; Nelson et al., 2007). A decline of functional ability is often associated with increasing age. This could entail that prospective, more people are going to be institutionalized. Much of the health care costs occur due to the patient's loss of functional independence and the probability to suffer accidents or develop other problems rise with age (Cochrane, Munro, Davey, Nicholl, 1998). Therefore functional independence could have an impact on health care costs which would increase as well. For this reason, it is necessary to support elderly to maintain an adequate physical functioning that helps them to live longer independently (Van Holle, van Cauwenberg, Deforche, van de Weghe, Bourdeaudhuij & van Dyck, 2015).

1.2 Frailty in elderly

Even though chronological and biological age correlates, two individuals who are in the same chronological age may differ in their health and functional status. According to Costello, Kafchinski, Vrazel and Sullivan (2011) the concept of frailty tries to give an explanation for the heterogeneity in elderly. Among elderly frailty frequently turns up with ageing. Frailty is the state in which a higher vulnerability for adverse health outcomes due to the decline of bodily functions is detectable. Elderly with frailty are at an enhanced risk e.g. fall accidents, less mobility, less independence, hospitalization or reduced longevity (Collard et al., 2012). According to a systematic review by Collard et al. (2012) including 21 cohorts with 61 500 participants, nearly 10.7 % of adults between 65 – 74 years are frail and 41.6 % of the participants show indications of pre-frailty. Moreover, nearly 30 – 40% of elderly (> 65 years) will experience a fall within a year and the severity and incidence rate of falls increase with age (Paterson et al., 2007).

Among elderly, sarcopenia often turns up with ageing. Sarcopenia is the process of losing muscle mass and strength (Marzetti & Leeuwenburgh, 2006). Marzetti and Leeuwenburgh (2006) point out that sarcopenia is a risk factor for frailty. To reduce the number of fall incidents and to be independent and perform mobility activities, it is necessary for elderly to have muscle strength. With older age, muscles become weak, the amount of motion is reduced and cognition often slows down as well.

The described impact of ageing can be reduced by encouraging elderly in doing physical activity (Nelson et al., 2007). With an individually adjusted exercise program, it is possible to strengthen the muscles or to do a balance retraining. In the case that an elderly has motor deficits (e.g. weak legs), an activity can be adjusted to minimize impairment (e.g. weight training or doing exercises while sitting). In order to exercise and maintain global balance skills, elderly might perform exercises in distinct environments and under different conditions (Paterson et al., 2007).

It is important to consider that elderly often pursue a different goal when doing physical activity than younger age groups. Thus, they have a different intrinsic motivation. The pursued goal is less about aspects like prevention of disease or increase life expectancy but more to do an activity that helps them to cope with ageing (e.g. maintain muscle strength). Physical activity messages should therefore highlight the point of successful ageing, because elderly live often with one or more chronic conditions and the message of preventing disease might have a lesser impact on elderly (Paterson et al., 2007).

As mentioned above, in order to maintain adequate physical functioning, physical activity is a solution. Physical activity is a broad term that is often defined "as any bodily movement" that needs energy expenditure (WHO, 2013). According to several studies, physical activity has the potential to improve not only physical health but also mental health and health – related quality as well. These improvements are also detectable in "previously sedentary and chronically diseased older adults" (Moschnyl, Platen, Klaaßen – Mielke,p.1, Trampisch & Hinrichs, 2011; Nelson et al., 2007; Physical Activity Guidelines Advisory Committee, 2008). Regular physical activity slows down physiological changes that are related to ageing and it can lead to an improved longevity, a lower probability of developing disabilities or a lower risk at chronic diseases of ageing. Furthermore, it can help in maintaining independence which means that elderly are less dependent on assistance in performing activities of daily life (Singh, 2002; Paterson, Jones & Rice, 2007).

1.3 Physical activity recommendation for elderly

The recommendation for physical activity is different for the various age groups. The "Nederland's Norm Gezond Bewegen" (NNGB) proposes that people aged 55 or older should at least engage on five days a week in moderate intensive physical activity for a half an hour. Moderate physical activity should consist of more than 3 MET (metabolic equivalent: a unit of measurement to express how much energy a certain physical effort cost in relation to the required energy in a break (Ooijendijk et al., 2007; WHO, 2010). An example of moderate intensive physical activity for elderly people is to walk with 3 - 4 km/ hour (Kemper et al., 2000; Ooijendijk et al., 2007). The NNGB recommendation is in line with the recommendation of the WHO. They recommend that people above 65 years should at least do 150 minutes of aerobic physical activity at moderate intensity level throughout the week.

The total of 150 minutes can be spread throughout the week e.g. a half an hour of moderate – intensity activity 5 times a week. An aerobic activity should be at have a minimal duration of 10 minutes and it is recommended that "muscle – strengthening activities, involving major muscle groups should be done on 2 or more days a week" (WHO, 2011). When elderly are not able to reach the recommendation because of their health condition, it is recommended that they should try to be as physically active as possible (WHO, 2011).

Physical activity provides physical, social and mental health benefits for elderly. However, many elderly people do not act according to the recommended guideline. According to the WHO (2013), physical inactivity is the fourth leading risk factor for global mortality. In western countries, 60 – 70 % of the elderly aged 65 years and above does not comply with the recommended physical activity (30 min/ 5 days a week). In 2012, only 68.6 % of people aged 55 or older fulfill the criteria for physical activity in the Netherlands due to the NNGB (A/N: this statistic might also include elderly who are limited by their health). This statistic of physical inactivity is also similar to the physical activity pattern in Germany for this age group. In a national survey in 2009 in Germany, it was found that 72.8 % of older women and 65.3 % of older men (aged 65 years and above) don't reach the recommended level of physical activity. In addition to that, nearly half of the respondents stated that they did not engage in any sporting activities (women: 48.2%, men: 52.8% did not engage in any physical activities at moderate – intensity) (Moschnyl et al., 2008).

1.4 Motivators and barriers of physical activity in elderly

In focus group interviews with 31 older adults (> 60 years), Costello et al. (2011) explore the individual perception of physical active and inactive older adults regarding physical activity and exercises. The results show that health concerns, socialization, the programming, accessibility (cost, convenience, safety), fun and encouragement from the physician are motivators according to the focus group. Some respondents started to exercise in order to stay healthy and/or to combat the effects of ageing. Older adults who were physically active often highlighted the social aspect of exercising in a group as a motivator. The exercise staff that provides education and knowledge and also personal encouragement was also often cited as a motivator. The answers about motivators of the physically inactive group were nearly similar. For them physical activity has to be fun, purposeful and social. But compared to the physical active group of older adults, the physically inactive group named more barriers (e.g. lack of motivation, lack of self – discipline, being intimidated by the speed in gym facilities and being afraid to slow others down) (Costello et al., 2011).

Sometimes barriers outweigh the motivators of older adults to fulfill the recommendation of physical activity. According to Wallace and Lahti (2005) barriers can be divided into 3 broad categories:

1.) Physiological barriers are barriers that relate to someone's physical body. An often cited barrier to physical activity is poor health e.g. balance disorders, vision problems, osteoporosis or decreased strength)
2.) Psychological barriers are barriers that inhibit physical activity due to mental or behavioral characteristics (Wallace & Lahti, 2005). Examples for psychological barriers are e.g. thinking that they already active enough , time constraints , misconceptions about physical activity, lack of knowledge about health benefits, lack of interest (Brawley, Rejeski, & King 2003; Schutzer & Graves, 2004).
3.) Environmental barriers are barriers that include aspects within someone's physical or economic context (Wallace & Lahti, 2005). Examples of this category are bad weather, lack of transportation, no place to sit down or rest during the physical activity (Schutzer & Graves, 2004). Furthermore, low socioeconomic statuses are also often named as environmental barriers in the lack of exercise description by physicians, (Schutzer & Graves, 2004).

1.5 Self – determination theory as a theoretical framework to explain physical (in)activity

From a health perspective, it is a critical issue to understand how elderly can be motivated to change their life style and do more physical activity. If the elderly has the motivation to be physically active, the probability increases that the actual behavior would correspond with their intention to be physically active.

A theory that is occupied to explore the motivation of individuals to behave in a particular way is the self – determination theory by Ryan and Deci (1985). This theory is suitable as a guiding framework to explore the motivation of elderly for physical activity. One of the strengths of SDT is that this theory includes the intrinsic motivation into its framework. External rewards have a decreasing influence with time and especially intrinsic motivation is relevant with regard to the longtime aim of maintaining physical activity (Ryan & Deci, 2007). This framework "has received research attention and support in predicting physical activity (Fortier, Duda, Guerin & Teixeira, 2012, p.1). It can be used to obtain a better insight into the choices elderly make with regard to physical activity.

According to the self – determination theory (SDT) physical activities can be extrinsically and intrinsically motivated (Ryan, Williams, Patrick, Deci, 2009). In the case of intrinsic motivation, a physical activity is performed because it provides pleasure and satisfaction. The physical activity itself is enjoyable and there is no exogenous reward necessary. In contrast to intrinsic motivation, extrinsic motivation refers to activities that are performed for instrumental reasons e.g. to obtain a particular outcome (getting a reward, avoid a punishment, attainment of approval/ recognition or health (Ryan et al., 2009).

According to the SDT, individuals have 3 basic psychological needs that are innate and crucial for health and well – being. These three needs are: autonomy ("degree to which elderly feel volitional e.g. initiator of their own behavior), competence ("degree to which one feels capable to achieve their goals") and relatedness ("degree to feel relatedness with a group e.g. connection and sharing with others in their age group") (Grodesky, Kosma & Solmon, 2006).

In the context of developing a physical activity program, it can be suggested that elderly would be more prone to be physically active if these three needs are fulfilled. Theory – based interventions can provide a better understanding in the process of behavior change and can be a supportive factor in the development of a successful intervention (Lonsdale, Hall, Williams, McDonough, Ntoumanis, Murray & Hurley, 2012). According to Lonsdale et al. (2012), the provider of a patient e.g. has to consider the perspective of a patient, and has to provide relevant information and opportunities for choice. Furthermore it has to encourage the patient to be responsible for their own health behavior without to judge or coerce the patient.

A study of Silva, Vieira, Coutinho, Minderico, Matos, Sardinha and Teixeira (2009) show that women (M=37.6 years, SD=7.1) in the SDT grounded intervention has an increased weight loss and higher levels of physical activity/ exercises compared to women in the control group (general health education program). Situations that support feelings of autonomy and competence lead to an enhanced intrinsic motivation (Williams & Deci, 2009). Williams and Deci (2009) point out that a given physical activity can be considered as interesting by an individual. However, the activity controlled by a coach who orders or puts pressure on the individual, would result in the loss of interest. When others around the individual give constant negative feedback this will negatively affect the motivation of the individual. They also point out that challenges that are too difficult can lead to feelings of incompetence and disengagement. Many physical activities use a combination of intrinsic and extrinsic motivation to sustain physical activity behavior (Williams & Deci, 2009). Also the need for relatedness has to be fulfilled. Gagné, Ryan and Bargmann (2003) point out that female gymnasts are more motivated and willing to follow practices, when they have a feeling of relatedness (e.g. cared by others within the domain of action), autonomy and competence during the practice.

Silva et al. (2014) show different strategies that considers the three needs of the self – determination theory (see Table. 1). These strategies may be helpful to support elderly to fulfill their potential need for autonomy, competence and relatedness.

Table 1. *Strategies to support SDT* (Silva et al. (2014)

SDT component	Strategy
Autonomy support	Choice: Providing multiple options when possible to encourage elderly to follow their interests Relevance: Provide meaningful reasons why a particular physical activity is advantageous Avoidance of control: Not using authoritarian or guilt – inducing methods/ language in the physical activity program
Competence support	Clarity of expectations: Setting collaboratively realistic goals and what can be expect from the behavior – linked outcome Feedback: Provide relevant informational feedback Practical skill training: Provide instrumental and practical guidance and support
Relatedness support	Dependability: Be available in case of need Affection: Display concern and acknowledgement for the elderly

1.6 Physical activity interventions for elderly with the risk of functional decline

There are several interventions that aim to support elderly to prevent functional decline. One Dutch program is Perssillaa. The aim of the project is to support older adults with a self- management module that encourage them to train in their home environment or at a Perssillaa point where older adults have the opportunity to be physically active at a location in their neighborhood. Many of the interventions that are offered to older adults are facility – based and not home – based. The barrier of transportation might inhibit older adults to use the offered intervention (Schutzer & Graves, 2004). Perssillaa offers older adults to view the instructions of the exercises digital in a video with verbal instructions. This provides visual guidance instead of only giving written instructions. In addition to that, Perssillaa uses personalization at the different levels of the program and not only at the beginning which makes the module different from other physical activity moduls.

The physical module of Perssillaa is an evidence – based home exercise program. It is based on the exercises of Otago. This program intends to prevent falls by older adults (Campbell et al., 2005). The Otago exercise program is a programm with a trained instructor that individually tailor strength and balance retraining.

In order to support elderly to be physically active, the program LIFE ("Living Independently Functioning Older adults") is being developed. LIFE is a home - based self – management program. The aim of the project LIFE is to contribute to a physically active life style. LIFE will offer elderly,

who are at risk of functional decline, various modules. These modules will contain personalized tips, recommendations and suggestions how they can develop or maintain a healthy behavior and prevent functional deterioration. In order to restrict functional decline, activities of the program will be tailored to the needs of the target group. The activities will be delivered preventive instead of being delivered to the target group after the functional decline has been progressed to the extent that elderly have to be hospitalized. A main aspect of the concept of the program LIFE is letting elderly choose between the various provided services and letting them make their own decisions (RRD, 2015).

1.7 Aim of the research and research questions

It is necessary to support elderly to maintain an adequate physical functioning that helps them to live longer independently (Van Holle et al., 2015). In order to maintain adequate physical functioning physical activity (PA) is a solution. Despite the physical, social and mental health benefits that physical activity provides for elderly, many elderly do not act according to the recommended guideline. In order to change physical activity behavior among elderly, who do not comply with physical activity guidelines, it is necessary to develop physical activity programs that meet the needs of the target group. According to the literature, self – determination theory (SDT) can be a useful framework for the development of a physical activity program. Silva et al. (2014) propose some SDT – supporting strategies. These strategies may be useful in the developing process of a physical activity program with well – grounded physical activity recommendations.

Therefore the aim of this study is to provide a first approach on how to develop a prototype of a physical activity program that is based on the elderly needs and the concept of the self – determination theory. The study will be carried out in cooperation with the Roessingh Research Development center (RRD) in Enschede. The results of this study aims amongst others to support the development of the program LIFE.

This leads to the specific research question of this study which is: “How to develop physical activity programs for elderly to facilitate their motivation to follow physical activity recommendations?” The results of this study can provide a starting point for the future development of physical activity programs.

To approach this aim, this study is divided in three sub questions:

(1) What are motivators and barriers of physical activity behavior in elderly?

The aim is to assess the needs of the target group and to identify the requirements for prototyping modified physical activity advices that initiate physical activity behavior. In order to encourage elderly to initiate in physical activity, it is important to identify the main motivators and barriers that keep

elderly in the target group from fulfilling the recommendation of physical activity. This is done through preliminary interviews. The experiences elderly made in the past can be used as a guiding point for the development of the prototype. This is necessary to develop a prototype with adequate exercises and that considers the wishes of the elderly. Therefore, physical activity behavior could be facilitated in a substantiated manner.

(2) How can physical activity programs be matched to the needs of the target group (when considering SDT)?

The self – determination theory will serve as an overall theoretical framework (explaining how to motivate target group to initiate PA) because as earlier said this motivational theory does also focus on intrinsic motivation. External rewards have a decreasing influence with time and especially intrinsic motivation is relevant with regard to the longtime aim of maintaining physical activity (Ryan & Deci, 2007). Based on the results of the first sub question, two low – fidelity prototypes (see chapter 2) will be developed. One prototype will consider SDT – strategies that might affect the motivation to use the program. The other prototype will be similar in terms of the interface design but will use reversed SDT strategies.

(3) What do elderly think of the developed prototypes of the physical activity program?

To explore the importance of the SDT features and how the prototypes are received by respondents in the target group, the two prototypes will be presented to elderly. Based on the concept of the self – determination theory, it is suggested that elderly are appealed more to the SDT (+) prototype than to the SDT (-) prototype.

Chapter 2: Method

2.1 Structure of the study and ethical issues

This chapter abstracts the methods and techniques which were used. In this study a user centered design (UCD) was chosen. This means that the needs, interests, expectations and motivation of the intended users (elderly) were central in the process. The UCD approach has the advantage that by involving end users in the development process, user satisfaction, usage and the quality of care can be enhanced (Gemert – Pijnen, Peters, Ossebard, 2013). Through considering user feedback in the development process on what they expect from a physical activity advice, the end product can be adjusted early in the development process.

The study was conducted in three phases. During the first phase (needs assessment), individual interviews were held with 14 elderly to get a better understanding of the determinants of their physical activity behavior (e.g. motivators and barriers of PA) and what they expect from a physical activity program. In the second phase of the study, information gathered from the first phase was translated into functional requirements of the prototype in combination with high SDT components in one prototype and low SDT components in another prototype. In the third phase of the study, it was explored how the two prototypes were received by the respondents of the target group. It was studied to what extent the different features of the SDT components were relevant for the physical activity program and what implications were in general important when developing a physical activity advice.

Table 2. *Structure of the study*

Subquestion	**Phases of the study**	**Method**	**Respondents (n=14)**
What are motivators and barriers of physical activity behavior in elderly?	1. Needs assessment	Interviews	Elderly aged above 65 years (n=14)
How can physical activity programs be matched to the needs of the target group (when considering SDT)?	2. Prototype(s) development		
What do elderly think of the developed prototypes of the physical activity advice?	3. Usability testing of the prototypes	Think aloud & interviews	Elderly aged above 65 years (n=10)

Ethical issues

The study procedure was approved in advance by the ethical commission of the University of Twente. All of the participants were informed in detail about the study and the procedure. Before the interview started, the participants were allowed to ask any questions related to the study and to give informed consent if…:

1.) …all their questions were answered
2.) … allowance to audiotape the interviews
3.) …to participate on the study

For privacy protection, all the data were processed anonymously.

2.2 Phase 1: Needs assessment

2.2.1 Participants

The target group in this study was elderly aged above 65 years who are at risk of functional decline, but are still able to do activities of daily living on their own. Elderly were recruited through convenience sampling. To get a representative overview of physical activity behavior in elderly, in this research 7 men and 7 women participated on the interviews (M= 69.43 years; SD= 3.82). There were 3 inclusion criteria:

- Respondents have to be older than 65 years, because as earlier explained they represent an important risk group for physical inactivity (Revised from Gregg et al., 1996). Elderly in this age group require "more than any other age group […] adequate fitness levels to help them maintain independence" (Revised from Gregg et al., 1996).
- Respondents should be able to do daily activities on their own.
- Respondents should be able to understand and speak German, because the interviews will be conducted in German. As earlier said physical inactivity among elderly is a global problem. Physical activity behavior among elderly should therefore be promoted at the (inter)national population level.

If participants didn't fulfill these three criteria's, they were excluded from the sample.

Procedure:

To answer the first sub question interviews were carried out. The intention of the interviews was to get a good overview of the problem and user requirements (barriers & facilitators of physical activity). It was a starting point for developing the two prototypes (needs assessment). Therefore semi – structured interviews (Appendix B) were held with 14 respondents to identify:

- Characteristics of the target group; their experiences with physical activity programs and their technical skills
- If the motivators and barriers stated by the respondents were in common with the literature and if possible motivators/ barriers were overlooked.
- What their physical functioning is and what exercises were appropriate when developing the two prototypes. In the case that most of the respondents have knee problems, exercises that are straining the knees would not be adequate.
- What respondents in the target group expect from a physical activity advice and program

The participants who were interested to participate on the intervention got visited at their home. The interviews were taken in the natural environment of the respondents to limit the burden of transportation for the elderly. Prior to the interview, the respondents were informed again about the intervention and were asked if they had any questions and to obtain permission to be recorded [see 2.6: ethical issues]. After all questions were answered, the respondents were asked for informed consent. Furthermore, it was pointed out that the respondents can stop the interview at any time.

The interview started with questions about general demographical data and questions about their current physical activity behavior, motivators and barriers of physical activity, experiences with physical activity advices and what they expect from a good PA advice and about their technical skills. A screenshot of the program "Perssillaa" was shown as an example (see Appendix B) and respondents gave their opinion about the example and what changes they would make. The interviews lasted between 20 – 35 minutes.

2.2.2 Materials:

Interview schedule

The interview schedule consisted mainly of open questions about general demographical data, questions about physical activity behavior, motivators and barriers of physical activity, experiences with physical activity advices and what they expect from a good physical activity advice and about their technical skills. During the interview, the screening site ReQuest was used to assess the SF – 36 Physical Functioning Subscale (PF – 10) and two questionnaires with items about motivators and barriers were presented to the respondents. The list with items was presented after the open questions were asked about personal motivators and barriers that inhibit elderly to be physically active (see Appendix B).

PF – 10

The PF-10 (Cronbach's $\alpha = 0.82$; for older adults) was a generic outcome measure that was used to assess the perceived limitation of the respondents health on basic activities/ mobility (White, Wilson

&Keysor, 2011). This information was necessary to find adequate exercises for the prototype that matches the physical functioning state of the target group. The PF – 10 consisted of 10 items. The responses were rated on a 3 – point Likert – scale (limited a lot, limited a little or not limited at all). The respondents were asked to rate the items based on their current health state. The PF – 10 has been applied for different target groups, including elderly. The answers of the respondents were summed to produce raw scores that were afterwards transformed to a score between 0 – 100. A higher score indicated a health status that limited the respondent less in basic activities. It took less than 10 minutes to fill in the questionnaire (White et al., 2011).

