# Changing sedentary behavior at the office

The development process of a persuasive mobile health application for office workers

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## Abstract

**Background:** Sedentary behavior has become a major public health problem. Office workers are at high risk for the negative consequences of sedentary behaviour, with sitting at work as the largest contributor of their daily sitting time. This increase the risk of some serious health consequences, namely cardiovascular disease, type 2 diabetes, poor mental health, higher risk of cancer and mortality. To change the sedentary behaviors of office workers interventions and eHealth technologies can be used. Yet, most of the existing interventions are not based on behavioural change theories and/or not designed with the help of a participatory development process. The potential eHealth solution could be a technological system, an example is Activate Your Sitting Awareness (AYSA), a seat sensor system for office chairs with the aim to change sedentary behaviour.

**Study goal:** The goal of this study is to develop a lo-fi prototype of the persuasive health application for AYSA, in order to change the sedentary behavior of office workers, based on a participatory design process and behavioral change theories.

**Methods:** Within this qualitative research, the CeHRes Roadmap was used for the participatory development process of eHealth. In the first interview round (N=13) office workers were interviewed to find user context, requirements and persuasive features from the persuasive system design model (PSD). With the help of the trans theoretical model (TTM), more insight on the process of change for sedentary behaviour was obtained. Data was deductively and inductively coded, to find the requirements and persuasive features for the application design. Afterwards a lo-fi prototype of the application, based on the requirements and persuasive features was designed. In the second interview round (N=5) usability interviews were conducted to gain insight into the usability and user-experiences of the application. Positive aspects of the application, suggestions for the prototype, and suggestions for implementation were deductively and inductively coded.

**Results:** Participants, the office workers, thought that they sit too much at work, but were willing to change their sedentary behaviour. For the development of the application requirements and persuasive features from participants were defined. These indicated that requirements about the content of the application were the most important for the application design. It was found that participants value that the application can be personalized and tailored to the user. The persuasive features can help to increase the persuasiveness of the application, most of the requirements matched one or more persuasive features. The second interview round showed that the overall experience of the usability was positive. Although, a few adjustments should be made on the layout of the application, to make it clearer and visualised. Participants preferred an application which could be used on multiple devices. More settings were suggested to integrate, so that the application has an indication of the user's environment and available functionalities at the office. Furthermore, they would receive more information about the consequences of sedentary behaviour and a bad sitting posture. The users suggested that the system will be implemented within an organization, so that colleagues will use the system along with them.

**Conclusion:** Office workers thought that they sit too much at the office, but did not know how to change their sedentary behaviour. This emphasizes the need for an eHealth intervention to change the sedentary behaviour at the office. Important requirements are personalisation, tailoring, and adherence, all requirements matched the goal of AYSA. With the help of the PSD-model, an user-friendly lo-fi prototype of the application was designed. Implementation of the system can be done with the help of the diffusion of innovation theory and organisational support. Suggested is to further develop an interactive hi-fi application, with the help of more research about the TTM. Further research can be done to get more insight into changing the sedentary behaviour at the office.

## Samenvatting

**Achtergrond:** Sedentair gedrag is een steeds groter wordende probleem in de volksgezondheid. Kantoorwerkers zijn als gevolg van hun zittende werkzaamheden vatbaar voor de negatieve gevolgen van sedentair gedrag, omdat kantoormedewerkers gemiddeld het meeste zitten op een dag. Sommige ernstige gezondheidsrisico's van sedentair gedrag zijn de vergrootte kans op hart- en vaatziekten, type 2 diabetes, slechte geestelijke gezondheid en een hoger risico op kanker en sterfte. Ehealth interventies zijn veelbelovend om sedentair gedrag van kantoorarbeiders te veranderen, hoewel veel bestaande interventies niet ontworpen zijn met een participerend ontwikkelingsproces of gebaseerd zijn op gedragsveranderingstheorieën. De potentiële eHealth-oplossing kan een technologisch systeem zijn, bijvoorbeeld Activate Your Sitting Awareness (AYSA) een zit sensor en applicatie systeem.