Questionnaire about motivators & barriers

The list of items about motivators was based on a study of Rasinaho et al. (2006). A list of 16 items about possible motivators were presented to the respondents in a 3-point Likert scale (don't agree, partly agree, agree). It took 3 -5 minutes to fill in the questionnaire. The list of items about barriers was based on a study of Moschnyl et al. (2011). The respondents were presented a list of 7 items on a 3- point Likert scale (doesn't agree, partly agree, agree). The list of items was used to round up the open questions about motivators and barriers that were asked beforehand. The information about motivators and barriers were used to explore the role of the three psychological needs of the SDT theory.

Example of an exercise from the physical activity program "Perssillaa"

A screenshot of the program "Perssillaa" was shown to the respondents (see Appendix B). This screenshot was used in order to show the respondents an example of an existing physical activity module. It was chosen for the example of the exercise "Moving the head" because it was an exercise that was easy to understand and follow (Appendix B).

2.2.3 Data analysis

For the qualitative analysis of the interviews deductive coding was used. A deductive way of identifying themes is "driven by the researcher's theoretical or analytical interest in this area" (Braun & Clarke, p.12, 2006). The interviews were written down as a transcript. Within the transcripts, it was analyzed what the respondents identify as determinants of physical activity behavior (motivators and barriers). Therefore a coding scheme was made. The transcripts were coded by one researcher. The coding scheme consisted of three main categories: autonomy – related, competence – related and relatedness – related and different labels were identified within the categories. The quotes of the respondents were afterwards assigned into the different labels.

2.3. Phase 2: Prototypes development

2.3.1 Procedure:

The interviews of phase 1 provided information about which values and wishes regarding physical activity the prospective users considered as important. SDT categories were used as a result classification for the development of the prototypes. These outcomes were now translated into functional requirements. This study used the strategies of Silva et al. (2014) as a theoretical framework and 2 low – fidelity prototypes were developed. The advantage of a low – fidelity prototyping is that the main features were worked out in the prototype but not in detail. It turned out to be an effective way to find faults in the developed system (Walker, Takayama & Landay, 2002). One prototype considered SDT supporting strategies and the other prototype was similar in terms of the interface design but without the SDT components. In the prototype, the received feedback was considered and suitable SDT strategies and persuasive features and behavioral change techniques were applied. The mock –ups for the prototype were made by the researcher with the program Balsamiq. This program allows user to create mock -ups in a quick way on a whiteboard through providing different user interface elements. This way of prototyping is fast and it is easy to create a graphical user - interface that conveys the most relevant features (Guilizzoni, 2010).

2.3.2 Materials:

- Strategies of Silva et al. (2014) as a theoretical framework (see chapter 1.5)

2.3.3 Data analysis

For the qualitative analysis of the interviews deductive coding was used. Within the transcripts, it was analyzed what the respondents identify as functional requirements of a physical activity program. Therefore a coding scheme was made. The transcripts were coded by one researcher. The coding scheme consisted of three main categories: autonomy – related, competence – related and relatedness – related and different labels were identified within the categories. The quotes of the respondents were afterwards assigned into the different labels.

2.4 Phase 3: Usability testing of the prototypes

2.4.1 Participants:

The third sub question is explored through presenting the two prototypes to a sample group of 10 elderly. The 10 elderly are with a randomized table chosen from the sample earlier. Two new respondents were included to the sample because of a bereavement situation of two elderly. The sample is divided into two groups and the respondents are assigned to one of the two groups. Each group consists of five respondents. It was chosen for a cross – over design. One advantage of this

design is that the prototypes are evaluated within the same respondents which reduced the risk of between subject variability. This approach was more suitable for the comparison of the two prototypes. Also fewer respondents were required (Mills, Chan, Wu, Vail, Guyatt & Altman, 2009). In addition to that, it was assumed that if all the respondents saw first the SDT (+) version, the answers for the SDT (-) prototype might be affected by the impression of the first prototype.

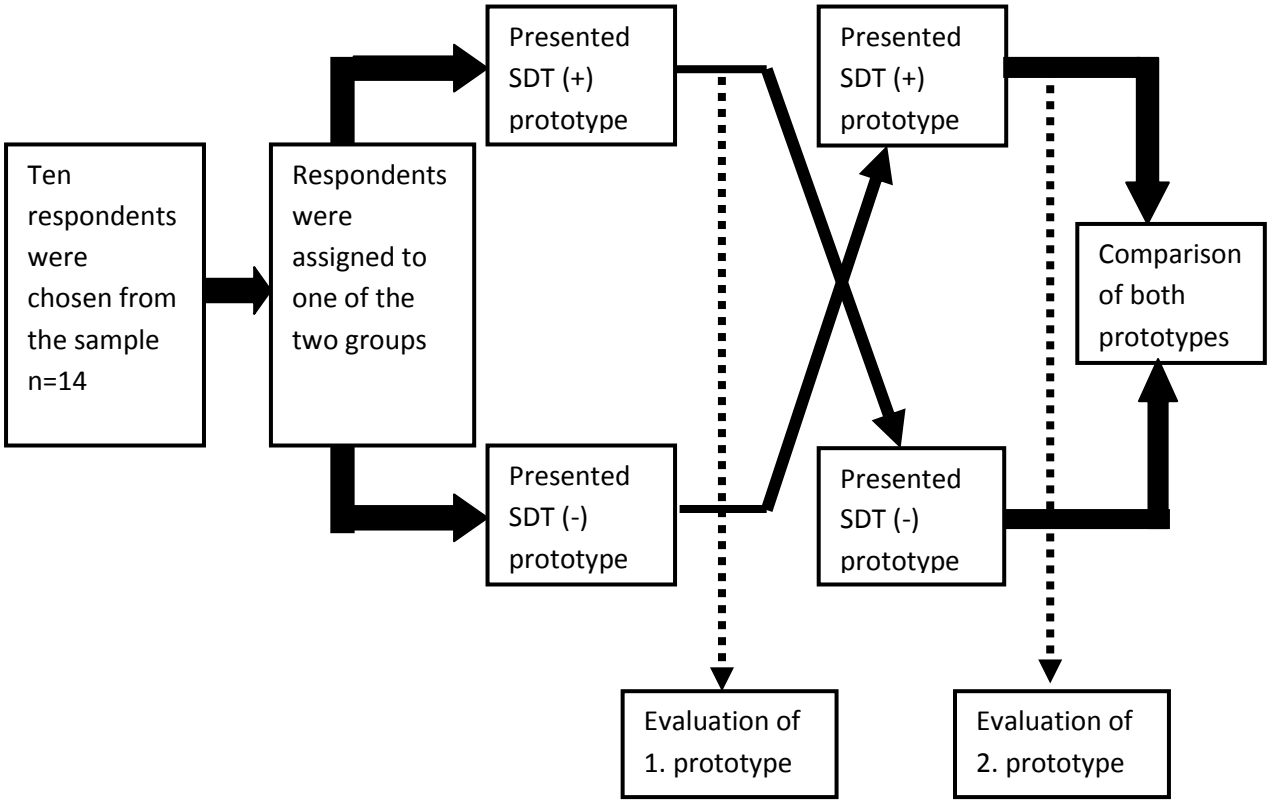


Figure 1. Cross – over design of usability study

Study procedure

For the evaluation of the two prototypes, they were presented to ten elderly. The elderly were visited again at their home. Based on the earlier steps, two personas and use – case scenarios were developed (Appendix D). Personas were fictional representations of the target group. They were used as an interaction design technique (Pruitt & Grudin, 2003). The scenarios were used to help the user to better imagine how the use of the technology could look like (Pommeranz, Brinkman, Wiggers, Broekens & Jonker, 2009).

The personas and the prototypes with the use – case scenarios were presented to the respondents. The female respondents were presented the persona of Marianne and the male respondents the persona of Frank. The respondents were guided through the usability testing by

means of scenarios that pose typical tasks they could encounter when using the program. In the usability study the respondents were asked to make use of the think – aloud method. This method contains that the respondents should verbalize their thoughts during testing the prototype (Ericsson & Simon, 1993). After testing each prototype, the respondents were asked to fill in the system usability scale (SUS) for the tested prototype. They were also asked to answer in a closure interview questions about their experience with working with the prototype and what they like or dislike about the prototype and what they would like to change. The evaluation lasted between 40 - 55 minutes.

2.4.2 Material:

Protocol for usability study

The protocol for the usability study was developed beforehand (Appendix D). The protocol consisted of the persona and the use – case scenarios and the open questions of the closure interview regarding the evaluation of the prototypes. The open questions were about:

- the experience to work with the prototype
- the design of the prototypes
- their opinion of the physical activity advice and the three different feedback versions they got after the exercise
- the comparison of the two prototypes and what the decisive factor was for their preference

System usability scale (SUS)

The system usability scale is a tool to measure the usability of a system and consisted of 10 items. After testing a prototype, the respondents were asked to rate on a 5- point Likert scale the different items of the system usability scale. The scale ranges from strongly agree (5) to strongly disagree (1). For example, the respondent has to rate on the 5 – point Likert scale the item: “I think that I would need the support of a technical person to be able to use this system.” or “I think that I would use this system frequently”. The system usability score (SUS) ranged from 0 – 100. A higher score indicates a better system usability (Brooke, 2011).

2.4.3 Data analysis:

Data analysis of system usability score (SUS)

Half of the items in the SUS were positive items (positive worded) and the other half were negative items (negative worded).

- For even item numbers (negative worded), the value has been subtracted from 5.
- For odd numbered items (positive items, 1 was subtracted from the score.

- The scores were then summed up and multiplied with 2.5 to get the total SUS (Brooke, 2011).

Data analysis of usability tests:

All usability tests were audio recorded and coded deductive retrospectively. The audio material and notes (think aloud & observation during the usability test), which were taken during the test were written down. The transcript was then reviewed by the researcher. A coding scheme was developed. Issues regarding the SDT features were grouped into different labels (developed practical SDT strategies). Furthermore, quotes regarding the system usability were grouped into another category.

Chapter 3: Results

In order to answer the research question, the result section was divided to three sections. In the first part of the result section, the results of the interviews were presented. In the second part of the result section, the development of the two prototypes was presented. The used strategies were summarized in table 6. In the third part of the result section, the results of the usability testing were presented.

3.1 Results of the interviews:

The information gained in the interviews was necessary as a starting point for the development of the prototypes. It gave an insight into the physical activity behavior of respondents in the target group, their physical condition, their technical skills and what respondents in the target group expected from a physical activity program. The results of the physical condition e.g. helped to estimate what physical activities were suitable for the prototype.

The elderly who participated in the interviews were all German. In total, 14 respondents (7 men and 7 women) participated on the interviews. The mean age of the respondents was 69.43 years (SD= 3.82) and range from 65 to 80 years. All respondents lived at their own home. Most of the respondents live together with their partner together; one man was divorced; one woman was a widow; the husband of one woman lived in a special – care home due to his health condition. Three of the respondents had a low educational level, seven had an average educational level and four of them had a higher educational level. Except one man, all respondents were now in pension.

The PF – 10 (physical functioning subscale of SF 36) showed that in general respondents in the sample had not many difficulties with daily activities. The PF – 10 mean score within the group of n=14 was M= 68.57. The scores within the group ranged from 30 – 95. Most of the 14 respondents had a PF – 10 score above 50 (n=10). The physical functioning was only limited by their health concerning item 1 (vigorous activities), item 6 (bend & kneel) and item 7 (walk a mile). In these activities respondents reported to be limited by their health. These results of the PF – 10 were considered when developing the prototype. The choice of exercises is adjusted to these limitations (e.g. the shown exercise will not put additional burden to the knees).

Furthermore, all respondents had some experience with using a computer and a mobile phone. Except for one man (80 years), everyone knew how to use a computer and mobile. Women stated that in the beginning, it was difficult to learn how to use the computer and mobile, but often their grandchildren gave them detailed (written) step – by step descriptions. With their guidance it was less difficult for her to handle the system. Respondents expected from the system that the content is presented well-structured and in multi – modal materials (video and text if possible) and that the letters were not too small.

Table 3. *Demographical data of the respondents in the interview*

Gender	
Male	7
Female	7
Mean Age (years), SD	69.43 years (SD= 3.82)
(range)	65 – 80
Living situation	
Partner	11
Divorced/ Separated	2
Widowed	1
Educational level	
Low	3
Average	7
Higher	4
PF – 10	The PF – 10 mean score within the group of n=14 was M= 68.57. The scores within the group ranged from 30 – 95. Most of the 14 respondents had a PF – 10 score above 50 (n=10). Only by item 1, item 6 and item 7 of the PF -10, respondents reported to be higher limited by their health (item 1: vigorous activities; item 6: Bend, kneel; item 7: walk a mile). Respondents reported to be at least limited by their health for item 9 and 10 (item 9: crossing a street, item 10: bathing).
Experience with technology	
None	(1)
Intermediate	8
Expert	5
Falls during the past 6 months	0

Motivational factors regarding physical activity

One reason to held preliminary interviews was to get further knowledge of the physical activity experiences of the respondents and if the named motivators were related to the constructs of the self – determination theory. The interviews showed that the constructs of the self – determination theory were recognizable when respondents talked about motivators and experiences regarding physical activity. This shows that the SDT can be useful as a framework when developing a physical activity program/service. The motivational factors were categorized into three categories and different labels (see table 3).

The first category was motivational factors that were autonomy – related. This category was most important for respondents. Many respondents (n= 9) mentioned that living independently was a main reason for trying to be physically active. Health – related factors that were named by the elderly were e.g. to stay healthy, to be mobile or to reduce pain (e.g. back pain) through doing physical activity.

A second category was motivational factors that were competence – related. Four respondents stated that a motivational factor for them was the competitive conduct. For example, when they saw that they were able to do the same exercises as younger people. Six respondents mentioned that especially the experience of success, after doing an exercise, was motivating. They felt a positive change and reduced pain.

A third category was motivational factors that were relatedness – related. Some respondents (5 women, 1 man) stated that physical activity helped people in their age to stay part of the society and to meet other people and not become too lazy when they had so much free time after getting pensioned.

The gained information about motivators was afterwards as best as possible considered in the development of the prototypes e.g. respondents mentioned that one motivator was to reduce back pain. This motivator was considered in the choice of exercises that were offered in the prototype (more information were given in chapter 3.2).

Table 4. *Motivational factors*

Category	Label	Citation
Autonomy – related	- Living independently	"*My motivation is that […] I can care for myself and be independent. I don't want to become a burden to my children"* (Male, 67 years)
	- Stay healthy	*"The things we do are exhausting enough. I sometimes go swimming or go bicycling […]. These are the activities, we want to keep up in order to feel healthy"* (Female, 65 years)
		"If you rest, you rust" (Female, 70 years)
Competence – related	- Competitive conduct (able to do the same exercises as younger people)	*„I like to set goals in the evening for the next day"* (Female, 68 years).
		"I set goals and I do everything to achieve them. This gives me a positive feeling" (Female, 68 years)
	- Experience success after doing an exercise	*"The experience of success […]. The strategy to keep going on with the exercises was when I realized that the exercises actually helped. So the efficacy was my motivation."* (Male, 69 years)

	-	Guidance	*For special exercises for the back I would first need guidance"* (Female, 69 years)
Relatedness – related	-	Be part of the society	*"My motivation to be physically is that I want to stay a part of the society […]. That's very important for me."* (Female, 65 years) "*Spend time with my husband. To do together activities like bicycling […]. We are both in pension now, so we want to try to spend more time together"* (Female, 69 years) *"Meet friends and do something together. That's better than staying home and sing the blues"* (Male, 67 years) *"Help my wife. She has health issues and I want to support her"* (Male, 69 years) *"I don't care if I do the activities with someone else or alone"* (Male, 69 years) *"It depends from the activity if I like to do them in a group or alone. E.g. bicycling is an activity that I would prefer to do alone."* (Female, 69 years)

Barriers regarding physical activity

The barriers that inhibited elderly from being physically active were also explored. As the motivational factors, many different barriers were mentioned by the respondents. The barriers that were mentioned can be categorized in the categories physical barrier, psychological barrier and environmental barrier.

Physical barriers that were mentioned were caused by their current health condition (e.g. problem with walking, back pain, knee problems). Next to physical barriers, many different psychological barriers were indicated by the respondents. The most frequently named barrier was the feeling of an inner resistance (named by nine respondents). Different factors contributed to the construct "inner resistance": laziness, not being able to fulfill the social norm when doing physical activity in public (they were afraid that they were overstrained and withheld others in a sport course) and habit were noted as barriers. Another psychological barrier was the fear to fall down and to worsen the pain. Only four respondents referred to environmental barriers. The environmental barrier that was recognized was bad weather or winter days when it is early dark and they could not go outside.

As it is shown above, different barriers needed to be considered when developing a physical activity program. The results were helpful to find suitable strategies for the prototype that decreased barriers for the users. For example, the fear that they were overstrained can be considered in the development of the prototype by offering the users multiple levels of difficulty that range from easy to difficult. Another example to consider the environmental barrier "weather" was to offer a physical activity that could be done at home.

Table 5. *Barriers*

		Citation
Physical barrier	Health condition (e.g. problem with walking, back pain, knee problems)	*"It depends on my physical condition. I have asthma and I get exhausted really fast."* (Female, 65 years) *"My knees hurt sometimes so much that I say to myself that today I wouldn't do anything related to walking."* (Male, 69 years)
	Afraid to fall down, make pain worse	*"I often hear from friends about falling down and getting injured. I don't want that to happen to me, so I don't do activities like bicycling* (Male, 80 years)
Psychological barrier	Inner temptation	*"My inner temptation is sometimes keeping me from being physically active. I have to overcome this temptation like this noon, when I first thought 'I don't need this.'"* (Female, 68 years)
	Laziness	*"General barriers that I see are a certain standard of comfort, laziness or if you are really handicapped."* (Female, 70 years)
	Afraid of doing physical activity in public	*"In a certain age, there are people who become kind of afraid of other people. Elderly who are overweight who don't to exercise in public due to their physical appearance."* (Male, 80 years)
	Habit – difficult to do the first step	*"The habit [could be a barrier] and how you were at a younger age. Some people are phlegmatic".* (Female, 69 years) *"To swallow one's pride and making the first step."* (Female, 72 years)
Environmental barrier	weather	"*On winter days, it is getting dark really early and I can't do my daily routine of walking. I don't feel comfortable to go walking alone in the dark"* (Female, 68 years) "*I sometimes set goals but what should I do if the weather is bad and it rainy, I can't change it. So I don't do it."* (Male, 65 years)

Expectations and wishes regarding a physical activity program

Respondents shared their experience about physical activity programs. Some of the respondents had participated on rehabilitation courses or went to some sport courses in the past but none of the respondents tried so far a digital physical activity program. They did not know if there were any digital physical activity programs for their age group in Germany and how such a program could look like. Therefore one screenshot of the Dutch physical activity program "Perssillaa" was shown (Appendix B). This gave the respondents an insight how a physical activity program could look like and gave them the possibility to share their thoughts about it. The citations of the respondents can be grouped into the broad concepts of the SDT constructs (autonomy, competence, relatedness).

Autonomy: Most of the respondents (n=10) stated that the possibility of having a choice between different options was important but only if the options were related to their health condition. Some users liked the idea that exercises were decided beforehand, but other users found it important that decisions were co – determined because then they would feel more motivated to do a certain exercise.

Competence: Users sometimes did not see the sense in a special exercise e.g. during a gym course where everyone in the course did the same exercise. The usefulness of the exercises in the course was not always explained. According to six users the guidance/ instructions in such courses was sometimes not clear. They made the experience that sometimes instructions given in a gymnastic course were not comprehensible formulated and they had difficulties to follow the instructions. It was stated by some respondents, that with increasing age, it was difficult to do all kind of exercises and that they wanted to physical activities that were not difficult. Other respondents liked to be challenged by an activity.

Relatedness: 5 out of 7 women stated that meeting other people during a physical activity was motivating. One woman stated that she did not care if she did an activity on her own. Sometimes it depended on her mood if she wanted to have other people around. Another woman did not like to do group activities because she felt exposed. She felt uncomfortable because she was not as sportive as other women her age. Relatedness is also for one female respondent dependent from the chosen exercise [*"If you do dry and boring exercises, I prefer to exercise in a group (…). But bicycling or other exercises I like to do by myself. It depends from the exercise and the situation."]*. For male respondents in the sample, it did not matter if they did exercises with others or not. But if they could choose, they liked to do exercise alone or only within a small group of people they knew.

Table 6. *Expectations regarding a physical activity program*

Category	Label	Citation
Autonomy – related	The possibility of having a choice	*"It's important for me to have a choice between different options"* (Female, 68 years)

		"I would like to be offered different exercises" (Female, 68 years) *"An exercise that is especially chosen for you might be useful because they would be appropriate for your own condition."* (Male, 65 years) *"[…] I am limited in my health due to my knee problems and back pain and don't have much choice in what activities I do. It depends on my current health state."* (Male, 69 years) *"It's important that decisions are co-determined because you don't like every exercise. If you co – determine the exercise, the probability is higher that you will actually follow the exercise. Exercises I don't like, I would postpone or I won't do it."* (Male, 68 years)
Competence – related	Users sometimes don't see the sense in a special exercise	*"In the spinal exercises course […]are exercises that don't help me at all and some that seem useful".* (Female, 69 years) *"I would like to be offered […] exercises but only if the exercises are proven in real life to be successful. This is really important to know in our age."* (Female, 68 years)
	Guidance	*"I don't do any particular sport. […] Before I do it [the exercise] wrong, I'll leave it as it is."* (Male, 66 years) *"Maybe you can suggest some good exercises or a program. Then I would consider it. I have enough time. That would be nice." (Male, 65 years)* *"I participated twice on a yoga course. We were in a room and the therapist showed us how to do the exercise. I really liked that."* (Female, 69)
	Relevance of feedback/ advice	*"Actually, it's not important. My feedback is that I see for myself that the exercise helped my body and that I feel better." (Female, 69)*
	Level of difficulty	*"I like to do easier exercises, you know? I can't do everything. I'm already 80 years old."* (Male, 80 years) *"I don't want to have only easy exercises. For me, it is better to have also difficult exercises."* (Female, 69 years)

		„I don't know. I don't have any experience. I don't do any exercises. " (Male, 65 years) *„It was good to see, even though it might sound egoistic, that I am not that stiff and was able to do the exercise. This was really a good feeling. […]This feeling of acknowledgement was great. To see what I am capable of."* (Female, 69 years)
Relatedness – related	Dependent from the exercise and mood if users want to do an activity together with someone else	*"Sometimes I do exercises alone and sometimes together with a friend. After doing a physical activity together, we like to drink a cup of coffee and talk. That's nice. Then you have besides the training, also the social facet. "(*Female, 71) *"For me, it is not of relevance. I do exercises by myself*." (Male, 69 years) *„If you do dry and boring exercises, I prefer to exercise in a group […].But bicycling or other exercises I like to do by myself. It depends from the exercise and the situation."* (Female, 69 years)

3.2 Results of the prototype development:

The aim of this study was to explore how physical activity programs should be developed for elderly to facilitate their motivation to follow physical activity recommendations. Based on the needs assessment and the expectations regarding the physical activity program, two prototypes were now developed.

Interface design:

The interface design for the two prototypes was similar. Complexity was reduced because elderly might feel lost and overwhelmed by a high amount of information. Scaffolding was used by creating the display in a familiar navigational tool that showed information in a predictable way. In the toolbar were e.g. all main features to navigate through the system. The toolbar contained e.g. an overview of the results, a glossary, a message box and the button to log off the program. The recommendation was shown on left side. The recommendation was either shown next to the icon of a doctor [SDT (+), surface credibility] or an exclamation mark [SDT (–), authoritarian symbol]. On the right side, users were shown one or three different exercises that went along with their preferences. According to a meta – analysis from Noar, Benac and Harris (2007) studies have shown that tailoring does have a significant positive effect on changes in health behavior. Tate, Wing and Winett (2001) suggested that tailoring might be more effective when tailoring is led by the user or was based on the preferences and requests of the user. In addition to that, the content is organized with visual cues like a bicycle icon

next to the bicycle activity. Elderly are also offered the possibility to rate an exercise ("rate this exercise and give 1 to 5 stars) in both prototypes.

Figure 2: Screenshot of SDT (+) prototype

Persuasive features and SDT strategies:

In table 6 the chosen SDT strategies and persuasive features and behavioral change techniques for the prototypes were presented. For the SDT (+) prototype, it was mainly chosen for the strategies developed by Silva et al. (2014). Furthermore suitable persuasive features or behavioral change technique were added. In the SDT (-) prototypes it was mainly attempted to reverse the SDT (+) strategies.

In the SDT (+) prototype the advice is formulated in a non – authoritarian or non - guilt – inducing language (strategy: avoidance of control). Moreover, autonomy was supported by providing the users with three options to encourage them to follow their interests and that are in control of the situation (strategy: choice). The offered choices were based on the results of the interviews. The results showed e.g. that respondents have back problems and that one environmental barrier to be physically active is bad weather. Therefore it was chosen for an exercise for the back that elderly could do at home. In the SDT (–) prototype authoritarian and guilt – inducing language was used. For example, the risks of physical inactivity were pointed out in the feedback when users did not complete the activity (strategy: low avoidance of control). A statistic of the world health organization about the risks of inactivity was e.g. used in the feedback. In addition to that, the system guided the user through

the process and provided only one physical activity which was based on the preference of the user (primary task support: tunneling, reduction).

To support the competence of the user, two SDT – strategies were used. One was to provide the user with instrumental and practical guidance and support. The other was to set (collaborative) realistic goals and earn stars. In the SDT (+) prototype was an additional bottom with the headline "click for more information" provided. This option provided them with meaningful reasons why a particular physical activity is advantageous for their health (strategy: clarity of expectation). The users were also provided a practical guidance video that showed how the exercise for the back has to be carried out (strategy: practical skill training). It was expected that this would led users to feel a sense of competence. In addition to that, it was possible to set collaboratively realistic goals. The SDT (+) prototype contained 3 levels of difficulty and the system gave a recommendation what level would be appropriate. By providing 3 levels of difficulty (easy, average and difficult), the user knew if he would be capable to achieve his goal (strategy: clarity of expectation/ BCT: goal setting).

They also earned stars by being physically active. In case they collected a specific amount of stars, new videos/ activities would be provided to the user (BCT: intercontigency management). They got three stars when they completed a physical activity, 1.5 stars when they started with a physical activity and pause with the physical activity. The other 1.5 stars they would get, when they continued and finished the activity. They got 1 star if they at least tried the physical activity, even though they decided to stop with the physical activity. The SDT (–) prototype also provided a video, but this video contained background information about back pain and what the processes were that led to the state. It gave an insight of the effects before and after physical inactivity (Primary task support: simulation). The instructions of the exercise were written down right to the video, but the exercise was not performed in the video. Therefore, the video gave less practical guidance than the video in the other prototype. In the SDT (–) prototype were also not different levels of difficulty available. In the SDT (–) prototype the user did not get a star for the back pain exercise.

In both prototypes message – based interactivity was used. This means that messages were based on numerous preceding messages (Tate, Wing & Winett, 2001). In the SDT (+) prototype users received messages that e.g. showed affection in the feedback after an exercise (praise) and the users were addressed directly. It was expected that the user might feel relatedness through this kind of feedback and the feeling of relatedness would be heightened, which in turn can affect the intrinsic motivation to be continuously physical active. Users were also given the possibility to get a reminder if they pause with an exercise (dialogue support). Furthermore the SDT strategies dependability (be available in case of need) and affection (display concern and acknowledgement for the user) was used in the feedback. In the SDT (–) prototype on the other hand, no personalization was used and instead of asking why the user stopped with an exercise and showing concern, the user is given the suggestion to try again or to monitor the results the user had reached so far.

Table 7. *Combination of persuasive elements and SDT strategies*

	Autonomy: degree to which elderly feel volitional (e.g. initiator of their own behavior)		Competence: degree to which one feels capable to achieve their goals		Relatedness: degree to feel relatedness with a group	
	Avoidanceof control	***Choice:***	***Pract. skills training***	***Clarity of expectation***	***Dependability***	***Affection***
High (SDT) strategy	Not using authoritarian or guilt – inducing language in the physical activity recommendation	Providing three options that matches their interests	Provide instrumental and practical guidance and support (video and text)	Setting collaboratively realistic goals and what can be expect from the behavior – linked outcome	Be available in case of need: additional help button (question can be written and send to administrated)	Display concern/ acknowledgement for the elderly in the feedback after doing an exercise
Trans-Latedinto Persua-sive feature &Beha-vioral change tech-nique (BCT)	System credibility support: Surface credibility Dialogue support: Liking	Primary Task support: Tailoring	Dialogue support: liking System credibility support: Expertise BCT: Contingency management (rewards)	System credibility support: Expertise BCT: Goal setting	Dialogue support: Reminder,	Primary task support: Personalization, Dialogue support: Praise, rewards
Low (Reverse SDTstrategy)	Using authoritarian or guilt – inducing language in the physical activity feedback	All options are shown but only one option is available to perform	Provide a video about effects before and after doing e.g. physical activity in general instead of instruction video	Settled goal for the user about level of exercise.	Instead of the help button, the feedback will consist of the suggestion to try again the exercise or to monitor the results the user has made so far	No personalization or reward. Show the option that in general rewards like stars can be earned but not for the chosen exercise.
	System credibility support: authority	Primary task support: Tunneling, reduction	Primary task support: Simulation BCT: (No) Contingency management	Dialogue support: suggestion BCT: Goal setting	Primary task support: Self – monitoring	System Credibility Support: Expertise

Examples of the two developed prototypes (The mock - ups of the entire prototypes were shown in Appendix C):

SDT (+) version. Recommendation page:

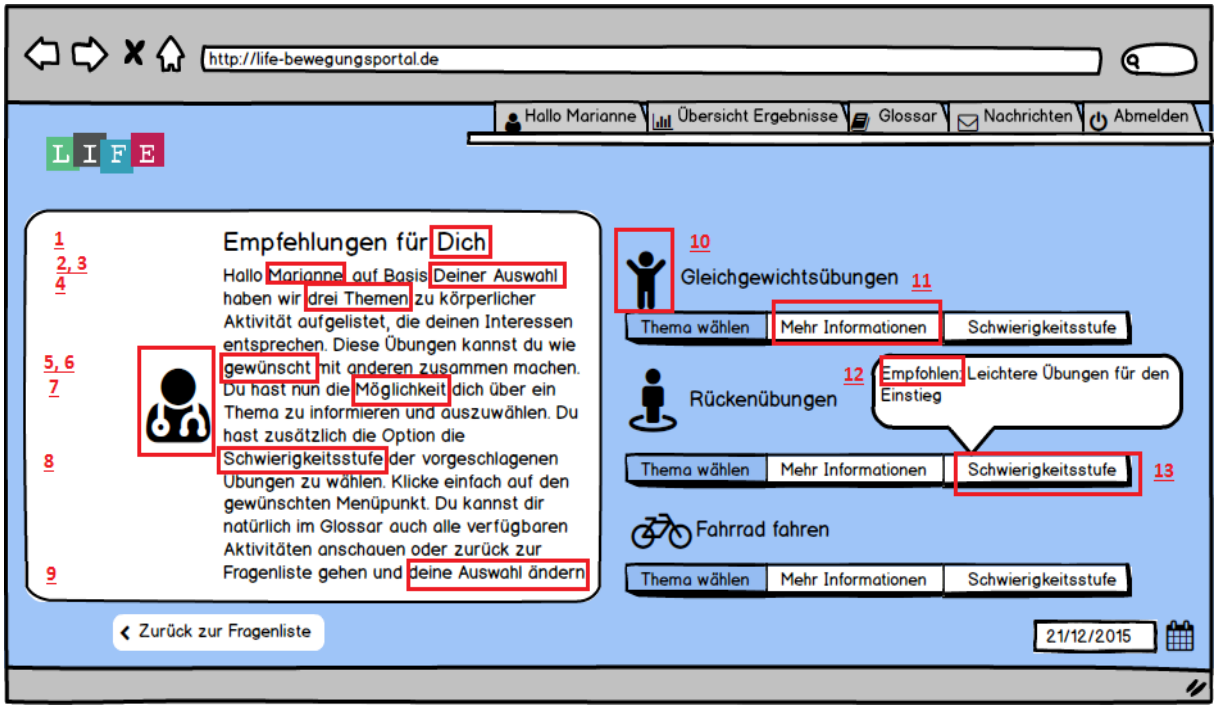


Figure 4: Screenshot of the recommendation page in the SDT (+) prototype

- SDT + A: Abbreviation for self – determination construct supporting autonomy
- SDT + C: Abbreviation for self – determination construct supporting competence
- SDT + R: Abbreviation for self – determination construct supporting relatedness

1.) SDT + R → strategy: affection. User is addressed directly. Dialogue support: Liking.

2.) SDT + R → strategy: affection. User is addressed directly. Dialogue support: Liking

3.) Primary task support: Tailoring. User is reminded that the advice is based on his interests he stated in the screening test

4.) SDT + A → strategy: Choice. User is shown that he has different choices and can select the one he preferred most, Primary task support: tailoring

5.) System credibility support: surface credibility. User sees an icon of a doctor

6.) SDT + A → strategy: avoidance of control. User is reminded that the offered advice is given based on the wishes of the user. Therefore the user knows that he is in control of the situation

7.) SDT + A → strategy: Avoidance of control. User is shown that he chooses what to do next.

8.) SDT + C → strategy: Clarity of expectation, system credibility support: expertise. User is provided with information about how difficult the exercise is and that he can choose which level he prefers.

9.) SDT + A → strategy: Avoidance of control. User is reminded that he can change his choices he made in the screening if he wants to do that

10.) SDT + A → strategy: Choice. User is shown three different exercises

11.) SDT + C → strategy: Provide instrumental support & system credibility support: Expertise. User has the possibility to get more information

12.) SDT + C → strategy: Clarity of expectation & dialogue support: suggestion of level of exercise

13.) SDT + C → strategy: Clarity of expectations through providing a suggestion. User can collaboratively set realistic goals when choosing between different levels of exercises

Example of the recommendation in the SDT (–) prototype:

Figure 5: Screenshot of the recommendation page in the SDT (+) prototype

- SDT – A: Abbreviation for self – determination construct oppressing autonomy
- SDT – C: Abbreviation for self – determination construct oppressing competence
- SDT – R: Abbreviation for self – determination construct oppressing relatedness

Important differences to the SDT (+) prototype:

1.) SDT – R → strategy: Low affection. User is not directly addressed

2.) SDT – R → strategy: Low affection. User is not directly addressed

3.) SDT – A → strategy: Low avoidance of control. Using authoritarian symbol. Instead of the icon an exclamation mark is used. It is a metaphor that points out that the advice has to be interpreted more as an order than as an advice.

4.) SDT – A → strategy: Low choice: Pointed out that system has decided what exercise would be appropriate according to the screening the user filled in, Primary task support: tunneling, reduction. System reduces effort to choose between several options.
5.) SDT – A → strategy: Low choice. Pointed out that user should do definitely the suggested exercise because it fits the screening and interests of the user
6.) SDT – A → strategy: Low avoidance of control. User gets more strictly guidelines how to go further. Directly addressed to the exercise
7.) SDT – A → strategy: Low choice. Users see that there were three different kinds of exercises but there was already made a choice by the system which exercise is appropriate. User can only choose the advised exercise.
8.) SDT – C → strategy: Low clarity of expectations. Users has not the possibility to get more information about the effect of the exercise
9.) SDT – A → strategy: Low choice. User is offered with two exercises. Primary task support: tunneling

3.3 Results of the usability study of the prototypes

In table 7, the demographics of the respondents of the usability study were presented. The two developed prototypes were evaluated by ten respondents (M= 69.1 years; SD= 4.51). Two of the respondents had a low educational level, six respondents had an average educational level and two of the respondents had a higher educational level. The respondents were asked about their technology skills prior in the interviews. The technology skills were slightly different within the group. Most of the respondents had average technology skills (n=6, they know how to use a computer), one respondent had higher technology skills and was more experienced and three respondents had low technology skills.

Five male respondents and five female respondents were randomly assigned to one of the two groups in the cross – over study. The first group consisted of two men and three women (M=69.2 years; SD=2.49). This group did first the usability test of the SDT (+) prototype. After they answered the evaluation questions (Appendix E), they did the usability testing of the SDT (–) prototype and evaluated the second prototype and compared it to the first (Appendix E). The second group consisted of three men and two women (M=69 years; SD=6.28). The respondents in this group did first the usability testing of the SDT (-) prototype and later on the usability testing of the SDT (+) prototype.

Table 8. *Demographical data of respondents in cross – over study*

Group	Respondent	Age	Gender	Educational level	Technology skills
1	1	73	Male	Average	Average
1	3	70	Female	Average	Average
1	6	67	Male	High	High
1	9	67	Female	Low	Low
1	10	69	Female	Average	Average
2	2	65	Male	Average	Low
2	4	80	Male	High	Low
2	5	65	Female	Low	Average
2	7	67	Female	Average	Average
2	8	68	Male	Average	Average

3.3.1 System usability scale for both prototypes

After testing a prototype, the respondents were asked to rate on a 5- point Likert scale (from "strongly disagree" to "strongly agree") the different items of the system usability scale for the tested prototype. Overall both prototypes were evaluated with a positive score. The total SUS for SDT (-) was 80.3 and the total SUS for SDT (+) was 79.8. The SUS can range from 0 – 100. The SUS for SDT (-) showed that it was slightly evaluated higher than the SDT (+). When the respondents were asked what lead to their rating, it was stated that they perceived the SDT (-) a bit less complicated because of the fewer options. But the difference was only marginal. The respondents were very content with the interface designs. The interface was not crowded and was well structured. The results of the evaluation showed that both prototypes were well structured and the program was easy to handle. Only respondent 4 evaluated the SUS for both prototypes lower than the average but respondent 4 was also the oldest respondent (age= 80 years) with low technical skills. The systems of both prototypes were not unnecessary complex.

Two respondents (R.6 and R.8) were already prior the usability testing confident that they would be able to handle the program. But in the beginning of the trial, most of the other respondents (n= 8) did not feel confident that they would be able to handle the program. Out of those respondents, seven elderly were surprised that they have barely any problem with the program, even though they have average technical skills and are not familiar to such a program. Only respondent 4 was insecure and said that he needed more guidance. He proposed to add a guidance video at the beginning. In the think aloud phase of the trials and during the observation, some points for improvement were noticeable. As earlier said, respondent 4 said that he would like to have an instruction video at the beginning of the program, because he has low technology skills and was a bit lost in the beginning. Respondent 2 and 9 also added that a short instruction video or manual would be helpful even though they learned quickly

how to use the program. They described that the short instruction video should introduce the participant to the different features of the program.

Two of the respondents (Respondent 2 and 3) had difficulty with starting the videos in both of the prototypes. Also all of the other respondents did need a long time to figure out how to start the video (six respondents needed more than a minute). It was in both prototypes not immediately clear how to start the exercise. In addition to that, some respondents (Respondent 1, 2, 3) needed time to find the button where they can open the reminder message and some overlooked the button to confirm the option they have chosen (R. 1, 4, 5, 9) . They were surprised, that they needed that much time to find the button (R.9:"How could I possibly overlook this button?"). The respondents named some general improvement points for the further development of the system:

- Font size should be adjustable. For some respondents the font size was difficult to read due to their bad eye sight. The researcher increased the font size so the outcomes are not affected by the font size.
- Take care that the voice messages in the program are loud enough even for 80 years old. The researcher used a mobile loudspeaker to adjust the volume for two respondents
- One respondent did not know what a glossary is
- Exercises could be rated by the user. But according to the users (R.6, 8, 9) the option of rating an exercise should not be offered when users pause with an exercise. They stated that people have to complete an exercise to be able to rate an exercise appropriately

Table 9. *System usability scale. Mean scores for the prototypes*

Participant	SUS for SDT (+)	SUS for SDT (-)
1	**82.5**	**70.0**
2	**62.5**	**67.5**
3	**75.0**	**87.5**
4	**57.5**	**62.5**
5	**85.0**	**87.5**
6	**90.0**	**90.0**
7	**90.0**	**85.0**
8	**85.0**	**82.5**
9	**85.0**	**85.0**
10	**85.0**	**85.0**
Total SUS Score	**79.8 (SD= 11.3)**	**80.3 (SD = 9.8)**

3.3.2 Comparison of the SDT (+) prototype with the SDT (-) prototype

The respondents named several advantages and disadvantages after testing the two prototypes (Appendix F). In general both prototypes were mainly evaluated positively. Respondents liked especially that the features of the program were well chosen and that the steps were logical to follow. When the respondents were asked which prototype they prefer, nine respondents out of ten stated they

preferred the SDT (+) prototype. They were content with the system usability of both prototypes and therefore it did not affect their preference. One respondent preferred the SDT (-) prototype because of its simplicity (less decisions to make). The preference for the SDT (+) was independent of the order of presenting the prototypes because the preference did not differ for group 1 and group 2 in the cross – over study. Many strategies to affect the motivation to use the program and be physically active were positively evaluated by the respondents. Nonetheless, there were some points respondents liked more in the SDT (-) version, they would like to change in the SDT (+) version.

Autonomy

In the SDT (+) prototype two methods were used to enhance autonomy: avoidance of control and choice. The strategies were: to provide three options that match the interest in the given use – case scenario and not to use authoritarian or guilt – inducing language. The evaluation of the strategies showed mixed results.

The strategy to avoid guilt- inducing or authoritarian language or metaphors did not affect all respondents. Three respondents experienced the guilt – inducing language in SDT (-) negative, but six of the respondents underlined that they liked the guilt – inducing feedback. They pointed out that it was necessary to underline the importance of being physically active. The statistic is named by some respondents of being a supportive factor. The statistic is evaluated by three respondents negatively and that it created too much pressure ["*I really don't need the guilt-inducing language. The statistic terrifies people. I think that when people bring themselves to do something, they do it because they want it. You shouldn't create pressure (…). I don't think that I would run faster if someone approaches me with this strategy"* (R.3)].

In addition to that, in the SDT (-) prototype an exclamation mark was used in the design. This mark was presented next to the advice and the feedback. Most of the respondents preferred the exclamation mark above the doctor. In addition to that six of the respondents did not recognize that the symbol in the SDT (+) represented a doctor with a stethoscope (R.3*: Oh, that's a doctor? It does not affect my motivation that much but I would prefer the exclamation mark. The necessity becomes more obvious with this symbol […], it's a real eye – catcher"*). The exclamation mark was perceived only by one respondent (R.1.) negatively. He stated that the exclamation mark next to the recommendation felt like an order and that he did not like to take orders.