**Studiedoel:** Het doel van dit onderzoek is het ontwikkelen van een lo-fi prototype van een overtuigende gezondheidsapp voor het systeem AYSA, met als doel om sedentair gedrag van kantoormedewerkers te veranderen, door gebruik te maken van een participatief ontwerpproces en gedragsverandering theorieën.

**Methoden:** In dit kwalitatief onderzoek is gebruik gemaakt van de CeHRes Roadmap voor het participerende ontwikkelingsproces van een eHealth interventie. In de eerste interviewronde (N=13) werden kantoormedewerkers geïnterviewd om gebruikerscontext, eisen en persuasive features (vanuit de persuasive system design model (PSD)) van een app te vinden. Met behulp van het trans-theoretische model (TTM) kon mogelijk meer inzicht verkregen worden in het veranderingsproces van sedentair gedrag. Gegevens werden deductief en inductief gecodeerd om de vereisten en overtuigende eigenschappen voor het ontwerp van de app te vinden. Vervolgens werd er een lo-fi prototype van de applicatie op basis van de eisen en overtuigende eigenschappen ontworpen. De tweede interviewronde (N=5) werden gebruikersinterviews uitgevoerd om inzicht te krijgen in de bruikbaarheid en gebruikerservaringen van de applicatie. Positieve aspecten van de applicatie, suggesties voor het prototype en suggesties voor implementatie werden deductief en inductief gecodeerd.

**Resultaten:** De deelnemende kantoormedewerkers, dachten dat ze te veel op het werk zaten, maar waren bereid waren om hun zitgedrag te veranderen. De eisen en persuasive features voor de app werden gedefinieerd, de eisen omtrent de inhoud van de app bleken het belangrijkste voor het ontwerp van de app. Het is gebleken dat deelnemers een gepersonaliseerd en aanpasbare app waardeerden. De persuasive features kunnen helpen om het gebruik van de app te stimuleren op verschillende manieren. Het was gevonden dat de meeste eisen voldoen aan één of meer persuasive features. In de tweede interviewronde bleek dat het gebruik van de app als positief werd ervaren. Hoewel er een aantal aanpassingen aan de lay-out van de applicatie gedaan kunnen worden, om de app duidelijker en visualiserende te maken. Deelnemers hadden de voorkeur voor een app die te gebruiken is op meerdere apparaten en meer instellingen voor een indicatie van de omgeving en de beschikbare functionaliteiten op kantoor konden toegevoegd worden. Daarnaast wilden kantoormedewerkers meer informatie over de gevolgen van zitgedrag en een slecht zithouding. Gesuggereerd werd om het systeem binnen een organisatie te implementeren, zodat collega's het systeem gezamenlijk gebruiken.

**Conclusie:** Kantoorwerkers dachten dat ze te veel op het kantoor zaten, maar wisten niet hoe ze hun sedentair gedrag zouden veranderen. Dit benadrukt de noodzaak van een eHealth-interventie om het sedentair gedrag op kantoor te veranderen. Belangrijke vereisten zijn personalisatie, aanpasbaarheid en afstemming en alle eisen voldoen aan het doel van AYSA. Met behulp van het PSD-model is een gebruiksvriendelijk lo-fi prototype van de applicatie ontworpen. Implementatie van het systeem kan worden gedaan met behulp van de verspreiding van

innovatietechniek en organisatorische ondersteuning. Het voorstel is om een interactief hi-fi app te ontwerpen, met behulp van meer onderzoek over de TTM. Verder onderzoek kan worden gedaan om meer inzicht te krijgen in het veranderen van het sedentair gedrag op kantoor.

## Table of content

## Introduction

People live a sedentary lifestyle in our modern society. It has become a major public health problem to live a sedentary lifestyle (WHO, 2016). Sedentary behavior has some serious health consequences, which makes behavioral change necessary (TNO, 2016). There are different interventions designed with the aim to change office workers sedentary behavior (Chu et al., 2016). Several eHealth technologies have been found successful in creating a positive change or improvement in knowledge, awareness or understanding (Lehto & Oinas-Kukkonnen, 2010). The system of Activate Your Sitting Awareness (AYSA), a seat-sensor system for office chairs is an example of a potential eHealth solution. Within this study, a persuasive health application will be developed which can be used in combination with AYSA. A participatory development process and the integration of behavioral change theories will help to design the prototype of the application, in order to change the sedentary behavior at the office.

A person with a sedentary lifestyle is often sitting or lying down while performing daily activities. Sedentary behavior is defined by Viir and Veraksitš (2012) as activities, which requires very low energy expenditure in combination with a sitting or reclining posture (with the exception of sleeping). A few examples of sedentary behaviors are sitting or lying down while watching television, sitting or lying down to read, study, write or work at a desk or computer, or sitting while travelling or driving a vehicle. It is still a misunderstanding that physical inactivity is the same as sedentary behavior because it was found to be a different health problem (Chau et al., 2016). The WHO (2016) defines physical activity as any bodily movement produced by skeletal muscles that require energy expenditure. A physical inactive person will not reach the WHO guideline of minimal thirty minutes of moderate to intensive physical activity every day (WHO, 2016). Therefore, a person can meet the guidelines to be defined as a physically active person, but still be considered as sedentary, because this person spends more than four hours a day with sedentary behaviors.

In 2014, the Netherlands was the country with the highest average sitting time compared to other European countries (Eurobarometer in TNO, 2016). 62% of the Dutch population sits more than 5.5 hours each day and approximately half of this sitting time is spent at work. In 2015, it was found that Dutch office workers sat in total for 9.5 hours on an average workday, what makes it the largest contributor to office workers daily sitting time (TNO, 2016 and Healy et al., 2013). Moreover, sitting time of office workers consists generally of prolonged and unbroken bouts of more than thirty minutes of consecutive sitting (Parry and Straker & Ryan et al. in Hadgraft, et al., 2016). Besides, studies showed that office workers who sit for three-quarters of their work day have to deal with serious health and safety issues (Hadgraft et al., 2016; Proper et al., 2011 and Tobin, Leavy & Jancey, 2016). However, sitting behavior at the office is found to be a habit, a learned act automatically performed, due to situational cues (Cooley & Pederson, 2013). Too much sitting in combination with physical inactivity was found as an indicator for relatively high risks of work absence and illness for a longer period (Hendriksen et al., 2013). This makes office workers who sit most of their workdays a sensitive risk group for the negative health consequences of sedentary behavior.

Sedentary office workers are exposed to serious short- and long-term health risks. The human body is built for motion, which ensures that blood can circulate properly, and the lungs have benefited from the moderate intensive physical activity. Sitting was meant to recover from stress or recover from exertion. Therefore, too much sitting can reduce the pulmonary oxygen uptake in the lungs or reduce the blood flow through the veins and fail of nerve signalling (Dalkilinç, 2015). Consequently, sitting will reduce the concentration and slows the

brain activity (Dalkilinç, 2015). Sedentary behavior has also a direct influence on the metabolism, a number of minerals in bones and vascular health (Hendriksen et al., 2013). Whereas, strong evidence is found for the negative effect on the fat metabolism in the legs, the most oxidative skeletal muscles (Hamilton in Owen, Healy, Matthews, and Dunstan, 2010). Although, there are some inconsistencies about the long-term health risks of sedentary behavior, research has shown that a high sitting time is associated with a higher risk of cardiovascular disease, type 2 diabetes, a higher risk of cancer and mortality (Chau et al. (2013) & Tobin, Leavy & Jancey, 2016). Prolonged sitting is according to Brakenridge et al., (2016) particularly detrimental for cardiovascular and musculoskeletal health. A potential relation between sedentary behavior and obesity still needs further investigation (Hendriksen et al., 2013). Sedentary behavior has not merely physical consequences, it also increases the risk of poor mental health (Tobin, Leavy & Jancey, 2016). There are also indications that depression is associated with sedentary behavior (Hendriksen et al., 2013). These negative consequences show how important it is to change the sedentary behaviour and sitting posture.