The possibility of having a choice between different options is mentioned by every respondent. All of the elderly said that they needed more than one option. According to the respondent, this was necessary because their choice of physical activity was dependent on their mood ["*What should I do if I'm just not in the mood to bicycle? I know I would rather do nothing than do an activity I have no interest at the moment.*" (R.1)], their personal interests [„*Having choices is better.*

I'm interested in exercises for the back and bicycling. And balance exercises are also important. Here are only back exercises. Therefore, I rather tend to choose the other version."(R.5)] and their physical condition [*"If you already have little aches and pains, you should not have to make them worse. The bicycle exercise has to be put aside, if your knees are busted"* (R.9)]. Also the option to pause with an exercise was mentioned positively by the respondents. The main advantage they pointed out was that they did not have to start with the exercise all over again if they were interrupted.

Competence

To enhance competence in the SDT (+) prototype, the methods practical skills training and clarity of expectations were used. The used strategies were to provide a video with instrumental and practical guidance of the back pain exercise. The other strategy was to set collaboratively goals and give information about what can be expected from the behavior linked outcome.

The video was positively evaluated by all respondents and was the strongest factor that affects their motivation to use the program and be physically active. Even respondents who started with the SDT (-) prototype suggested that a video with someone who showed the exercise would be more helpful. Two respondents explicitly said that they found it easier to follow the steps if they can simultaneously do it while watching the video (R.3 & R.6). It also enhanced the feeling of interactivity according to one respondent (R.6). All female respondents started to try parts of the exercise while watching the video and some stated after the trial that they felt motivated (R.3, 5, 7 and 9) and asked if there were more videos they can try out now (R.9). The instructions were most important when following exercises according to respondent.3. But seven of the respondents also liked the video in the SDT (-) version about general information. They said that such a video was helpful to understand how everything is related *["I really like the video about the general information. Especially the sketch about the back and how everything is related*" (R.4). They suggested that the video of the SDT (-) version should be added in the SDT (+) version.

Clarity of expectation was also frequently mentioned. Respondent 3 said: *"You would not do it [the exercises] when you don't know if they are indeed helpful*". Also the option to collaboratively decide the level of difficulty was mentioned by everyone. Six of the respondents stated that they were first afraid that the exercises or activities could be too difficult for their age group. But they were content to see, that they were capable to follow the chosen activity in the prototype ["*It's good that the exercise is not too difficult. It is possible to do it even if you are older. I like that there are different nuances. Everyone can decide based on their current state what exercise they prefer. That's really a good thing."* (R.8)]

The function of collecting stars to get access to new videos/ exercises was evaluated positively by seven respondents *["Based on the amount of stars, I can estimate my performance so far. This helps me more than base flattery."* (R.9)]. One respondent added that it would be good to adjust the

feedback to the collected amount of star [*I would add some explanation about the meaning of the collected stars. For example, if you can earn 30 stars, I would adjust the appraisal in three sections. From 1-10, 10 – 20. If you are below 10 stars, you can say something like, that's a good start but I'm sure you can improve. Try harder and keep going on. And if you earn e.g. 30 stars: 'That was really great for your body. This is excellent for your health. You did a really good job.' You have to reward the people on this level.*" (R.6)]. Two respondents did not care about the function of collecting stars and one respondent did not like the function ["*I don't need stars. For me praise is enough. The stars are distracting. Is it possible to minimize the part about the stars? I prefer the other one more."* (R.10)]. One respondent suggested to add the feature of a quiz about health issues where you can earn points (R.6).

Relatedness

The third construct that was tested was relatedness. In the SDT (+) prototype, the method dependability was used by providing a help button and a reminder email. Affection was shown by display concern acknowledgement for the elderly and gave praise in the feedback. In addition to that, to personalize the content, the user was addressed directly. The elderly named the affection strategy praise when they explained why they preferred certain aspects of the feedback.

The reminder email was mainly seen as a helpful tool to increase the motivation to be physically active ["*I like the reminder mail. I know my habits. If I interrupt with an exercise, I usually won't continue with it. But the reminder helps me to fight this inner temptation, to letting it go."* (R.9)]. Some elderly [R.2. R.3 & R.9] stated that they did not care if they were praised and it "is only important if the exercise actually helps the body".

Other respondents highlighted the importance of being praised [„*The first one (SDT +) is more motivating. Compliments, congratulations, you receive three stars. I already feel it. People want to be a bit praised. A small thank you, a little reward is simply nice."(*R.6)]. It was also mentioned that a mix of being praised and highlighting the importance of physical activity like in SDT (-) would be a good solution ["*Maybe I am sensitive, but when I do this exercise for myself, then I want to be a little bit praised. Of course, there are sometimes feedbacks, which are not nice. But it has to include some positive motivational element. Maybe mixing up the two versions would be useful. I would underline the importance of doing the exercise according to the guidelines and include the positive encouragement from the other feedback version."* (R.5)].

The results also showed that many respondents preferred to be addressed by name because they were used to it in rehabilitation class or in daily life but they stated that it did not affect their motivation to use the program.

Chapter 4: Discussion:

4.1 Reflection:

The aim of the present study was to investigate, how a physical activity program for elderly had to be designed to facilitate the motivation to follow physical activity recommendations. In this context design means not only the interface design of the program but also how recommendations and feedback has to be given. Based on the literature, the self – determination theory (SDT) was chosen as a suitable framework for the development of a physical activity program. In the literature were theoretical frameworks presented with SDT supporting strategies (Silva et al., 2014). However, it was not shown how they can be implemented in an actual physical activity program.

To develop a prototype that was built on the SDT principles, interviews were held with elderly in the target group to gain knowledge about user requirements. The methods and strategies for the development of the prototypes contained the manipulation of SDT strategies, persuasive elements and two behavioral change techniques. With the program "Balsamiq" mock – ups were made that showed how the SDT strategies could be worked out in a physical activity program. Two prototypes were made. One prototype was built on the SDT strategies and in another prototype was the SDT strategies reversed. To evaluate the prototypes, a cross – over study with a cross – lagged within subject design was carried out. Both prototypes had good system usability scores (SUS). The SUS of the SDT (–) was only marginal higher. The closure interview of the usability study showed that nearly all respondents preferred the SDT (+) prototype above the SDT (–) prototype.

Based upon the self – determination theory, it was suggested that if all three psychological needs are fulfilled, the motivation to engage e.g. in physical activity will be positively affected (Deci & Ryan, 1985). The results of a study from Sheldon and Niemiec (2006) showed that the best outcome is reached when all 3 psychological needs are equally satisfied. In the current study, this suggestion was partly supported. All three needs are somehow important for the respondents but not all the needs seem to be equally important.

Autonomy – supportive features like having multiple choices were evaluated extremely positively by the respondents. This finding is supported by the literature. According to Katz and Assor (2006), it is relevant that the offered choices meet the needs of the individual. In this study, the interviews helped to identify different choices that meet the needs of the target group.

Surprisingly, there were mixed results for the SDT (-) prototype that contained the autonomy reducing strategy of guilt – inducing language and the exclamation mark. The mixed- results within the subjects shows that the subjective perception differs from the objective evidence. Some elderly point out that the guilt – inducing message about the risk of inactivity is perceived motivating, but

only in combination with positive feedback. They stated that the message highlighted the importance of being physically active and gave them an additional push to follow the advice. A possible explanation for the positive evaluation of the guilt – inducing language was that it helped elderly to see the necessity of the exercise. As mentioned earlier, the highlighting of the risks were only evaluated positively, when they were combined with positive encouraging statements. Williams and Deci (2009) pointed out that if too much pressure is put on the individual, the interest in the activity will be gone. Also constant negative feedback will negatively affect the motivation. The findings of a study of Ruiter, Kessels, Peters and Kok (2014) suggest that information should be aimed at increasing perceptions of response effectiveness or self – efficacy than highlighting threatening health information. Thus, instead of highlighting the risk, the benefits from the physical activity should be mentioned in the feedback.

Based on the results of a study from Sheldon and Niemiec (2006), it was expected that all 3 psychological needs have to be equally satisfied. But in this study, the competence component seems to have the most decisive contribution According to the respondents in the closure interview, practical guidance is the main factor to choose the SDT (+) prototype. An explanation for this finding could be that the sample in this study consisted of respondents, who already e.g. experience high autonomy. Therefore their need to satisfy their need for competence may be higher. According to Vallerand (2007) people behave in a particular way to satisfy their needs. Thus, in this sample, respondents may experience a lack of practical guidance to be physically active. The practical guidance video is evaluated positively because it gave them guidance and enhanced their competence.

Allen and Howe (1998) suggested that positive feedback can be effective for women to increase (perceived) competence in the individual. In this study, competence was mentioned by the respondents as important factor to prefer the SDT (+) prototype above the other prototype. The construct of competence is e.g. comparable to the self – efficacy concept (Bandura, 1997) which is a strong predictor of physical activity (Sallis& Brown, 2002). Williams and Deci (2009) stated that if challenges are too difficult, they could lead to feelings of incompetence and disengagement. Therefore, the preference for the SDT (+) prototype could be related to the practical guidance and different levels of difficulty that helped respondents to feel more competent to attain their physical activity goal.

The feature of collecting stars is mainly positively valued and is described as a feature that enhances the interactivity of the program and the motivation use to use the program to be physically active. In some previous studies, it was suggested that rewards can lead to an overjustification effect (Heckhausen & Heckhausen, 2006). This effect was suggested to appear when an expected reward was no longer offered. The underlying hypothesis was that a pre –existing intrinsic motivation to perform a

behavior will be undermined when a formerly unrewarded behavior, is rewarded and the focus shifts to extrinsic motivation. It was suggested that extrinsic rewards have to be constantly offered; otherwise it would negatively affect motivation. But recent studies showed, that under certain conditions, extrinsic rewards can be supportive to maintain intrinsic motivation instead of decreasing it. A meta – analysis from Cameron, Banko and Pierce (2001) showed that the overjustification effect only occurs when the activity is really interesting, material rewards are given instead of praise and when rewards are expected. So, if an individual has a low initial level of interest in a physical activity, using rewards as an extrinsic motivation can help to involve the individual in starting with an activity. In order to motivate elderly in being physically active, extrinsic rewards (like earning stars when engaging in exercises and get access to new videos/ exercises) could be used to gradually shift the extrinsic motivation into intrinsic motivation.

The results of this study showed that the relatedness – supportive strategies for affection can be useful when developing a physical activity program. In the prototype of this study was no option for face – to – face contact with the provider intended. However, the user has the possibility to send a message to the administrator. The features reminder mail and praise were pointed out positively for the motivation to be physically active.

4.2 Strong points of the study

One strong point of this study is the qualitative approach to develop a prototype. By using the results of the qualitative approach, it was possible to develop prototypes with good system usability that also matches the interests of the target group. Respondents are surprised how easy the programs (prototypes) are to handle. Many elderly expected their low or average technical skills to be a barrier but this barrier was considered by reducing complexity in the interface design and by creating the display in a familiar navigational tool that shows information in a predictable way.

In addition to that, a strong point in this study is the cross-lagging of the order in which respondents are shown both prototypes. If all the elderly would have seen first the SDT (+) version, the answers for the SDT (-) prototype might have been manipulated through the order of precedence of the SDT (+) prototype. Thus, the results show that the preference is independent from the order because the results do not differ per group.

Another strong point of this study is the use of the think - aloud method. The think – aloud data were analyzed in a methodologically verified way that gave an insight into the spontaneous thoughts of the respondents. In addition to that, the observation of the respondents during the usability test was very helpful. For example, all female elderly started spontaneously to follow the shown exercise in the video of the SDT (+) prototype. It was not asked in the usability test to do exercises. All respondents

asked prior the usability testing if they would to have to do any exercises in this part of the study. Therefore, the reactions of the female respondents are not an indication of willingness to do the usability test correctly, but more an indication of increased motivation to engage in physical activity. This reaction would have been missed if the evaluation would have been carried out e.g. through an online questionnaire.

Another strong point was that this study shows how strategies to enhance autonomy, competence or relatedness can be carried out in a prototype/ program and how it is perceived by respondents in the target group. These results can be useful when developing a program to increase physical activity motivation. The results of this study can be used as guidance for operationalizing a physical activity program that is built on SDT.

4.3 Limitations of the study

This study has some potential limitations. An important limitation regarding the design of this study is that outcomes are based on respondent's subjective appraisal of SDT strategies. It's limited to overt preferences (and susceptible to biases). More covert cognitive processes are neglected. In this study the actual usage and change in physical activity could not be measured. It is only a hint that the motivation of respondents to use the SDT (+) program is higher than for the SDT (-) program. The actual usage and physical activity behavior has to be tested after developing a hi – fi prototype.

A second limitation could be a possible social desirability bias in the closure interviews after the usability testing. In the face – to – face interview some elderly might tend to answer questions in a manner that they view as favorably for the researcher. This might bias the results that respondents avoid more negative statements about the prototype. The researcher tried to minimize this aspect by pointing out the necessity of a critical view for the further development of the program. This did not seem to bias the answers of the respondents in the other direction. Respondents still pointed more positive aspects out than negative aspects.

The respondents in this study consisted mainly of respondents that have at least a basic motivation in physical activity. When already motivated respondents were involved, who might already experience high autonomy and competence became in this case relatively important. Within this sample, the study still generated valid results. In addition to that, it should be considered that elderly, who are in the hard – to – reach group, might experience other difficulties that are not considered in this prototype yet. In hard – to reach groups are people, who are difficult to access because of a characteristic of its members (Faugier et al. 1997). One example might have been social isolation in elderly. According to Hawkley, Thisted and Cacioppo (2009), social isolation was associated with poor life style behaviors such as physical inactivity. In the prototype of this study the chosen exercises can be done alone or with a partner. It was also intended to create interactivity by

showing a role model who does the exercise in the practical guidance video. Therefore, the user had the possibility to do the exercise simultaneously with the role model. It had to be explored of elderly who were in the earlier described hard – to – reach group would be satisfied with this implementation. Therefore, for elderly in the hard –to – reach group a closer examination of the user requirements may be necessary. Consequently, the possible findings of this study may not represent the whole range of user requirements. They might have some additional values for a physical activity program that were not considered yet.

4.4. Implications for future research

The next step for future research should be to replicate the usability test among a sample with different characteristics. It would be interesting to see, if the results of this study would be the same and the program would be evaluated differently for really inactive elderly or social isolated elderly. The elderly in this study had a basic motivation to be active. It could be possible that the used strategies were not convincing enough for really inactive elderly or that they preferred different features. Other characteristics that may be considered are e.g. age, technology – focus of the elderly, multi – morbidities. In this context, another interesting aspect for future research would be to deliver different versions to specified target groups. This could increase the future usage of the program and the physical activity behavior.

The current prototype in this study is lo – fi. It was a quick transition of a high – level design concept to test how a physical activity program that contains the (manipulation) of SDT – principles are evaluated. The current prototype had some interactive elements, but at the current state it was not Hi-fi enough to test actual usage. The program should be tested over a longer period. This could help to answer the question, if the physical activity program could be a supportive feature to help elderly to be physically active and if the physical activity behavior changes positively.

In addition, a dissemination strategy for awareness should be considered (Grimshaw, Thomas, MacLennan, Fraser, Ramsay, Vale, Whitty, Eccles, Matowe, Shirran, Wensing, Dijkstra & Donaldson, 2004). Elderly in this sample said that they do not know, if there was any technology – based physical activity program in Germany available. Thus, if elderly were not aware of such programs, they were not able to participate on it. Therefore it is necessary to think thoroughly about methods and strategies on how to reach the intended target group after developing the hi-fi prototype. For example, to raise awareness and promote the physical activity prototype/ program, facilities that are frequented by elderly, can be visited.

4.5 Conclusion

This study provides a first approach on how a prototype can be built on SDT principles. The results could be useful guidelines to adapt the technology and to develop a physical activity program for elderly that meet their needs. The SUS for the prototypes were good and shows that the interface

design was appreciated by the elderly in the sample. This can affect their motivation use the program and be physically active. This study also shows that preferences are not always consistent with empirical evidence. The strategy to avoid guilt – inducing language or use authoritative symbols as the exclamation mark showed mixed results within the sample. But especially the strategy to offer different choices, using at least one of the two strategies praise or reward and practical guidance videos were important factors that should be considered in the built – up of a physical activity program. All three components of the SDT theory have to be considered when developing the program. In this study, the need for competence is evaluated as most important by the respondents. A hi–fi prototype has to be developed based on the results of this study to assess the actual usage and the usability study should be replicated to have a better generalizability.

5. References

Allen, J.B., & Howe, B. (1998).Player ability, coach feedback, and female adolescent athletes' perceived competence and satisfaction. *Journal of Sport and Exercise Psychology*,20,280–299.

Beweegnormen | NISB. (2016). Retrieved from http://www.nisb.nl/weten/normen.html

Brawley, L., Rejeski, W.J., King, A.C. (2003). Promoting physical activity for older adultsThe challenges for changing behavior. *American Journal of Preventive Medicine*, *25*(3), 172-183. doi:10.1016/s0749-3797(03)00182-x

Brooke, J. (2011). SUS - a quick and dirty usability scale. Retrieved from http://hell.meiert.org/core/pdf/sus.pdf

Cameron, J., Banko, K.M., Pierce, W.D. (2001). The Pervasive Negative Effects of Rewards on Intrinsic Motivation: the myth continues. *The Behavior Analyst*, 24, 1-44

Campbell, A. J., Robertson, M.C., La Grow, S.J., Kerse, N.M., Sanderson, G.F., Jacobs, R.J., Sharp, D.M., Hale, L.A. (2005). Randomised controlled trial of prevention of falls in people aged >=75 with severe visual impairment: the VIP trial. *BMJ*, *331*(7520), 817-0. doi:10.1136/bmj.38601.447731.55

Cochrane, T., Munro, J., Davey, R., &Nicholl, J. (1998). Exercise, Physical Function and Health Perceptions of Older People.*Physiotherapy*, *84*(12), 598-602. doi:10.1016/s0031-9406(05)66153-6

Centraal Bureau voor de Statistiek. Persbericht: Tempo vergrijzing loopt op. CBS 2010; PB10-083.

Collard, R.M., Schoevers, R.A., Oude Voshaar, R.C. (2012). Prevalence of frailty in community-dwelling older persons: A systematic review. *Journal of the American Geriatrics Society*, *60*(8), 1487-1492. doi:10.1111/j.1532-5415.2012.04054.x

Costello, E., Kafchinski, M., Vrazel, J., & Sullivan, P. (2011).Motivators, Barriers, and Beliefs Regarding Physical Activity in an Older Adult Population.*Journal of Geriatric Physical Therapy, 34*(3), 138-147. doi:10.1519/jpt.0b013e31820e0e71

Deci, E. L., & Ryan, R. M. (1985).Intrinsic Motivation and Self-Determination in Human Behavior.doi:10.1007/978-1-4899-2271-7

Ericsson, K. A., Simon, H. A. (1993). Protocol Analysis: Verbal Reports as Data. *MIT Press*, Cambridge, MA.

Fortier, M. S., Duda, J. L., Guerin, E., & Teixeira, P. J. (2012). Promoting physical activity: Development and testing of self-determination theory-based interventions.*International Journal of Behavioral Nutrition and Physical Activity, 9*, 1-14

Gagné, M., Ryan, R. M., &Bargmann, K. (2003). Autonomy support and need satisfaction in the motivation and well-being of gymnasts. *Journal of Applied Sport Psychology*, *15*, 372-390.

Gemert-Pijnen, L, In Peters, O., & In Ossebaard, H. C. (2013).*Improving ehealth*. The Hague: Eleven International Publishing.

Giné-Garriga, M., Guerra, M., &Unnithan, V. B. (2013). The effect of functional circuit training on self-reported fear of falling and health status in a group of physically frail older individuals: a randomized controlled trial. *Aging Clinical and Experimental Research*, *25*(3), 329-336.doi:10.1007/s40520-013-0048-3

Grimshaw, J., Thomas, R., MacLennan, G., Fraser, C., Ramsay, C., Vale, L., Whitty, P., Eccles, M.P., Matowe, L., Wensing, M., Dijkstra, R. & Donaldson, C. (2004). Effectiveness and efficiency of guideline dissemination and implementation strategies. *International Journal of Technology Assessment in Health Care*, *21*(01). doi:10.1017/s0266462305290190

Grodesky, J. M., Kosma, M., &Solmon, M. A. (2006).Understanding Older Adults' Physical Activity Behavior: A Multi-Theoretical Approach.*Quest*, *58*(3), 310-329. doi:10.1080/00336297.2006.10491885

Guilizzoni G. (2010). Balsamiq Mockups, Balsamiq, Received: http://www.balsamiq.com

Hawkley, L. C., Thisted, R. A., & Cacioppo, J. T. (2009). Loneliness predicts reduced physical activity: Cross-sectional & longitudinal analyses. *Health Psychology*, *28*(3), 354-363. doi:10.1037/a0014400

Heckhausen, J., Heckhausen, H. (2006). *Motivation und Handeln: Mit 43 Tabellen*. (Motivation und Handeln.) Heidelberg: Springer.