There is more research done on how office workers can prevent or decrease the negative consequences of sedentary behavior. Still, there is no existing clinical guideline for sedentary behavior in the Netherlands (Hendriksen et al., 2013). A clear guideline will help to improve the office workers situations when the guideline includes a maximum sitting time, the frequency of sitting, and the duration to interrupt sitting time (Hendriksen et al., 2013). A number of studies already gave recommendations to decrease sedentary behavior. For example, important is to interrupt sitting time every twenty to thirty minutes with leg muscles movements. However standing for longer than two hours per day will have an adverse effect (Healy et al., and TNO, 2016). Ergonomics believe that an active way of retaining body alignment is most favourable. A combination of sitting passively and actively is preferable for the spine (Grooten, Conradsson, Äng & Franzen, 2013). Additionally, it is important to find the intentions towards sedentary behavior, which make sitting a habit. Sitting at work is adopted out of habit, due to expectation and 'necessity', instead of conscious decision-making (Biddle, 2011). Research has found to see the context and social factors of sedentary behavior, instead of focussing on the individual level (Davis, Campbell, Hildon, Hobbs & Michie, 2015). It also corresponds with the suggestion of Biddle (2011) to change sedentary behavior, with a focus on habit breaking, what means that the focus has to be on less conscious processing and great environmental manipulation together with behavioral prompts. Cooley and Pederson (2013) mentioned that prompts at the points of decision can change habits, however, the effectivity of prompts are doubted.

Intervention programs have been found to be effective in reducing sedentary behaviour. Two examples of effective interventions were using a sit-stand desk (Straker et al., 2013), or a portable pedal machine (Carr, Karvinen, Peavler, Smith & Cangelosi, 2013). The intervention of Carr et al. (2013) added a behavioral component and a motivational website, which was also found effective in decreasing sedentary behavior. However, at this moment deploying interventions like these are expensive, due to the devices and implementation of these interventions. Electronic health (eHealth) interventions are promising for sedentary behaviour change because these can facilitate in behavioral change, it is very time and cost-efficient, and it can provide persuasive communication. At this moment, the mobile phone is widely adopted and people tend to carry their phone everywhere (Klasnja & Pratt, 2013). A mobile phone consists of increasing technical capabilities with the option of sensing and integrating phone based personal information (King et al., 2013 and Klasnja & Pratt, 2012). Moreover, it is possible to adjust the device to provide automated, behavioral and

contextual tailored information, throughout the day and across a variety of environments (King et al., 2013). An example is an application of Bond et al., (2014), to break up periods of prolonged sitting to reduce sedentary time with brief physical exercises. The results of this study showed a significant decrease of sedentary behavior and the real-time smartphone display and feedback did significantly increase motivation to break up sedentary time with physically active breaks. These results are corresponding with the study of Hamper et al. (2016) who claimed that features of a smartphone have the optimal conditions to intervene and persuade behavior change.

However, most of the existing eHealth interventions are not based on behavioral change theories and/or evidence (King et al., 2013). Biddle (2011) explained that it is unknown which behavioral change theory is best applicable to sedentary behavior. Behavioral change theories assess the fundamental causes of public health behaviors, which can offer an understanding of the processes and occurrence of behaviors (Kinzie; Sallis & Owen in Sudholz, 2014). Gardner et al. (2015) reviewed effective components of interventions with the aim to change sedentary behavior change. They explained that it must be understood what works in changing sedentary behavior and why this works, before developing an effective intervention. This shows the importance of an intervention program to change sedentary behaviour based on behavioural change theories and techniques to increase effectiveness.

The behaviour must be understood so that behavioral change processes can be targeted with behavioral change techniques (Webb, Joseph, Yardley, & Michie, 2010). Theoretical constructs can be targeted (e.g. attitude, self-efficacy) with mechanisms underlying the behavior change techniques (eg. vicarious learning in modelling). It was already discovered that interventions based on behavior change techniques were more effective compared to other interventions (Gourlan et al., in Gardner, Smith, Lorencatto, Hamer & Biddle, 2015). Intervention components can contribute to the effectiveness of behavioral change (Michie & Abraham in Gardner et al., 2015). One of the effective behavioral change techniques is providing information on health consequences of sedentary behavior to increase knowledge and awareness of office workers (Abraham & Michie in Gardner et al., 2015). Some behavioral change techniques that were found in the most promising studies to change sedentary behavior were self-monitoring behavior, problem-solving, modifying social and physical environments, and giving information on the health impact of sitting (Gardner et al., 2015). Furthermore, it was discovered that the more behavioral change techniques were used, the more promising the interventions will be (Gardner er al., 2015). These behavioural change techniques have to fit the behaviour change that must occur.