Katz, I., &Assor, A. (2006). When Choice Motivates and When It Does Not. *Educational Psychology Review*, *19*(4), 429-442. doi:10.1007/s10648-006-9027-y

Kemper, H.G.C., Ooijendijk, WTM, Stiggelbout, M. (2000). Consensus over de Nederlandse Norm voor Gezond Bewegen. *TijdschriftSocialeGezondheidszorg*, *78*, 180 - 183.

Lonsdale, C., Hall, A., Williams, G. C., McDonough, S. M., Ntoumanis, N., Murray, A., & Hurley, D. (2012). Communication style and exercise compliance in physiotherapy (CONNECT). A cluster randomized controlled trial to test a theory-based intervention to increase chronic low back pain patients' adherence to physiotherapists' recommendations: Study rationale, design, and methods. *BMC Musculoskeletal*, *13*, 10.doi: 10.1186/1471-2474-13-104

Marzetti, E., &Leeuwenburgh, C. (2006).Skeletal muscle apoptosis, sarcopenia and frailty at old age.*Experimental Gerontology*. doi:10.1016/j.exger.2006.08.011

Mills, E. J., Chan, A., Wu, P., Vail, A., Guyatt, G. H., & Altman, D. G. (2009). Design, analysis, and presentation of crossover trials. *Trials*, *10*(1), 27. doi:10.1186/1745-6215-10-27

Moran, M., Cauwenberg, J.V., Hercky-Linnewiel, R., Cerin, E., Deforche, B., Plaut, Pnina. (2014). Understanding the relationships between the physical environment and physical activity in

older adults: a systematic review of qualitative studies. *International Journal of Behavioral Nutrition and Physical Activity, 11*(79).doi:10.1186/1479-5868-11-79

Moschny, A., Platen, P., Klaaßen-Mielke, R., Trampisch, U., &Hinrichs, T. (2011).Barriers to physical activity in older adults in Germany: a cross-sectional study. *Int J BehavNutrPhys Act, 8*(1), 121. doi:10.1186/1479-5868-8-121

Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., Macera C. A., Castaneda -Sceppa, C. (2007). Physical Activity and Public Health in Older Adults: Recommendation from the American College of Sports Medicine and the American Heart Association. *Medicine and Science in Sports and Exercise*. doi:10.1249/mss.0b013e3180616aa2

Noar, S. M., Benac, C. N., & Harris, M. S. (2007). Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. *Psychological Bulletin, 133*(4), 673-693. doi:10.1037/0033-2909.133.4.673

Ooijendijk, W.T.M., Hildebrandt, V.H., Hopman - Rock, M. (2007). Trendrapport Bewegen en gezondheid 2004/2005. *Hoofddorp/Leiden:TNO*.

Paterson, D.H., Jones, G.R., Rice, C.L. (2007). Ageing and physical activity: evidence to develop exercise recommendations for older adults. *Canadian Journal of Public Health, 32*, 69-108. doi:10.1139/H07-111

Physical Activity Guidelines Advisory Committee (2008): Physical Activity Guidelines Advisory Committee Report. Washington, DC: U.S. Department of Health and Human Services

Pommeranz, A., Brinkman, W.-P., Wiggers, P., Broekens, J., &Jonker, C. M. (2009). Design guidelines for negotiation support systems: an expert perspective using scenarios. *ECCE 2009*, 1-8.

Pruitt, J., & Grudin, J. (2003).Personas.*Proceedings of the 2003 conference on Designing for user experiences - DUX '03*. doi:10.1145/997078.997089

Rasinaho, M., Hirvensalo, M., Leinonen, R., Lintunen, T., Rantanen, T. (2006). Motives for and Barriers to Physical Activity Among Older Adults With Mobility Limitations. *Journal of Aging and Physical Activity*, *50*, 90-102.

Roberts, G. C., Treasure, D. C., & Conroy, D. E. (2012). Understanding the Dynamics of Motivation in Sport and Physical Activity: An Achievement Goal Interpretation.*Tenenbaum/ Handbook*, 1-30. doi:10.1002/9781118270011.ch1

Ruiter, R. A., Kessels, L. T., Peters, G. Y., & Kok, G. (2014). Sixty years of fear appeal research: Current state of the evidence. *International Journal of Psychology, 49* (2), 63-70. doi:10.1002/ijop.12042

Ryan, R. M., &Deci, E. L. (2007). Active human nature: Self-determination theory and the promotion and maintenance of sport, exercise, and health. *Intrinsic motivation and self-determination in*

exercise and sport, 1-19. Champaign, IL: Human Kinetics.

Ryan, R. M., Williams, G. C., Patrick, H., &Deci, E. L. (2009). Self-determination theory and physical activity: The dynamics of motivation in development and wellness. *Hellenic Journal of Psychology*, *6*, 107-124.

Schutzer, K., Graves, B.S. (2004). Barriers and motivations to exercise in older adults.*Preventive Medicine*, *39*(5), 1056-1061. doi:10.1016/j.ypmed.2004.04.003

Sheldon, K. M., &Niemiec, C. P. (2006). It's not just the amount that counts: Balanced need satisfaction also affects well-being. *Journal of Personality and Social Psychology*, *91*(2), 331-341. doi:10.1037/0022-3514.91.2.331

Silva, M. N., Vieira, P. N., Coutinho, S. R., Minderico, C. S., Matos, M. G., Sardinha, L. B., & Teixeira, P. J. (2010). Using self-determination theory to promote physical activity and weight control: A randomized controlled trial in women.*Journal of Behavioral Medicine*, *33*, 110-122.

Silva, M. N., Marques, M., & Teixeira, P. J. (2014).Testing theory in practice: The example of self-determination theory-based interventions.*The European Health Psychologist*, *16*, 171-180. doi: 10.1186/1479-5868-9-20

Singh, M.A.F. (2002). Exercise comes of age: rationale and recommendations for a geriatric exercise prescription. *Journal of Gerontology*, *57*(5), 262-282.

Smith, B.J., Ploeg, v.d.H.P, Buffart, L.M. (2008). Encouraging physical activity.Five steps for GPs. *Australian Family Physician*, *37*(1/2), 24-28.

Spirduso, W. W., & Cronin, D. L. (2001). Exercise dose-response effects on quality of life and independent living in older adults. *Medicine and Science in Sports and Exercise*, *33*(Supplement), 598-S608.doi:10.1097/00005768-200106001-00028

Van Holle, V., Cauwenberg, J.V., Deforche, B., Van de Weghe, N., Bourdeaudhuij, I.D., van Dyck, D. (2015). Do psychosocial factors moderate the association between objective neighboorhood walkability and older adults' physical activity?.*Health& Place*, *34*, 118-125. Retrieved from http://dx.doi.org/10.1016/j.healthplace.2015.05.004

Wallace, K. A., & Lahti, E. (2005).Motivation in Later Life.*Topics in Geriatric Rehabilitation*, *21*(2), 95-106. doi:10.1097/00013614-200504000-00003

Walker, M., Takayama, L., &Landay, J. A. (2002).High-Fidelity or Low-Fidelity, Paper or Computer?Choosing Attributes when Testing Web Prototypes.*Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *46*(5), 661-665. doi:10.1177/154193120204600513

White, D. K., Wilson, J. C., &Keysor, J. J. (2011). Measures of adult general functional status: SF-36 Physical Functioning Subscale (PF-10), Health Assessment Questionnaire (HAQ), Modified Health Assessment Questionnaire (MHAQ), Katz Index of Independence in Activities of

Daily Living, Functional Independ. *Arthritis Care Res*, *63*(S11), S297-S307. doi:10.1002/acr.20638

WHO (2010). Global recommendations on physical activity for health. Retrieved from http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf

WHO (2011). Global recommendations on physical activity for health. Retrieved from http://apps.who.int/iris/bitstream/10665/44399/1/9789241599979_eng.pdf.

WHO (2013). Physical Activity. Retrieved from http://www.who.int/dietphysicalactivity/pa/en/

6. Appendices

Appendix A: Study information & informed consent:

Studieninformation und Einverständniserklärung

Liebe(r) Untersuchungsteilnehmer/in

Das niederländischeForschungs-/ und Entwicklungszentrum Roessingh ("Roessingh Reasearch and Development") in Enschede entwickelt derzeit in einem Forschungsprojekt ein Programm für Menschen ab 65 Jahren, dass unterstützend dazu beitragen soll einen gesunden Lebensstil zu hantieren und sich körperlich ausreichend zu bewegen. Damit das Programm den Bedürfnissen der Zielgruppe entspricht ist es wichtig, dass diese die Möglichkeit hat ihre eigenen Erfahrungen und Ideen miteinzubringen. Hier kommen Sie ins Spiel. Durch die Teilnahme an dem Interview haben Sie die Chance, das Programm indirekt mitzugestalten..Wir freuen uns, dass Sie sich für diese Forschung interessieren und ggf. bereit sind, an der Studie teilzunehmen. Außerdem würden wir uns freuen, wenn Sie bereit wären an der Folgeuntersuchung teilzunehmen, die einige Wochen später stattfindet. In dieser haben Sie die Möglichkeit Teilbereiche einer ersten vereinfachten Version des Programms zu testen und uns Ihre Gedanken dazu mitzuteilen.

1. **Ziel des Forschungsprojektes**

Im Rahmen meiner Masterarbeit an der Universität Twente untersuche ich, Thivvya Gugathas, wie das Bewegungsverhalten von Menschen, die älter als 65 Jahre sind, aussieht. Es geht hierbei im speziellen um die Fragen, welche Motive und Faktoren eine Rolle spielen bei dem Folgen von Bewegungsratschlägen und wie diese in einem Selbstmanagement Programm zur Förderung eines gesunden Lebensstils praktisch umgesetzt werden können.

2. **Ablauf und Inhalt der Untersuchungen**

Die Untersuchung ist in zwei Teile gegliedert und findet an zwei separaten Tagen statt. Im ersten Teil geht um die Durchführung des Interviews und im zweiten Teil geht es um das Testen von Teilbereichen einer ersten vereinfachte Version des Programms.

Termin 1:

Im ersten Teil der Untersuchung wird das Interview abgenommen. Zunächst werden wir mit Ihnen (telefonisch) einen Termin und Ort vereinbaren, an dem das Interview abgenommen werden kann. Es ist möglich, dass Interview bei Ihnen zu Hause durchzuführen, so dass Sie keine Strapazen auf sich

nehmen müssen. Das Interview erstreckt sich voraussichtlich über eine Länge von 30 - 45 Minuten und wird für die spätere Ausarbeitung mit einem Diktiergerät aufgezeichnet.

Das Interview startet zunächst mit ein paar demographischen Fragen zu Ihnen persönlich. Um einen Einblick zu bekommen, in wie weit Sie bei täglichen körperlichen Aktivitäten beeinträchtigt sind, werde ich Ihnen zehn Aussagen präsentieren, bei denen Sie angeben sollen, ob Ihre Gesundheit Sie bei diesen Aktivitäten (teilweise)einschränkt.Anschließend werde ich Ihnen einige Fragen zu Ihrer körperlichen Aktivität stellen. Es geht hierbei insbesondere um Ihre eigene Erfahrungen und was sie beispielsweise motiviert um sich körperlich aktiv zu halten oder welche Hindernisse Sie sehen, wenn es darum geht, körperlich aktiv zu bleiben. Hierzu werden ich Ihnen im Anschluss auch zwei Listen mit Aussagen präsentiert bei der Sie wie zuvor kurz angeben sollen, in wie weit Sie persönlich den Aussagen zustimmen. Im weiteren Verlauf des Interviews geht es um Ihre Meinung zu Bewegungsratschlägen, Selbstmanagement Programmen und Übungen zur körperlicher Aktivität und Ihren allgemeinen Erfahrungen mit technischen Apparaten wie Tablets oder Handys. Sie haben im Anschluss selbstverständlich noch die Möglichkeit Fragen zu stellen oder Anmerkungen hinzuzufügen.

Wenn Sie weiterhin Interesse haben an dem zweiten Teil der Untersuchung teilzunehmen, vereinbaren wir im Anschluss einen Folgetermin mit Ihnen. Sollten Sie zu dem Zeitpunkt noch nicht wissen, wann ein Termin in Ihren Terminkalender passt, können Sie mich telefonisch oder per E – Mail kontaktieren. Die Kontaktdaten stehen am Ende dieses Schreibens. Vielen Dank.

Termin 2:

Im zweiten Teil der Untersuchung wird ein Teilbereich einer vereinfachten Version des Programms getestet. Für diesen Teil der Untersuchung wird ein separater Termin mit Ihnen vereinbart. Wie zuvor beim Interview wird auch dieser Teil der Untersuchung zunächst für die weitere Ausarbeitung mit einem Diktiergerät aufgenommen.

Zu Beginn stellen wir Ihnen einen von drei Gebraucher – Szenarien vor. Ein Szenario ist beispielsweise das wählen einer Übung. Es gibt verschiedene Versionen des Musterbeispiels, welche Ihnen vorgelegt werden. Um von diesen einen Eindruck zu erhalten, bitten wir Sie während der Ausführungder Übung ihre Gedanken laut auszusprechen.

Anschließend würden wir Ihnen gerne noch ein einige Fragen bezüglich der Ihnen vorgelegten Musterbeispielen stellen. Diese beziehen sich u.a. auf ihren ersten Eindruck von dem Musterbeispiel; was Sie besonders angesprochen hat oder nicht angesprochen; ob es Schwierigkeitenoder Unklarheiten bei der Handhabung gab; ob Sie das Produktim täglichen Gebrauch benutzenwürden und ob Sie noch weitere Anmerkungen oder Fragen haben.

3. Freiwilligkeit und Anonymität

Die Teilnahme an der Untersuchung ist freiwillig.Alle Information, die wir im Rahmen der Untersuchung von Ihnen erhalten, werden absolut vertraulich behandelt. Bei der Auswertung und Aufbereitung Ihrer Daten werden die Unterlagen selbstverständlich anonymisiert, so dass es nicht möglich ist Rückschlüsse auf Sie zu ziehen. Die Unterlagen werden sicher aufbewahrt und die Audioaufnahme wird nach der Ausarbeitung der Studie vernichtet.

4. Was nutzt ihre Teilnahme?

Sie leisten durch ihre Teilnahme an der Studie einen entscheidenden Beitrag zur Erforschung vom Bewegungsverhalten von Menschen ab 65 Jahren. Diese Erkenntnisse könnengenutzt werden, um die Angebote zur Unterstützung von körperlicher Aktivität zielgenau an die Bedürfnisse der Zielgruppe anzupassen, so dass die Zufriedenheit der Gebraucher dadurch auch gesteigert wird und das Programm seine bestmögliche Wirkung entfalten kann.

5. Welche Risiken sind mit einer Teilnahme verbunden?

Es sind keine Risiken mit Ihrer Teilnahme an der Untersuchung verbunden. Sie können die Teilnahme an der Untersuchung zu jedem Zeitpunkt beenden, ohne dass Ihnen dadurch Nachteile entstehen.

6. Einverständniserklärung

Ich habe die Informationen über die Studie sorgfältig gelesen und eine Kopie dieses Schreibens für meine Unterlagen erhalten.

Ich erkläre mich hiermit

☐ Einverstanden

☐ Nicht einverstanden

an der Untersuchungvon Thivvya Gugathas (Universität Twente) und dem „Roessingh Research and Development“ Zentrum teilzunehmen. Ich bin damit einverstanden, dass die im Rahmen des Forschungsprojektes erhobenen Daten und Untersuchungsergebnisse in anonymisierter Form zu Forschungszwecken verwendet werden dürfen. Bei weiteren Fragen erreichen sich mich unter meiner E – Mailadresse ([redacted] oder telefonisch unter der Nummer ([redacted]

Datum _____ Unterschrift _____

Appendix B: Semi – structured interview

The interview is conducted in German with the respondents because the respondents are all German – speaking.

Aim of the Preliminiary interview: To get an insight into the physical activity behavior of elderly and to answer the following questions: What do elderly think of physical activity (programs)? What are motivators and barriers of physical activity? What do elderly think of physical activity advices? How can they be improved? What are their technical skills?

Materials: Technical device to record the interview; paper & pencil to make further notes (observational data) and notes if the elderly does not want the interview to be recorded, bottle of water and glasses if elderly is exhausted

Process: The elderly is first welcomed and thanked for participation on the study.

"Guten Tag, mein Name ist ... und ich freue mich Sie hier begrüßen zu dürfen. Schön, dass Sie sich entschlossen haben an der Untersuchung teilzunehmen. Wie Sie in der schriftlichen Information zur Untersuchung bereits erfahren haben, geht es beim heutigen Interview darum, mehr über das Bewegungsverhalten von Menschen, die älter als 65 Jahre sind, zu erfahren. Das Interview wird voraussichtlich 25- 35 Minuten dauern. Sie können das Interview jederzeit abbrechen. Bevor wir mit dem Interview starten, wollte ich erst nachfragen, ob Sie noch Fragen zur Untersuchung haben oder ob alle Fragen geklärt sind." **[if the participant has further questions concerning the study, they will be answered]**. *"Sollten alle Fragen geklärt sein, würde ich Sie bitten eben die Einverständniserklärung zu unterzeichnen.*

[the signed informed consent will be copied and the copy will be handed to the elderly and the original will be filed in a folder].

"*Gut, dann können wir ja nun beginnen. Zunächst würde ich Ihnen gerne einige Frage zu Ihnen persönlich stellen. Es geht hierbei um demographische Informationen.*

- *Wann sind Sie geboren?*
- *Leben Sie zu Hause? Wohnen mit Ihnen noch weitere Personen im Haushalt?*
- *Wie sieht Ihre schulische Laufbahn aus?*
- *Nun kommt eine Frage, die sich auf den Zeitraum der letzten drei Monaten bezieht. Sind Sie in dem Zeitraum ein oder mehrmals gestürzt?*

[Then the construct PF – 10 of the SF – 36 will be assessed]

"Nun möchte ich Ihnen gerne einige Aussagen präsentieren. In dieses Aussagen geht es um Aktivitäten, die Sie vielleicht an einem typischen Tag machen. Ich würde Sie bitten anzugeben, in wie weit Ihre Gesundheit Sie bei diesen Aktivitäten möglicherweise einschränkt. Würden Sie sagen, dass

Sie stark eingeschränkt sind, ein bisschen oder gar nicht eingeschränkt sind bei den folgenden Aktivitäten?

Subscale: PF – 10 (SF – 36)	Ja, stark eingeschraenkt	Ja, etwaseingeschraenkt	Nein, ueberhauptnichteingeschraenkt
1. anstrengende Tätigkeiten, z.B. schnell laufen, schwere Gegenstände heben, anstrengenden Sport treiben	○	○	○
2. mittelschwere Tätigkeiten, z.B. einen Tisch verschieben, staubsaugen, kegeln, Golf spielen	○	○	○
3. Einkaufstaschen heben oder tragen	○	○	○
4. mehrereTreppenabsätzesteigen.	○	○	○
5. Einen Treppenabsatz steigen	○	○	○
6. Sich beugen, knien, bücken	○	○	○
7. Mehr als 1 Kilometer zu Fuß gehen	○	○	○
8. Mehrere Straßenkreuzungen weit zu Fuß gehen	○	○	○
9. eine Straßenkreuzung weit zu Fuß gehen	○	○	○
10. sichbadenoderanziehen	○	○	○

*„Wie Sie sicherlich wissen, geht es in dem Untersuchungsprojekt darum ein Programm für Menschen ab 65 Jahren zu entwickeln, dass unterstützend dazu beitragen soll einen gesunden Lebensstil zu hantieren und sich körperlich ausreichend zu bewegen. Damit das Programm den Bedürfnissen der Zielgruppe entspricht ist es wichtig, dass Sie die Möglichkeithaben ihre eigenen Erfahrungen und Ideen miteinzubringen und das Programm indirekt mitzugestalten. Daher werde Ihnen im Verlaufe des Interviews unter anderem Fragen stellen, dich sich darauf beziehen, welche Motive und Faktoren bei Ihnen eine Rolle spielen bei dem Folgen von Bewegungsratschlägen und wie diese in einem Selbstmanagement Programm zur Förderung eines gesunden Lebensstils praktisch umgesetzt werden kö*nnen. *Mein Fragen an Sie lauten daher zunächst:“*

- *„Wieviel Stunden verbringen Sie in der Woche durchschnittlich mit körperlicher Aktivität?“*
- *„Wie sieht eine typische Woche bei Ihnen aus“?* ***(Note: give elderly some time to describe a typical week)***
- *„Was ist ihr Antrieb, um körperlich aktiv ist?“*

- *„Welchen Einfluss kann das Setzen von Zielen gemeinsam mit ihrem Hausarzt oder beispielsweise Physiotherapeuten Ihrer Meinung nach haben?“*
- *„Welche Rolle spielt ihr soziales Umfeld in Bezug auf Ihr körperliches Aktivitätsverhalten? Was sind Ihre Erfahrungen?*
- „Auf einer Skala von 1 – 5, wie schätzen Sie die Bedeutung ein, um aus einer Reihe aus verschiedenen Übungen wählen zu können? Warum denken Sie das?“
- *„Wie schätzen Sie die Bedeutung von Feedback ein nach dem Ausführen einer Übung? Können Sie das näher auslegen?“* [**waitforanswer**]. Folgefrage: „*Wenn Sie nach einer Übung einen kurzen Satz der BeSTAETIGUNG kriegen, wie beispielsweise „Das haben Sie heute sehr gut gemacht. Prima“, sind Sie dann motivierter, um sich in Zukunft körperlich zu bewegen?*

[Note: give elderly some time to formulate their answers and speak loud and clearly and not too fast]