A theory that conceptualizes the process of intentional behavioral change is the Trans Theoretical Model from Prochaska and Norcross (1999). This theory is designed to assess the readiness of behavior change, gives an understanding of 'how' behavior is changed and gives insight into the maintenance of the changed behavior (Hemper et al., 2016). The TTM was already found effective for lots of different behavioral health problems, for example, alcohol use, smoking and physical activity (Redding et al., 2000). The TTM describes behavioral change as an individual process, instead of an event. This process contains five stages: the stages of change (Prochaska and Norcross, 1999). These stages show the decisional steps of an individual in behavioral change. The stages of change are divided into the following stages: *pre-contemplation* (sedentary, no intention), *contemplation* (sedentary and 6-month intention), *preparation* (irregularly active and intention), *action* (regularly active for the last 6 months), and *maintenance* (regularly active for longer than 6-months). People move through these stages when modifying behavior, while it is variable how much time a person stays in each stage. What means that individuals often make progress, relapse back to the stage before, to move forward again. However,

this process helps individuals to learn from their acquired experiences (Prochaska and Norcross in Woods, Mutrie & Scott, 2002). Redding et al., (2000) concluded that specific processes within each specific stage could demonstrate successful change in behavior. This implies that a stage-matched intervention may have a greater effect on changing sedentary behavior. An integration of the processes of change can provide a useful guide for interventions (Marcus et al., in Woods, Mutrie & Scott, 2002).

Based on the aforementioned literature it can be concluded that it is highly needed to develop an effective eHealth intervention to change the sedentary behavior of office workers. There occurred a lot of mismatches between eHealth interventions and the context of use, which leads to misuse of the technology, dissatisfaction, low adoption rates, and higher costs (Van Velsen, Wentzelf, and Van Gemert-Pijnen, 2013). To develop an effective, persuasive and user-friendly eHealth intervention the CeHRes Roadmap of from van Gemert-Pijnen, Peters, and Ossebaard (2013) will be used. The CeHRes Roadmap can help plan, coordinate and accomplish the participatory development process of designing and implementing the eHealth technology. The phases used within the Roadmap are the *contextual inquiry, value specification, design, operationalization,* and *summative evaluation* (Gemert-Pijnen et al., 2013). In each step of the Roadmap integration of relevant stakeholders and evaluation is suggested to receive more relevant information for the design process. The model which can help to design an application which influences people's attitude behaviors and rituals without using coercion and deception is the theory of the persuasive system design model (PSD) (Oinas-Kukkonen & Harjumaa, 2009). The PSD model is focused on the interaction of the user with the technology, with the help of persuasive features.

This study is aimed to develop a lo-fi prototype of a persuasive health application to change the sedentary behavior of office workers. The application will be designed for a system called 'Activate Your Sitting Awareness' (AYSA), which exists of an ergonomic office chair and two office chair sensors. The system has the intention to learn users to sit in an active position with the help of exercises. The current application design is not based on any behavioral change theories. In this study, the Trans Theoretical Model will be used to get more insight into the process of behavioral change. With the help of the CeHRes Roadmap (Gemert-Pijnen, Peters & Ossebaard, 2013) the application can be elaborated, based on the wishes and needs of the end-user and the requirements of a behavioral change design. The Persuasive Design Model will be used to design the system related to intended goals for changing compliance, behavior, and attitude. Finally, the system can be successfully implemented within the office. To fulfil the aim of this study, the following research questions will be answered:

(1) How much time does office workers spent sedentary in their current work situation on an average workday?
(2) At what stage of change of the Trans Theoretical Model are the interviewed office workers when it comes to changing their sedentary behavior at work?
(3) What are the user requirements for the application of the technological system AYSA, with the aim to change the sedentary behavior of office workers?
(4) Which persuasive features from the PSD model will help to create a persuasive application for the technological system AYSA?
(5) What suggestions do users have for the lo-fi prototype of the AYSA application and implementation of the system?

## Methods 1

### Study design and ethical approval

A qualitative research was used for the development of the prototyped application to support AYSA. In total, two interview rounds were held: the first interview round consisted of semi-structured interviews to gain more information about the specific needs of the target group and requirements of the application. The second interview round was focused on the user-experience, usability, and implementation within the office of the system AYSA. This study is ethically assessed and approved by the Ethical Committee faculty Behavioral Medicine and Social Sciences (BMS) of the University of Twente, Enschede.

### Setting

At the starting point of this study Activate Your Sitting Awareness (AYSA) was already invented by SR-motion. AYSA has the aim to change sedentary behaviour at the office, with the help of seat sensors and sitting exercises to stimulate and active sitting posture. AYSA consists of an office chair with two seat sensors and a prototyped application (Appendix 3). The sensors of AYSA will measure the sitting position and behavior of the users. The measured data will give more insight in the sedentary behaviour of office workers, which can be found within the connected application.

The prototyped application can be connected with the seat sensors (Fig 1a.), after calibration, the seat sensors can be used in combination with the application. The application menu shows an overview of exercises, with four different exercise types, namely the lower back, sit position, relaxation, and neck. All exercises are displayed in a list, where unlocking is used to access more exercises. The display of each exercise (Fig. 1b.) consists of a description of the exercise, an animated image of a person and a bar to show how fast the exercise should be performed. After one exercise is completed, a graph gives more insight into the performed exercise. More information about the average sitting time and sitting passively or actively is shown in the statistical overview (Fig 1c.).

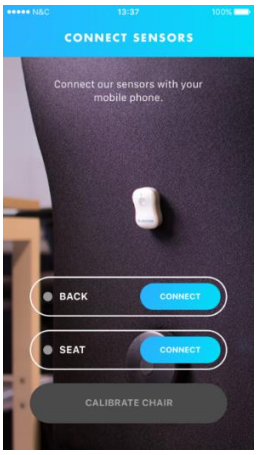


*Figure 1a.* AYSA sensors on an office chair (for connection with the application)

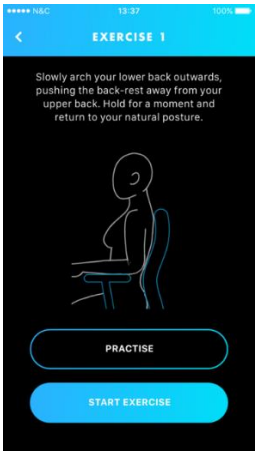


*Figure 1b.* Exercise explanation

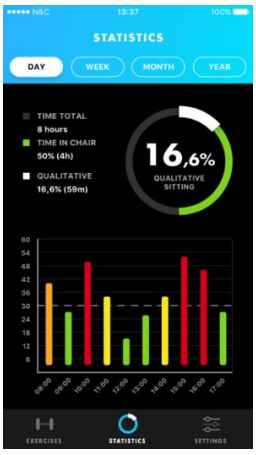


*Figure 1c.* Statistical overview of sitting time

## Interview round 1

The first interview round was targeted to give answers to the first four research questions. More insight was obtained about the work situation, stages of change, the requirements, and persuasive features of the potential end-users of 'AYSA'. The first interview round reflects the first two phases of the CeHRes roadmap (Gemert-Pijnen, Peters, and Ossebaard, 2013): the *contextual inquiry* and *value specification*. Aimed to get an understanding of the users and their context, strong and weak points of current tools, and to establish the needs and problems of the potential end-users.

### Participants

The target group of this study were office workers, because AYSA is focused on changing sedentary behaviour at the office. Within the first interview round thirteen participants were included. The included participants were office workers from three different offices in the Netherlands. Seven participants worked for a municipality in Twente, five office workers worked for the University of Twente, and one participant worked for an it-company. The study sample consisted of four male and nine female participants. The youngest participant was 25 years and the oldest participant 56 years, with a mean age of 35 years. The participants worked between 6 and 9 hours per day ($\bar{x}$=7.6 hours), and between 3 and 5 workdays per week, with a mean of 4 days per week.