[Now present the elderly the shortened list of Rasinaho et al. (2006) about possible motivators of physical activity and give a short introduction]

“Hier habe ich nun eine Liste vor mir liegen mit möglichen motivationalen Faktoren. Um zu sehen, in wie weit diese Faktoren auch für Sie von Bedeutung sind, würde ich diese Liste gerne kurz mit Ihnen durchgehen und Sie bitten mir anzugeben, ob Sie den Aussagen zustimmen, zum Teil zustimmen oder gar nicht zustimmen.“

Item	Ichstimmezu	Ich stimme zum Teil zu	Ich stimme gar nicht zu
1. Körperliche Bewegung ist ein guter Zeitvertreib	○	○	○
2. Körperliche Bewegung hilft mir meine Gesundheit aufrechtzuerhalten	○	○	○
3. Körperliche Bewegung hilft mir neue Leute kennenzulernen.	○	○	○
4. Ich habe keinen Grund mich körperlich zu bewegen	○	○	○
5. Körperliche Bewegung lindert meinen Schmerz.	○	○	○
6. Ich genieße die Natur, wenn ich mich draußen körperlich betätige.	○	○	○
7. Körperliche Bewegung hält mich in einer guten physischen Kondition.	○	○	○

8. Körperliche Aktivität steigert meine Energie.	◯	◯	◯
9. Körperliche Bewegung macht Spaß	◯	◯	◯
10. Körperliche Aktivität gibt mir Selbstvertrauen	◯	◯	◯
11. Es gibt gute körperliche Bewegungsanlagen-/ Einrichtungen in der Nähe meines Zuhauses.	◯	◯	◯
12. Ich treffe Freunde, wenn ich mich körperlich bewege.	◯	◯	◯
13. Körperliche Aktivität bewahrt mich davor faul zu werden	◯	◯	◯
14. Körperliche Aktivität hält mich jung und verzögert das Altern.	◯	◯	◯
15. Es ist schön sich bei guten Wetter körperlich zu bewegen.	◯	◯	◯
16. Fachkräfte des Gesundheitswesen haben mir geraten mich körperlich zu bewegen.	◯	◯	◯

„Jetzt haben wir einige motivationale Faktoren besprochen, aber diese scheinen nicht für jede Person gleichbedeutend zu sein, da Menschen unterschiedlich aktiv sind und unterschiedliche Vorlieben haben. Welche Barrieren sehen Sie, die dafür sorgen, dass manche ältere Menschen nicht körperlich aktiv oder sehr wenig körperlich aktiv sind?“ **[if the respondent can't name any barrier, the respondent is asked to describe a situation in which he may be personally experience that it was difficult to motivate to be physical active]**

„In einer wissenschaftlichen Studie wurde eine Reihe von möglichen wahrgenommenen Barrieren zusammengestellt, die Menschen hindern könnten körperlich aktiv zu sein. Diese Liste möchte ich Ihnen in verkürzter Form nun gerne präsentieren und wissen, ob Sie diese auch als Barriere einstufen würden und der Aussage zustimmen, teilweise zustimmen oder gar nicht zustimmen.“

Item/ Aussage	**Ich stimme zu**	**Ich stimme teilweise zu**	**Ich stimme gar nicht zu**
1. Ich habe keine Zeit für körperliche Aktivität.	◯	◯	◯
2. Ich habe Angst, dass ich falle oder mir wehtue während einer körperlichen Aktivität	◯	◯	◯
3. Ich habe keine Begleitung/ Gesellschaft. Ich würde aktiver sein mit einem Partner oder in einer Gruppe.	◯	◯	◯
4. Aus gesundheitlichen Gründen habe ich das	◯	◯	◯

	Gefühl, dass ich nicht aktiver sein kann.			
5.	Es gibt keine geeignete Sportprogramme oder Freizeitanlagen für mich.	○	○	○
6.	Ich habe keine Fahrgelegenheit zu Sportprogrammen oder Freizeitanlagen.	○	○	○
7.	Ich bin nicht interessiert an körperlicher Aktivität.	○	○	○

[Note: Pay attention to body language and ask if they need a short break before going further with the interview if the elderly seem exhausted]

„Die jetzt folgenden Fragen beziehen sich auf Ihre Meinung zu Ratschlägen über körperliche Aktivität. Was denken Sie über Ratschläge, die sich auf körperliche Aktivität beziehen? Wenn Ihnen jemand beispielweise mitteilt: (…) Ihre Werte sind angestiegen. Deswegen, ist es erforderlich, dass Sie körperlich aktiver sind. Ich empfehle Ihnen, dass Sie sich mindestens an fünf Tagen die Woche eine halbe Stunde lang moderat körperlich aktiv verhalten. Spazieren wäre gut.“

- *„Wie würden Sie auf diesen Ratschlag reagieren?“*
- *„Was gefällt oder missfällt Ihnen an diesem Ratschlag?“*
- *„Was sind Ihre eigenen Erfahrungen bezüglich körperlicher Aktivitätsratschläge?“*
- *„Was erwarten Sie von einem guten Ratschlag, wenn es um körperliche Aktivität geht?“*
- *„Wie sollte ein solcher Ratschlag präsentiert werden?* **[if the respondent don't know what to say, one example is given]**. *KönnenSie das näherauslegen?“*

*“Heutzutage spielt Selbstmanagement eine große Rolle. Es gibt beispielsweise verschiedene körperliche Aktivitätsübungen, die zu Hause ausgeführt werden können, ohne dass die Hilfe von jemand anderen benötigt wird***[Show an example→pictureof an exercisefromtheprogramPerssillaaandaskthefollowingquestions].***Hier sehen Sie ein Beispiel aus dem Programm Perssillaa. Perssillaa soll ältere Mensch unterstützen einen körperlichen aktiven Lebensstil zu entwickeln. Es soll Menschen in dem Alter dazu initiieren dreimal die Woche eine halbe Stunde in Ihrer häuslichen Umgebung körperlich aktiv zu sein. Die Übungen werden in einem Video gezeigt und im Hintergrund sind verbale Instruktionen zu der Übung zu hören. Die Übungen werden in unterschiedlichen Schwierigkeitsgraden angeboten. Auf dem folgenden Bild sehen Sie die deutsche Übersetzung einer Übung aus dem Programm.“*

Figur 1: Beispiel eines Trainingsvideo aus dem PERSSILAA körperlichen Aktivitätsmodul.

- *„Wenn Sie nun dieses Bild vor sich liegen haben, was denken Sie darüber?"*

  a.) *Denken Sie, dass Selbstmanagement Programme eine Rolle spielen können beim Verbessern der körperlichen Aktivität von älteren Menschen?"*

  b.) *Würden Sie so ein Programm testen?*

  Ja →Aus welchem Grund würden Sie es benutzen?

  Nein → Aus welchem Grund würden Sie es nicht gebrauchen? Welche Anforderungen müssen erfüllt werden, um Sie zu überzeugen, ein solches Programm zu testen?

Technical skills:

„Was sind Ihre Erfahrungen mit technischen Geräten und haben Sie ein solches technisches Gerät zu Hause? Wissen Sie wie man das Gerät verwendet?"

4.) *Tablet?*

5.) *Handy?*

[If the answer is „yes", question b is asked if the answer is „no", it is asked if the participant would like to learn how to use it. If the participant don't want to learn how to use a tablet/ mobile it is asked what the reasons are.]

Ja → weiter mit Frage b

Nein → "Würden Sie gerne lernen wie man ein solches Gerät benutzt?" / Was sind die Gründe, dass Sie es nicht erlernen möchten?"

a.) *„Zu welchem Zweck haben Sie das technische Gerät verwendet?"*
b.) *„Wie war Ihre Erfahrung damit zu arbeiten? Gab es irgendwelche Schwierigkeiten beim Gebrauch?"*

„Nun haben wir das Ende des Interviews erreicht. Haben Sie noch selber Fragen, die Sie gerne stellen möchten oder Anmerkungen? **[give elderly time to react and then ask if they are still interested in taking part on the usability study and inform them how the usability study is conducted and make an appointment/ agree to]**. *Dann möchte mich zunächst ganz herzlich bei Ihnen für die Teilnahme an dem Interview bedanken. Wie Sie aus dem Informationsschreiben erfahren haben, besteht die Untersuchung aus zwei Teilen. Wir würden uns freuen, wenn Sie bereit wären auch an der Folgeuntersuchung teilzunehmen, die einige Wochen später stattfindet. In dieser haben Sie die Möglichkeit Teilbereiche einer ersten vereinfachten Version des Programms zu testen und uns Ihre Gedanken dazu mitzuteilen. Zu Beginn stellen wir Ihnen einen von drei Gebraucher – Szenarien vor. Ein Szenario ist beispielsweise das Wählen einer Übung. Es gibt verschiedene Versionen des Musterbeispiels, welche Ihnen vorgelegt werden. Um von diesen einen Eindruck zu erhalten, bitten wir Sie während der Ausführung der Übung ihre Gedanken laut auszusprechen.*

*Anschließend würden wir Ihnen gerne noch ein einige Fragen bezüglich der Ihnen vorgelegten Musterbeispiele stellen. Diese beziehen sich u.a. auf ihren ersten Eindruck von dem Musterbeispiel; was Sie besonders angesprochen hat oder nicht angesprochen hat; ob es Schwierigkeiten oder Unklarheiten bei der Handhabung gab; ob Sie das Produkt im täglichen Gebrauch benutzen würden und ob Sie noch weitere Anmerkungen oder Fragen haben. Wenn Sie weiterhin Interesse haben, dann würde ich gerne mit Ihnen einen Folgetermin vereinbaren. Sollten Sie jetzt noch nicht wissen, wann sich ein Termin in Ihren Terminkalender einplanen lässt, können Sie mich telefonisch oder per E – Mail kontaktieren. Die Kontaktdaten stehen am Ende dieses Schreibens***[waitfor an answer]**. *Vielen Dank (undaufWiedersehen)."*

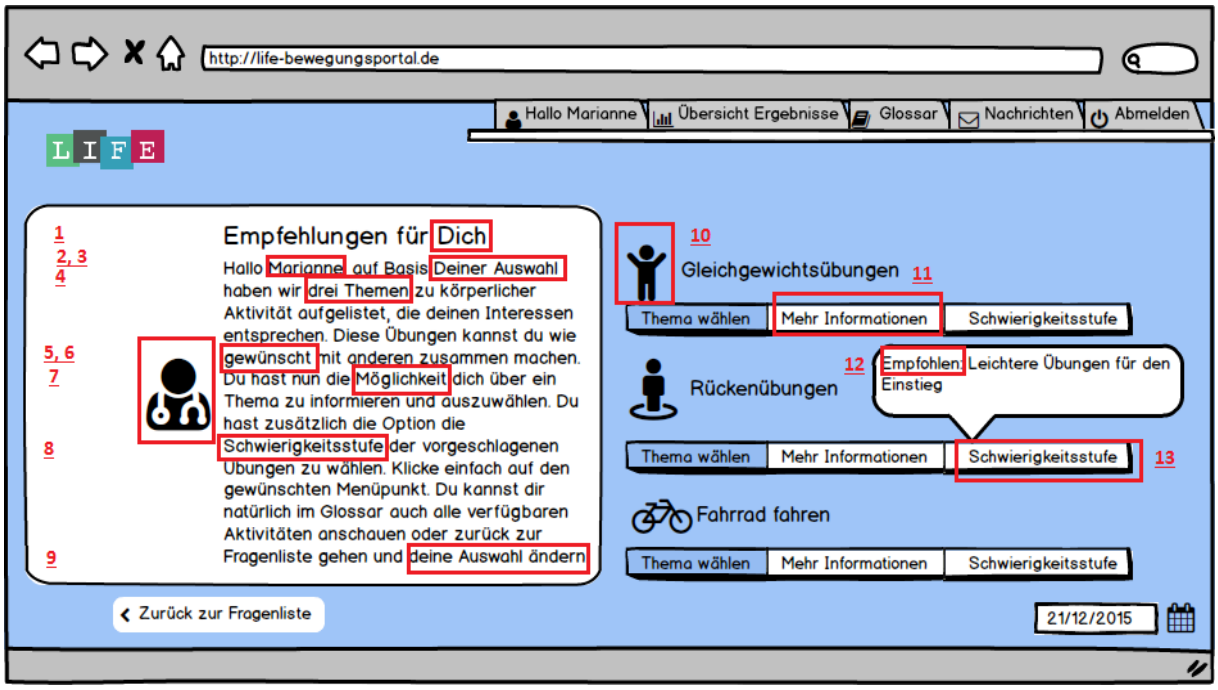
Will participate on the usability testing:

☐ Yes

☐ No

Appendix C: Mock – ups of the two prototypes

High version: SDT (+) prototype



14.) SDT strategy: affection. User is addressed directly. Dialogue support: Liking.

15.) SDT strategy: affection. User is addressed directly. Dialogue support: Liking

16.) Primary task support: Tailoring. User is reminded that the advice is based on his interests he stated in the screening test

17.) SDT strategy: Choice. User is shown that he has different choices and can select the one he preferred most, Primary task support: tailoring

18.) System credibility support: surface credibility. User sees an icon of a doctor

19.) SDT strategy: avoidance of control. User is reminded that the offered advice is given based on the wishes of the user. Therefore the user knows that he is in control of the situation

20.) SDT strategy: Avoidance of control. User is shown that he chooses what to do next.

21.) SDT strategy: Clarity of expectation, system credibility support: expertise. User is provided with information about how difficult the exercise is and that he can choose which level he prefers.

22.) SDT strategy: Avoidance of control. User is reminded that he can change his choices he made in the screening if he wants to do that

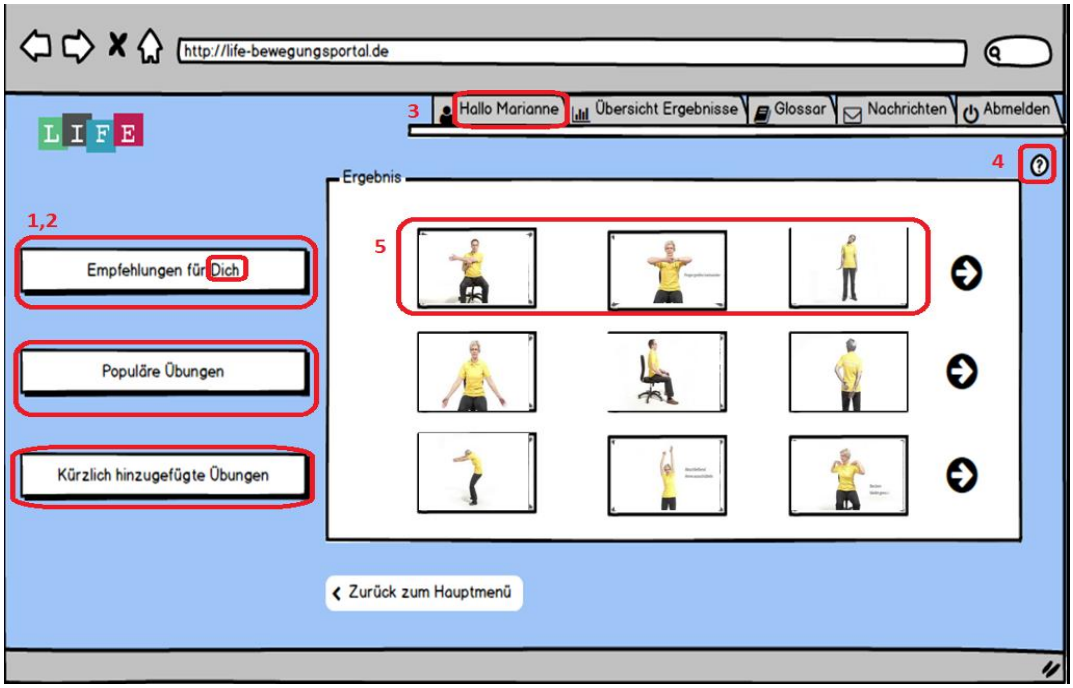
23.) SDT strategy: Choice. User is shown three different exercises

24.) SDT strategy: Provide instrumental support & system credibility support: Expertise. User has the possibility to get more information

25.)SDT strategy: Clarity of expectation & dialogue support: suggestion of level of exercise

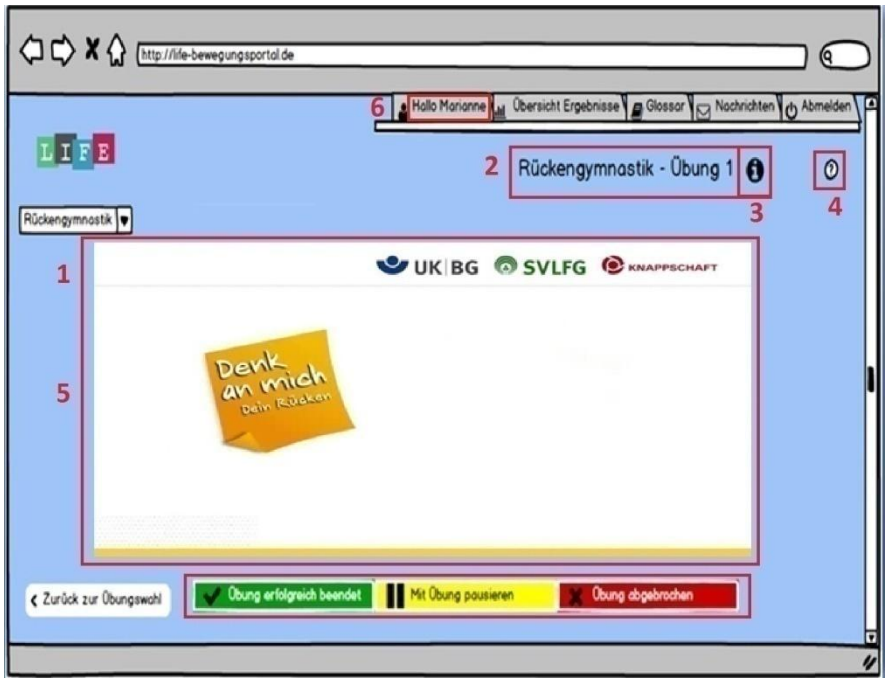
26.) SDT strategy: Clarity of expectations through providing a suggestion. User can collaboratively set realistic goals when choosing between different levels of exercises

User is guided to this page: Several exercises for the chosen topics are provided. In the first row are advices for him, in the second row are the exercises that are best rated and in the third row are exercises that are chosen the most.



1.) SDT strategy: Avoidance of control. Pointing out that these are only suggestions but user is in control about what happens next, Dialogue support: suggestion, primary task support: tailoring
2.) Dialogue support: liking. User is addressed directly
3.) SDT strategy: affection. User is addressed directly. Dialogue support: Liking
4.) SDT strategy: dependability. User has the opportunity to look for help through the help button.
5.) SDT strategy: Choice. Within the three categories the user can choose between several exercises.

Then the user will be guided to the page of the chosen exercise:

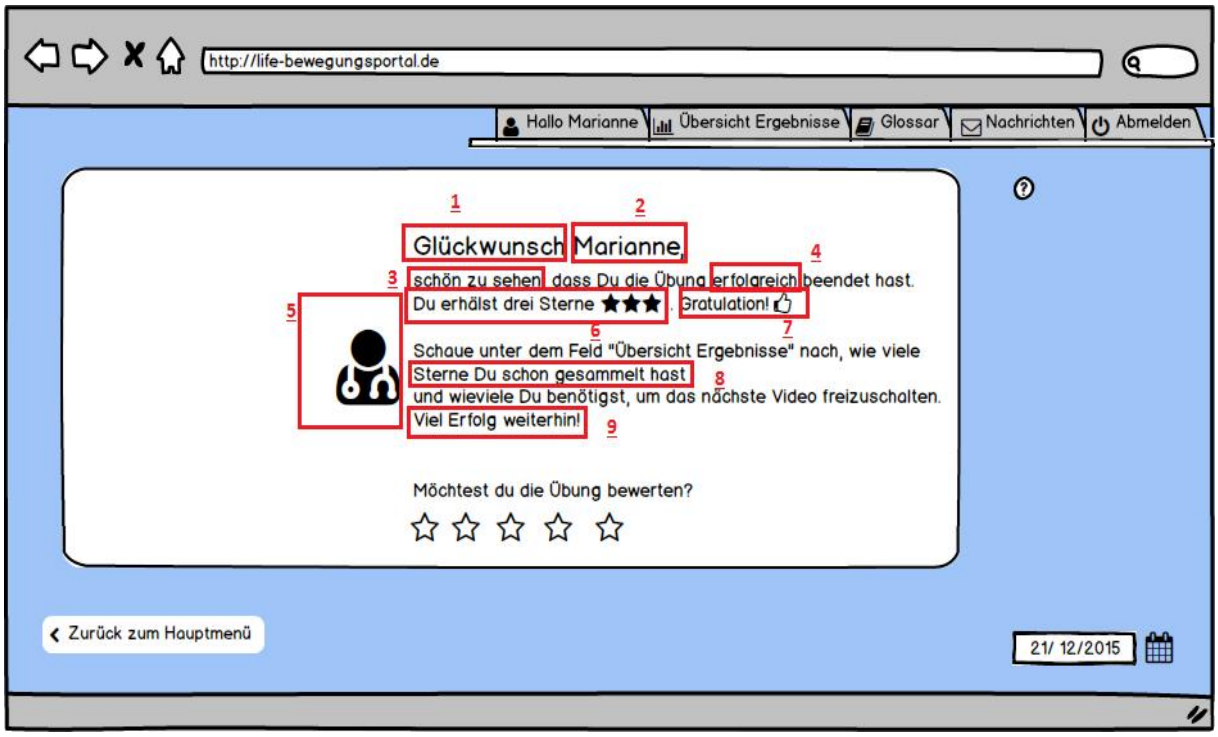


1.) SDT strategy: Practical skills training. Video with exercise is shown to the user. Dialogue support: liking.
2.) Dialogue support: reminder. User is reminded of the choice he made.
3.) SDT strategy: Clarity of expectation. User can get information about the effect of the exercise
4.) SDT strategy: Dependability. User can look for help if there are any problems
5.) SDT strategy: Provide instrumental guidance & Dialogue support: liking. Provide information and instructions in multiple ways (additional text is presented in the video)
6.) SDT strategy: affection. User is addressed directly. Dialogue support: Liking

7.) SDT strategy: Avoidance of control, choice. User is provided with different options. He can choose if the exercise went successfully, if he wants to pause with the exercise or to stop with the exercise. The user is in full control of the situation

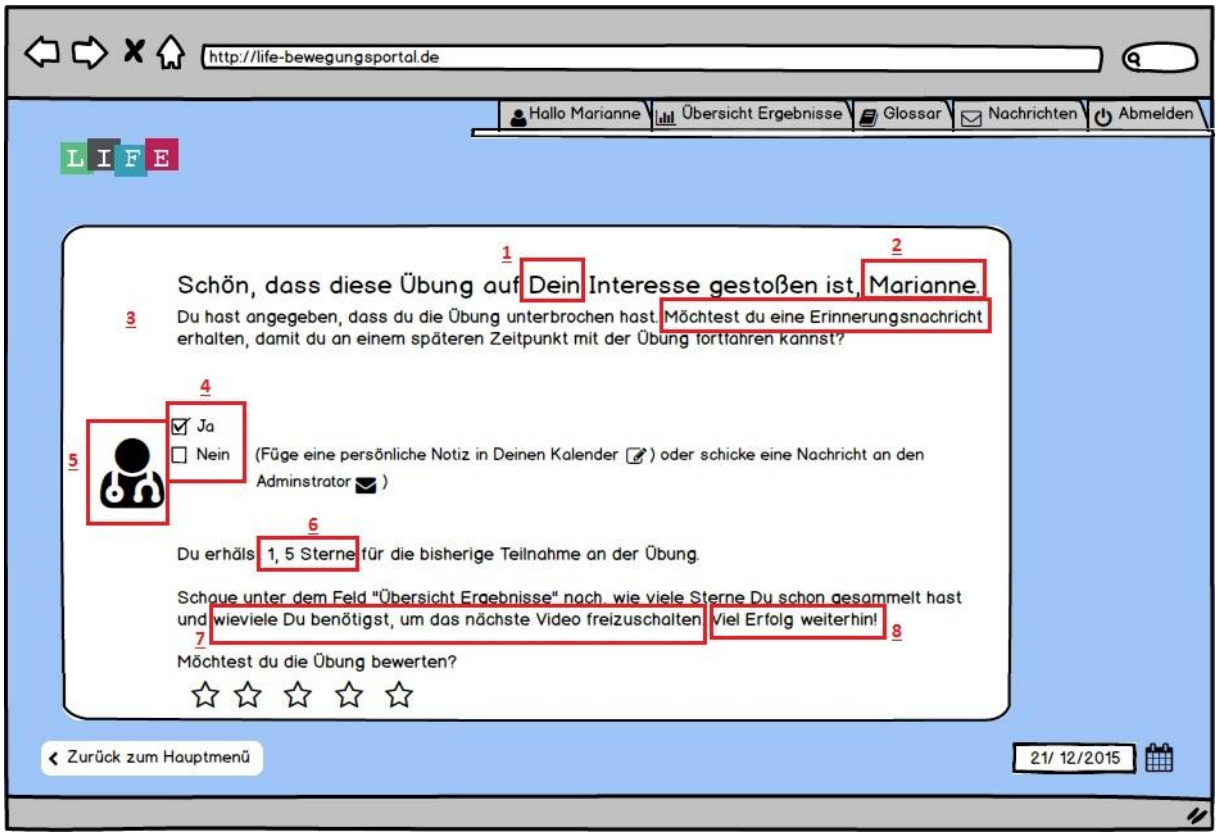
Then the user will get one of these three feedbacks:

If the exercise was successful:



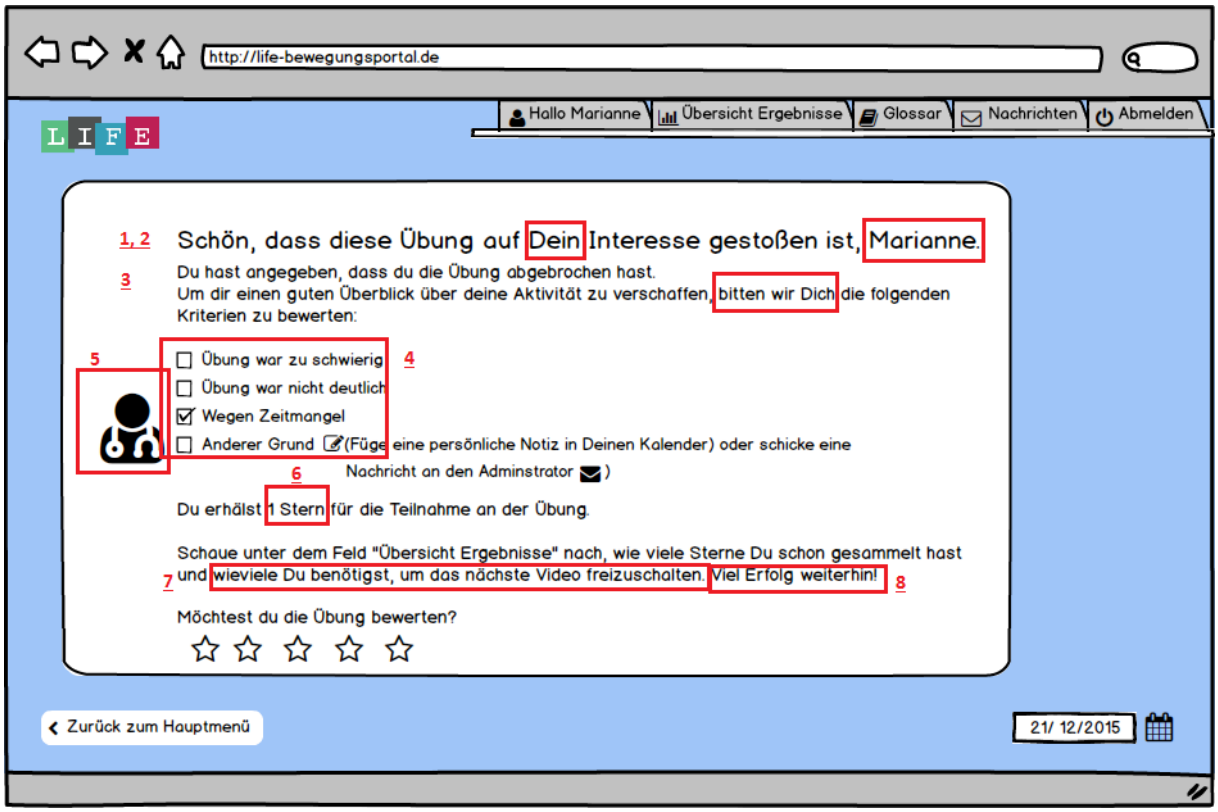
1.) SDT strategy: Affection & Dialogue support: Praise. User is shown acknowledgement for his achievement
2.) SDT strategy: affection. User is addressed directly. Dialogue support: Liking
3.) SDT strategy: Affection
4.) SDT strategy: Affection. User is shown acknowledgement
5.) System credibility support: surface credibility. User sees an icon of a doctor
6.) SDT strategy: Competence & Dialogue support: Reward. User gets three stars for successfully completing the exercise
7.) SDT strategy: Affection & Dialogue support: Praise
8.) Social support system: competition. User is reminded that he can look how many stars he has collected and how many he need until the next video of an exercise will be granted access to
9.) SDT strategy: Affection. User is wished success for the next exercises

If the user paused with the exercise, this feedback will be shown:



1.) Dialogue support: Liking
2.) Dialogue support: Liking
3.) SDT strategy: Affection. Through offering the possibility of a reminder, the user is shown concern, Dialogue support: reminder
4.) SDT strategy: Choice, Avoidance of control. User can choose between two options and is in control about what happens next
5.) System credibility support: surface credibility. Users sees an icon of a doctor
6.) SDT strategy: Affection. User will be shown acknowledgement for trying the exercise. User gets 1.5 stars. BCT: contingency management: If the user continues with the exercise later, he can get the remaining 1.5 stars for completing the exercise
7.) Social support: competition. User is told that he can look how many stars he has already achieved and how many he needs to get access to a new video/ exercise.
8.) SDT strategy: Show concern. User is wished good luck for future exercises.

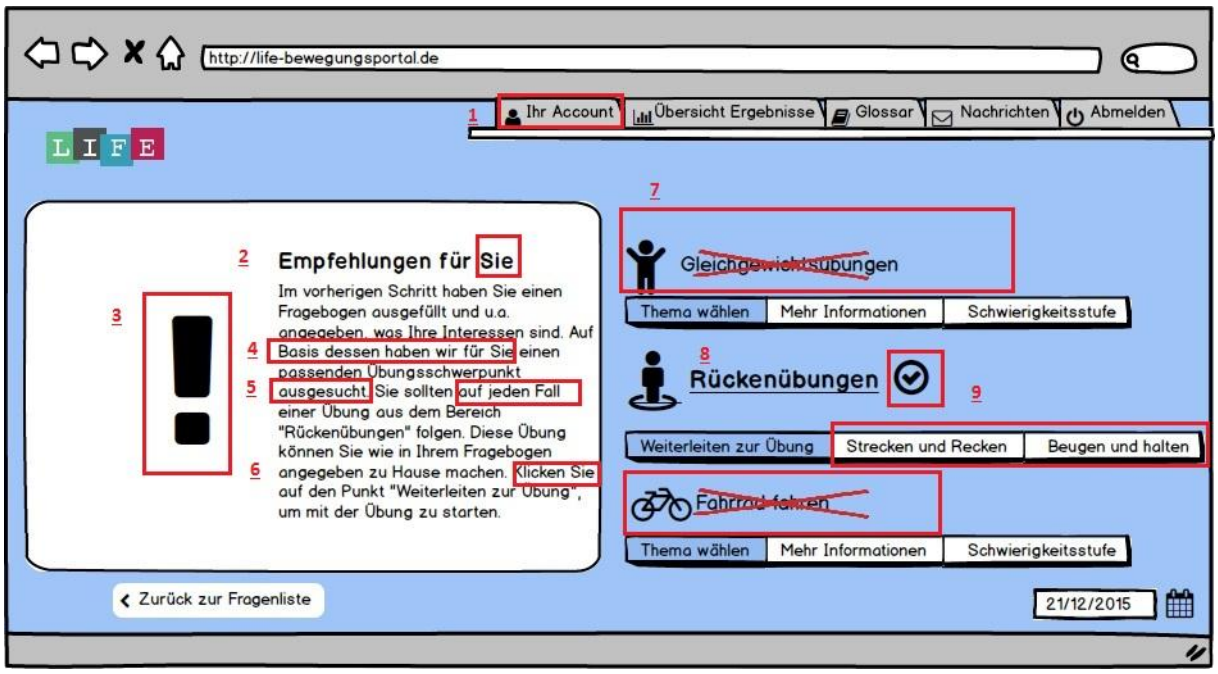
If the user stops with the exercise, this feedback will be shown:



1.) SDT strategy: affection. User is addressed directly. Dialogue support:
2.) SDT strategy: affection. User is addressed directly. Dialogue support: Liking
3.) SDT strategy: Avoidance of control, Affection. User is asked if he may answer the question why he stopped with the exercise
4.) SDT strategy: Choice. User can choose between 4 options. He can state if the exercise was: too difficult OR if the instructions were not clear OR if he has not enough time OR if he has another reason. User is shown concern through asking the question.
5.) System credibility support: surface credibility. Users sees an icon of a doctor
6.) SDT strategy: Affection. User will be shown acknowledgement for trying the exercise. User gets 1 star.
7.) Social support: competition. User is told that he can look how many stars he has already achieved and how many he needs to get access to a new video/ exercise. BCT: contingency management: If the user continues with other exercise later, he can get stars to unlock a new video.
8.) SDT strategy: Show concern. User is wished good luck for future exercises

Here are now the mock –ups with the low versions of SDT components

Low version: To create a second prototype with low SDT components the SDT strategies used in the first prototype are often reversed e.g. Instead of using non – authoritarian language to avoid that the user feel controlled, it is chosen for authoritarian or guilt – inducing language.



Important differences to the other version:

10.)Low Avoidance of control. Using more authoritarian language. User is not directly addressed

11.)Low avoidance of control. Using authoritarian language. User is not directly addressed

12.)Low avoidance of control. Using authoritarian symbol. Instead of the icon an exclamation mark is used. It is a metaphor that points out that the advice has to be interpreted more as an order than as an advice.

13.)Low choice: Pointed out that system has decided what exercise would be appropriate according to the screening the user filled in, Primary task support: tunneling, reduction. System reduces effort to choose between several options.

14.)Low choice. Pointed out that user should do definitely the suggested exercise because it fits the screening and interests of the user

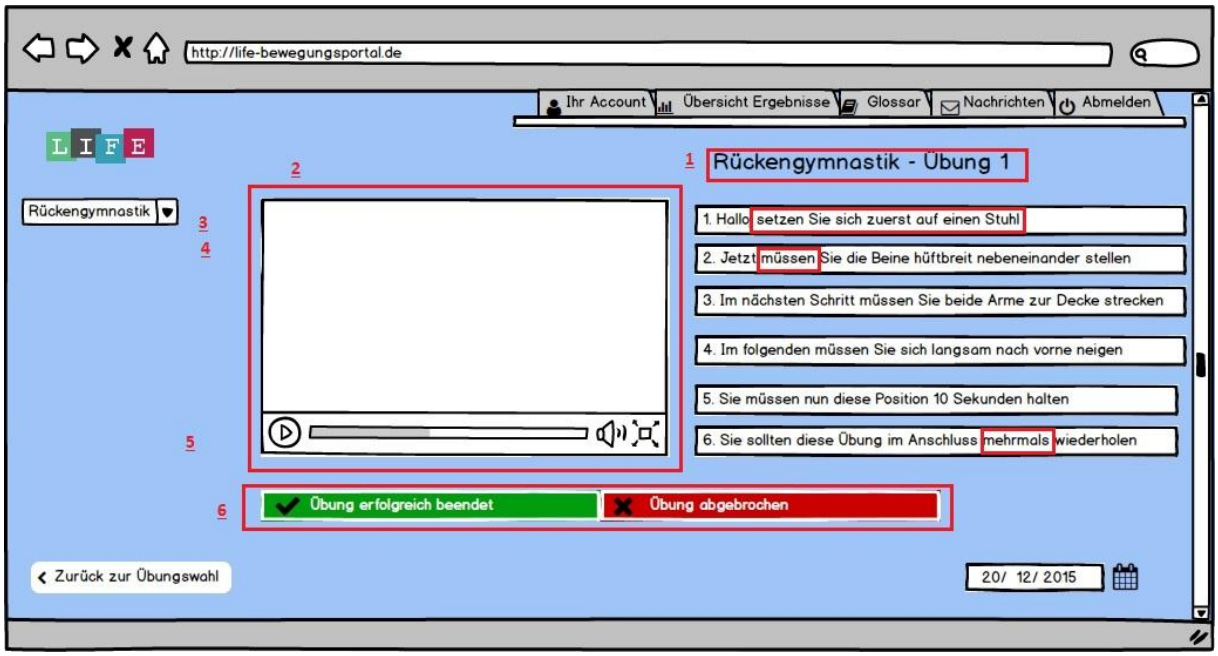
15.)Low avoidance of control. User gets more strictly guidelines how to go further. Directly addressed to the exercise

16.)Low choice. Users see that they were three different kinds of exercises but there was already made a choice by the system which exercise is appropriate. User can only choose the advised exercise.

17.)Low clarity of expectations. Users has not the possibility to get more information about the effect of the exercise

18.)Low choice. User is offered with two exercises. Primary task support: tunneling

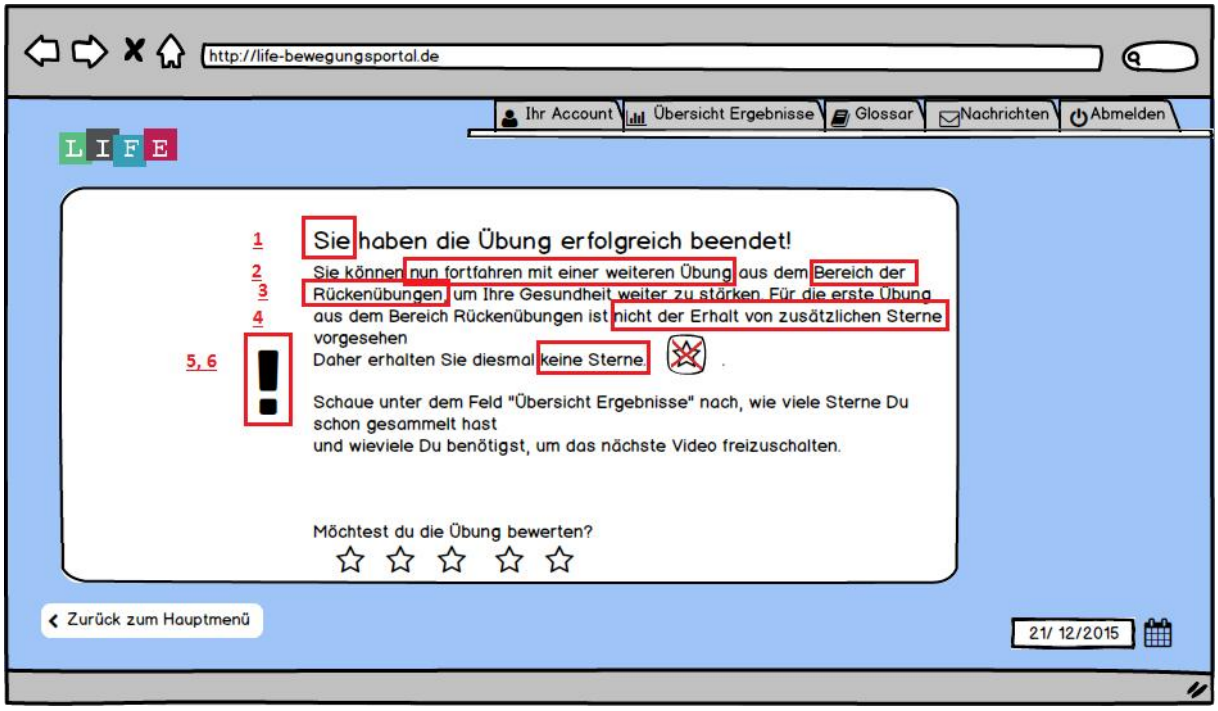
After the user has clicked on the “Fortfahren mit der Übung”, this screen will be shown:



1. Low clarity of expectation. User has not the possibility to get more information about the effect of the exercise. Low dependability. User is not offered an additional help button to search for help
2. Low practical skills training. User is provided with a video about effects general advantages of e.g. physical activity instead of an instruction video
3. Low avoidance of control. User is ordered to sit first. The instructions expressed more as orders
4. Low avoidance of control. User is told that he have to follow the guideline.
5. Low clarity of expectation. User is not told how many times he has to do the exercise. There is only written “multiple times”
6. Low choice. User has only two options. He can state that the exercise was successfully completed or to stop the exercise. There is not the possibility to continue with the exercise later on.