### Procedure & Materials

Participants have been recruited through convenience sampling. The researcher asked three office workers, within her network, in person if they were willing to participate in this study. A recruitment letter was sent to the potential participants, including information about the purpose of the study and first interview round (Appendix 1). With the help of snowball sampling, more participants were recruited by spreading the recruitment letter within the offices of the earlier recruited participants. Inclusion criteria for the target group were that participants had an office job at the office at the time of interviewing. They worked for at least three days per week as an office worker. Besides, participants performed their work proceedings while sitting on an office chair.

Before the interview started, the researcher gave a short introduction of herself and a short description of the study goals. After the explanation of the study participants had to sign, the informed consent (Appendix 2). The interviews were held by the first researcher, a health psychologist in training. The first interview round took place at the end of December 2016 until the beginning of February 2017. The face-to-face interviews took place at the office of the participant. The interviews lasted 31 and 53 minutes, with a mean time of 39.5 minutes. All interviews were transcribed verbatim after being completed.

#### *Interview scheme, round 1*

The developed interview scheme (Appendix 4) for the semi-structured interviews was based on prior knowledge on designing E-health applications and the stated research questions of this study. The interview scheme was tested with one test person, an office worker. Afterwards, a few adjustments were made to the interview scheme. The interview consisted of six parts: *(1) demographical information, (2) sedentary behavior at work, (3) work schedule, (4) stages of change, (5) the system AYSA, (6) example applications* and *(7) health promotion at work.*

The questions about the *demographical information* (*1*) were followed by the questions about (*2) sedentary behavior at work*. Before, it was remarked that the following questions were focused on the time that

office workers are at work. Participants were asked to fill in a (*3*) *work schedule* on paper (see appendix 4, Part 3), which gave an overview of the average workday of an office worker. This table shows the participants average workday on the following topics: proceedings, with who they work, how do they work (sitting, standing or walking etc.), and what different activities stirred them during a work day. The fourth part (*stages of change*) of the interview consisted of twelve questions to determine in which stage of change participants were situated, based on the literature of the Trans Theoretical Model (Prochaska, 2011). Hereby the stages of change were used to ask questions belonging to each stage of change. When the participant answered the main question of a stage with the answer 'yes', the questions for the next stage were asked. When the answer was 'no', the researcher asked open-ended questions for that particular stage to get more insight into the participant situation. An example question is for one of the stages is: '*Do you consider changing your sedentary behavior at work?*' This way, participants could be pre-classified in their situated stage of change during the interviews.

During the fifth part (the system *AYSA (5)*), a brief explanation of the office chair sensor system (AYSA) was given by the researcher (Appendix 4, part 5). After the explanation, participants were asked about their opinion towards the idea and functionalities of the system, and if they think they could use it at work. The next part, examples of several existing applications were shown to the participants. This part of the interview is meant to find out what the needs, wishes and requirements towards the application design of the participants are. The *example applications* (6) were found on Google within the categories sport, fitness and sedentary behavior applications (Appendix 4, Part 6). The researcher selected relevant examples and categorized them in the following categories: sitting posture, sitting exercises, schedule, rewards, suggestions and reminders, social element. During the interview, the researcher gave a brief description of each category for application designs. Furthermore, the researcher explained what different features were showed within each example image. The categories rewards, suggestions and reminders, notifications, and social elements at work existed of a few more questions to get more insight into the opinion towards the persuasive features. The final part of the interview consisted of questions which were focused on the availability and participation in health promotion programs at work. Finally, participants had the opportunity to ask questions or give any suggestions. The researcher asked whether the participant would also take part in a follow-up interview (round two) and if they would like to receive a debriefing of the outcomes of this study.