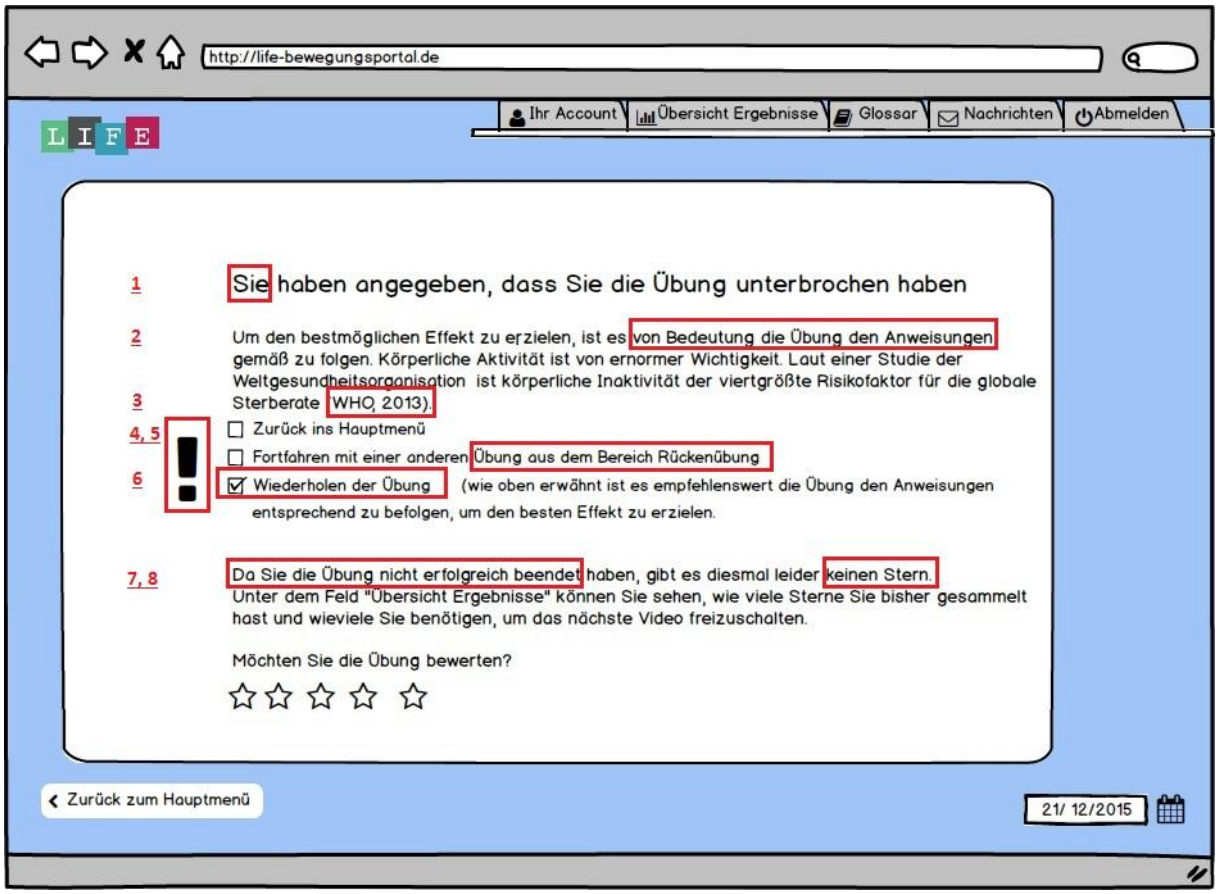
Then the user will get one of these two feedbacks (there is no third version of feedback because the user in the SDT (-) prototype does not have the possibility to pause with the exercise. He could only state that the exercise went successfully or that he stopped the exercise.

If the exercise was successful:



1.) Low avoidance of control. User is addressed in a more authoritarian language
2.) Low choice. User is told how to go further. Has limited options to decide independently how to go further
3.) Low choice. User is given the possibility to go do another exercise of the given category. Primary task support: tunneling, reduction
4.) Low competence. No reward. User is told that for this exercise no stars can be earned. User is now shown acknowledgement for his effort.
5.) Low avoidance of control. Using authoritarian symbol. Instead of the icon an exclamation mark is used. It is a metaphor that points out that the advice has to be interpreted more as an order than as an advice.
6.) Low competence: No reward. User is shown with the icon that he will not get a reward.

If the exercise was not successful, this feedback will be shown:



1.) Low affection: User is not addressed directly. More authoritarian way to address someone
2.) Low avoidance of control. Guilt – inducing language. Importance of following the guidelines is pointed out
3.) Low avoidance of control. Guilt inducing language. Risk factor of being physically inactive is named. System credibility support: Authority. Giving a statistic from the WHO
4.) Low avoidance of control. Using authoritarian symbol. Instead of the icon an exclamation mark is used. It is a metaphor that points out that the advice has to be interpreted more as an order than as an advice.
5.) Low choice. User is offered only the possibility to do an exercise from the given category. Primary task support: Tunneling, Reduction
6.) Low affection & dependability. User is not asked why the exercise did not work and the user has not the possibility to look for help
7.) Low affection: User is reminded that he did not complete the exercise successfully
8.) Low affection: User is not shown acknowledgement for trying out the exercise. The user gets no star.

Appendix D: Persona + Use – case scenario

Marianne

Marianne ist 68 Jahre alt. Sie lebt in einem kleinem Haus zusammen mit ihrem Mann Helmut. Ihre drei Kinder sind alle erwachsen und vor Jahren ausgezogen. Marianne ist sich bewusst, dass körperliche Aktivität wichtig ist und ihre Hauptmotivation um aktiv zu sein ist, gesund und unabhängig leben zu können.

Marianne ist für ihr Alter in einer guten körperlichen Verfassung. Sie macht gerne Aktivitäten draußen. Sie geht gerne schwimmen oder Fahrrad fahren. Bei Alltagsaktivitäten hat sie nicht viele Probleme, nur wenn sie sich bücken muss. Ihr Rücken macht ihr manchmal schon zu schaffen. Sie würde gerne Aktivitäten kennenlernen, die ihr helfen fit zu bleiben. Vorzugsweise auch Übungen, die sie bei schlechten Wetter zu Hause machen kann.

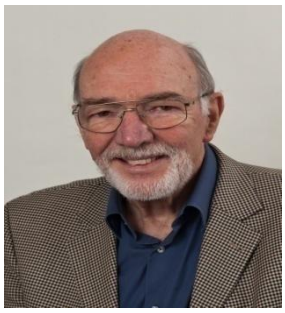
Von Ihrer Freundin Susanne hört sie von dem Programm LIFE. Diese Programm gibt personalisierte Ratschläge. Marianne entschließt sich das Programm zu testen und meldet sich an. Sie füllt einen Fragebogen mit ihren Interessen aus und wird zu Ihrer persönlichen Seite weitergeleitet.

Scenario 2: Frank ist 68 Jahre alt und lebt mit seiner Frau Hilde und ihrem Hund in einem kleinen Appartment. Sie haben ein Kind und drei Enkel, die in einer Nachbarstadt wohnen. Sie besuchen die beiden zweimal im Monat. Frank hat viele Jahre als Mechaniker gearbeitet und nach seiner Pensionierung, ist er aufgrund der vielen ungewohnten Freizeit etwas träge geworden.

Frank startet jeden Tag mit einem gemeinsamen Frühstück mit seiner Frau. Dann macht er manchmal handwerkliche Tätigkeiten im Haus oder geht mit dem Hund spazieren. Er trifft sich gerne mit seinen Freunden zum Karten spielen oder geht gerne zum fischen oder bowlen einmal im Monat.

Vor einigen Jahren hat er erfolgreich den Krebs besiegt. Ein Ziel seitdem war körperlich aktiver zu sein.

Mit seinen 68 Jahren ist er sorgfältiger bei der Wahl seiner Übungen. Frank sagt, dass man in seinem Alter nicht mehr alle Aktivitäten machen kann. Er ist manchmal in seinen täglichen Aktivitäten eingeschränkt. Er kann keine langen Strecken laufen. Frank ist schon interessiert in neue Übungen, aber er findet die Informationen im Internet unübersichtlich und weiß nicht, ob die Übungen passen. Gestern hat er in einem Artikel von dem Programm Life gelesen. Laut dem Artikel gibt das Programm personalisierte Ratschläge und Aktivitätsvorschläge. Er entscheidet sich dem Programm eine Chance zu geben und registriert sich dafür. Er füllt einen Fragenbogen zu seinen Interessen aus und kommt zu seinem persönlichen Konto mit Ratschlag.



Use – casescenarios:

Prototype SDT (+)	Instruction for elderly
Gettingmoreinformation	You have decided that you want to have more information about the proposed exercises.
Level of difficulty	After you have read the information, you have decided for the exercises for the back. This exercise you can do at home even when the weather is bad. You notice that that the exercises are offered in different level of difficulties. You want to know how many levels there are.
Choose exercise	You see that it is recommended that for beginners the option “easy” would be appropriate. You decide to follow the advice and you want now to start with an exercise for the back
	After you have chose for the topic exercises for the back, the following screen appear (see below). You choose for a particular exercise.
Start with exercise	You were lead to the following page (see below). Now you want to start with the exercise
Discontinue the exercise	You want to discontinue the exercise. Something has cropped up. You want tocontinue the exercise later on. Choose the suitable option.

Read Feedback + option of reminder	You read the feedback that appears on the screen and now you want to state that you want to receive a reminder mail. Choose the suitable option.
Log off	You are busy for a short spell. You decide to log out of your account.
Continue with exercise and complete successfully	You have signed on and see that you have a new message. It is the reminder mail. You are lead to the exercise you started before. You follow the instructions of the exercise and complete the exercise successfully. Choose the suitable option.
Second exercise	The weather is good. You want to take advantage of the circumstances and you decide to choose the option „bicyle“. Choose the option
Cancel the exercise	You choose an appropriate distance. But then you notice that it is already late. You decide to cancel the exercise. Choose the option.
Log off	Choose an option why you stopped with the exercise and log off from the program.
SUS	Fill in SUS

Prototype SDT (-)	**Instruction for elderly**
Reading advice	After you have successfully completed registration and filled out your preferences for activities the following screen appear (see below). At first, you read and listen carefullyto the advice.
Chooseexercise	The program has detected on basis of your preferences that exercises for the back are appropriate for you. Two exercises are chosen that you should follow. Now, you want to start with the first exercise.
Watch video	You are curious to see the video. Choose the suitable option.
Read instructions	In the video are general advantages and effect of back exercises shown. Now you have to read the instructions and follow the steps
Exercise successfully completed	You have followed the instructions and completed the exercise successfully. Choosethesuitableoption.
Rate exercise and go back to main menu	After reading the feedback you decide to rate the exercise and to go back to the main menu because you want to do another exercise.
Choose second exercise	You see that there is another exercise. You choose this second exercise.
Start with exercise	You were lead to the second exercise. As before you watch the video. The video shows again the advantage of exercises of the back. You read the instructions and follow them.

Cancel exercise	During the exercise, you notice that the first exercise was more exhausting than you have expected. Therefore you decide to do the second exercise again in the evening. For now, you want to cancel the exercise. Choose the suitable option.
Choose how to go further	You were lead to a page with feedback. You read thoroughly the feedback and choose one of the options how to go further.
Log out	You decide that you did enough for the moment. You want to log out of the program. Choose the suitable option
SUS	Fill in SUS

Appendix E: Protocol for usability study

[Vorstellen der Persona Marianna oder Frank]

[Präsentation des ersten Prototyps starten – Offline Version PPT SDT +/-]

Nun haben Sie einen ersten Eindruck erhalten, wie das Bewegungsprogramm aussehen könnten. Ich würde Ihnen nun gerne einige weitere Fragen stellen, um eine bessere Einsicht über die erste Testversion zu erhalten, bevor ich Ihnen die zweite Version präsentiere. Ich werde Ihnen zunächst ein paar generelle Fragen über ihren ersten Eindruck vom Programm stellen (z.B. das Design). Danach stelle ich Ihnen einige Fragen zu Ihrem Eindruck zum angebotenen Ratschlag und dem Feedback, dass das Programm anzeigte. Das Interview besteht hauptsächlich aus offenen Fragen zu dem Programm. Falls eine Frage nicht deutlich ist, zögern Sie nicht nachzufragen. Ich würde das Interview gerne mit einem Diktiergerät aufzeichnen. Das Interview wird anonym verarbeitet und anschließend gelöscht. Die Studie dauert ca. 30 – 50 Minuten.

AllgemeineFragen:

Frage:	Folgefrage:	WichtigePunkte
Wie würden Sie Ihre Erfahrung mit dem Programm beschreiben?	Was hat Ihnen an dem Programm gefallen? ➔ KönnenSiebeschreibenwarum? Was hat Ihnenmissfallen? ➔ Weshalb? ➔ Haben diese Punkte Ihre Motivation beeinflusst, dass Programm zu benutzen? Inwiefern? ➔ Was denken Sie über das Video?	Erfahrung mit dem Program
	<u>Was denken Sie über das Design vom Programm?</u> ➔ Aufbau der Seite? Art der Präsentation? ➔ WelcheÄnderungsvorschlägehabenSie?	Design &mögliche Design Fehler entdecken

Frage:	Folgefragen:	WichtigePunkte
Zu Beginn des Programms haben Sie einen Ratschlag bekommen. Was ist Ihre Meinung zu dem Ratschlag?	Z.B. die Formulierung? Was sind die Stärken des Ratschlags? Was sind Schwachpunkte des Ratschlags?	Starke & schwache Punkte des Ratschlags
	Wie motiviert waren Sie dem Ratschlag zu folgen? ➔ Können Sie erklären, warum Sie sich motiviert gefühlt haben?	Motivation

Fragenzum Feedback:

Fragen: Was denken Sie über das Feedback dass sie erhalten haben, nachdem Sie…	Folgefragen	WichtigePunkte
… eine Übung erfolgreich abgeschlossen haben?	Wie haben Sie sich gefühlt nach dem Lesen des Feedbacks? Was ist Ihnen beim Feedback ins Auge gefallen? Inwieweit hat das Feedback Ihre Motivation sportlich aktiv zu sein verändert?	Reaktion auf Feedback 1
… mit einer Übung pausiert haben? **[wird nur gefragt bei dem SDT (+) prototype Interview]**		Reaktion auf Feedback 2
… eine Übung nicht erfolgreich abgeschlossen haben.		Reaktion auf Feedback 3

[Präsentation des zweiten Prototyps starten – Offline Version PPT SDT +/-]

[selbe Fragen wie oben stellen, anschließend die Fragen zum Vergleich]

Fragen:	Folgefragen	WichtigePunkte
Wenn Sie die zwei Versionen vergleichen welche präferieren Sie?	- Kurze Zusammenfassung der genannten Stärken und Schwächen der Prototypen. Dann: was waren die entscheidendenFaktorenfürIhreEntscheidung?	Präferenz für SDT + oder SDT -?
Welche Unterschiede sind Ihnen zwischen den beiden Programmen	Bei SDT features die genannt werden, die Features durchgehen für die Evaluation: - Was denken Sie über dieses Feature? - Denken Sie dieses Feature ist nützlich? - Weshalb?	SDT feature Bedeutung der SDT features feststellen

aufgefallen?	- Denken Sie, dass dieses Feature motivierend sein kann, für Leute um das Programm zu benutzen und aktiver zu werden? - Wenn Sie die verschiedenen Feedbacks vergleichen in den beiden Versionen, was waren die wichtigsten Unterschiede? - Wie haben diese Unterschiede Ihre Absicht körperlich aktiv zu sein beeinflusst?	Unterschiede Feedback
	Bei nicht auf SDT features bezogenen Merkmale, nachhaken: - An welche Unterschiede erinnern Sie sich bei den verschiedenen Feedbacks? - Inwiefern wurde Ihre Motivation dadurch beeinflusst, dass Programm zu benutzen und aktiver zu sein?	Relevanz der SDT features Unterschiede Feedback
	- Welche Verbesserungen würden Sie vorschlagen für das Programm?	Verbesserungsvorschlägefür das Programm

Appendix F: Evaluation of SDT features: Citations

SDT Feature	Citations of the elderly in the evaluation
Autonomy	
Not using guilt – inducing or authoritative language	Statistic in SDT (-): - "I really don't need the guilt-inducing language. The statistic terrifies people. I think that when people bring themselves to do something, they do it because they want it. You shouldn't create pressure. In competitive sports this might be necessary but in this case the participants are elderly who try to be active in their free time. This might discourage elderly. I don't think that I would run faster if someone approaches me with this strategy" (R.3) - "Underline the importance is good. This sentence has to be kept so that everyone knows the relevance." (R.6) - „The statistic has a supportive function. The

	underlining of the importance, too."(R.7) - „I don't need that much praise. I think it is important to point out the risks related to inactivity. I perceive this as a kind of a push." (R.9)
Providing three option that matches their interests	- "It feels constricting if I have only one option. What should I do if I'm just not in the mood to bicycle? I know I would rather do nothing than do an activity I have no interest at the moment." (R.1) - Having choices is better. I'm interested in exercises for the back and bicycling. And balance exercises are also important. Here are only back exercises. Therefore, I rather tend to choose the other version [SDT +] (R.5) - "I need easy exercises that are well to handle and that support me." (R.8) - „I would like to choose all three topics. All three are good and interesting for me."(R.7) - Without multiple options would be bad. If you already have little aches and pains, you should not have to make them worse. The bicycle exercise has to be put aside, if the knees are busted". (R.9)
*Avoidance of control by giving different options*after starting with the exercise (exercise successfully completed; to pause with the exercise; stop with the exercise)	- *"*What should I do if I'm just not in the mood to bicycle? I know I would rather do nothing than do an activity I have no interest at the moment." (R.1) - "To have a choice is always good. And to identify what physical activity is appropriate for me. If it is already decided beforehand, you might resign and think: 'oh no'". (R.3) - "The option to pause with an exercise is really good. Then you don't have to start from the beginning" (R.3) - The option to pause is useful. I can decide what I want to do. I would prefer this option. Rather than turning the program off and to start the program all over again (R.5)
Competence	
Video	- "I like it when I see someone who shows me how to do an exercise and I can internalize the steps. Sometimes you don't understand the steps [if you don't have an instructor who shows you the exercise] and then an exercise is useless. You would then think: 'what does he want me to do?'I made this experience in my water gym class" (R.3) - "A video about general background information is

	nice to see but I'm not sure if I really care about the functions of the back. The content of the exercise is most important." (R.3) - You would not do it [the exercises] when you don't know if they are indeed helpful". (R.3) - "I really like the video about the general information. Especially the sketch about the back and how everything is related" (R.4) - "The video with general information is helpful. For this exercise, I don't need the video with the video instruction. The picturealoneissufficient."(R.7) - The tips during the exercises are good." (R.8) - (SDT (-) video: „General informations are also important. They influence the motivation. You should not use only a video with the exercise instruction." (R.9) - The video is better than the picture because you can do the exercise simultaneously. I already started to follow the exercise partly (laughed)" (R.9)
Setting collaboratively realistic goals	- I like that the exercises were not too difficult and that I could decide to start with an easy activity. This is good to get into such an activity and program. This motivates me. The level of difficulty is okay because it is possible to increase it." (R.9)
Different levelsofexercise	- "Different levels of exercise are important" (R.5.) - "There are people who are limited in their health. You have to offer them different levels of difficulty. That's necessary. There are elderly of 75 years who say: I can only do exercises of an easy level" (R.6) - "I like the different levels of difficulty. I can increase the level if I want to do it."(R.7) - It's good that the exercise is not too difficult. It is possible to do it even if you are older. I like that there are different nuances. Everyone can decide based on their current state what exercise they prefer. That's really a good thing." (R.8)
The doctor icon next to the message	- Oh, that's a doctor? It does not affect my motivation that much but I would prefer the exclamation mark. The necessity becomes more obvious with this symbol […], it's a real eye – catcher" (R.3) - "I like the exclamation mark more. It draws your attention. I find this more motivating. It highlights the message" (R.4) - I prefer the exclamation mark. What is this other symbol? A doctor ?[surprised]. Hmh, the

		exclamation mark exclaim to do it [the exercise] now. (R.5) - "I did not pay attention to the doctor icon. Maybe you should put it in a bigger size? But I thinkthedoctoriconisinteresting."(R.6) - „I prefer the exclamation mark instead of the doctor icon. Personally, I made some bad experience with doctors and associate it rather negative. The exclamation mark highlights the importance of being physically active." (R.9)
Option to get more information	-	"I need this. I want to know: what are balance exercises? How are they helpful?" (R.6)
Relatedness		
Help button in case of need	-	(/) → is not mentioned by anyone - But it was asked for an instruction video (R.2 & R.3): "I need an instruction video where someone explains at the beginning the different features. That would be much easier for me. I'm not used to technical programs" (R.3)
Affection: User is named directly	-	I like the personally addressed way more. In my old sport classes it's common to be called by name." (R.5).
Reminder	-	"The reminder mail is actually good. When you see that mail, you know what you still have to do. That's motivating for me" (R.4) - "I like the reminder. Otherwise you think you stopped the exercise and it's okay letting it go" (R.5) - "I don't need this." (R.7) - "I like the reminder mail. I know my habits. If I interrupt with an exercise, I usually won't continue with it. But the reminder helps me to fight this inner temptation, to letting it go." (R.9)
Stars/points	-	"Where are my stars?" (R.1, 2,) - "It's a nice to have, but not important for me." (R.4) - "The whole presentation with the stars and the acknowledgement. You need this because you are on your own." (R.5) - "When I do all activities, I have a maximal amount of stars, right? I would add some explanation about the meaning of the collected stars. For example, if you can earn 30 stars, I would adjust the appraisal in three sections. […] If you earn 30 stars: 'That was really great for your body. This is excellent for your health. You did a really good job.' You have to reward the people on this level." (R.6) - "It is like in school. There you also get stars and rewards."(R.7) - "Praise is less important for me. Maybe a small praise. But I really like the function of collecting stars. I was a bit disappointed that I did not get any stars in the other version." (R.9) - "Based on the amount of stars, I can estimate my

	performance so far. This helps me more than base flattery." (R.9) - "I don't need stars. For me praise is enough. The stars are distracting. Is it possible to minimize the part about the stars? I prefer the other one more [without star]." (R.10) -
Praise	- "I don't need that much praise" (R.3) - "I like this more [feedback in SDT +] because the other one is a bit negative. It motivates me more if it is expressed positively." (R.5) - "Maybe I am sensitive, but when I do this exercise for myself, then I want to be a little bit praised. Of course, there are sometimes feedbacks, which are not nice. But it has to include some positive motivational element. Maybe mixing up the two versions would be useful. I would underline the importance of doing the exercise according to the guidelines and include the positive encouragement from the other feedback version." (R.5) - „The first one [SDT (+)] is more motivating. Compliments, congratulations, you receive three stars. I already feel it. People want to be a bit praised. A small thank you, a little reward is simply nice."(R.6) - "It motivates me more [SDT (+)]. It is nicely written. The human being is more directly addressed. The otheroneis not thatmotivating." (R.7)