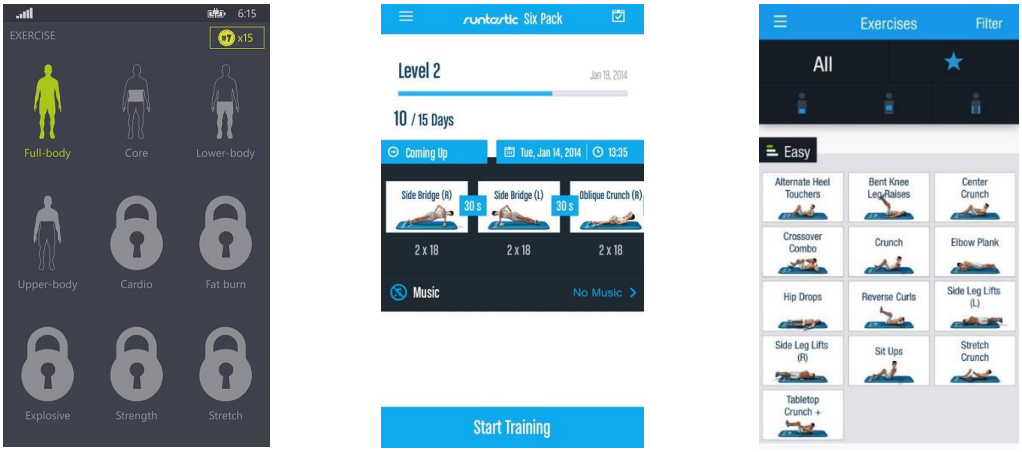


*Figure 2.* Interview scheme example application images in the category sitting exercises

**Data analysis**

The researcher who conducted the interviews was also the coder during the data analysis of the interview transcripts. The coder re-read all transcripts to familiarize with the collected data. Data analysis was an iterative process whereby the interviews were first deductively coded and afterwards inductively coded (categories were derived from the data). The deductive codes were based on the following categories of the interview scheme: *(1) sedentary behavior at work, (2) sedentary behavior change at work, (3) stages of change, (4) requirements and persuasive features.* During deductively coding relevant fragments within each of the aforementioned categories were selected for the individual transcripts.

Within the first category (1) sedentary behaviour answers on the interview questions three until six were used. Quantitatively analyses determined quantities of the sedentary behaviour in the current work situation, namely the *sitting time, prolonged sitting time,* and the *awareness of the health consequences*. More information about the sedentary behaviour in the current work situation could be found with the help of the answers participants gave while filling in the work schedule. Relevant fragments were inductively coded and gave answer to the first research question.

Within the third category the five *stages of change* were defined and used as constructed codes. Pre-classification, which was done during the interviews, each participant was situated in a stage of change. During the analyses the researcher individually situated each participant in the stage of change for sedentary behavior change with deductive codes. Relevant fragments were inductively coded to find differences and similarities between participants within each stage of change. The situated stage of change were the answer to the second research question.

The interview part *(4) requirements and persuasive features* were not transcribed verbatim but pre-processed. By pre-processing the data, the researcher selected the relevant quotations of the interview, with the focus on the requirements and persuasive features for the application design. The relevant quotations were transcribed verbatim. Deductively coding was done with the help of the following subcategories of the fourth interview part: *sitting posture, sitting exercises, schedule, rewards, suggestions and reminders, social element*. After deductively coding the data, inductively coding was done, with the aim to find quotations which expressed requirements and/or persuasive features for the application. Inductive codes were used for a requirement mentioned by one or more participants. Because, not all participants had the same opinion towards each requirement, a distinction was made between the positive and negative quotations towards the requirement.

First, the researcher analysed the requirements mentioned by participants within the same stage of change, to define requirements for participants within each stage of change With the help of inductive codes requirements could be defined. Evaluation of the requirements for each stage of change showed a minimal difference within the requirements associated with every stage. This was the main reason of the researcher to define requirements for all participants independent of the situated stage of change.

With the help of the sorted out transcripts for each participants, the researcher qualitatively analysed the requirements independent of the stages of change. The positive and negative quotations which were focused on the same part of the application or system were evaluated, so that a compromise between the opinions of the participants could be made. During the evaluation the researcher kept in mind both of the opinions of that part and the goal of the application. All defined requirements could be divided into five different types as mentioned by Van Velsen, Wentzel and Van Gemert-Pijnen (2013): *(1) functional and modality requirements, (2) service*

*requirements, (3) organizational requirements, (4) content requirements* and *(5) usability and user experience requirements*. The requirements were found with the help of the answers to the interview questions of the example applications, and gave answer to the third research question.

Finally, within the defined requirements, as described above, the researcher analysed if the requirements matched any of the persuasive features from the PSD model (Oinas-Kukkonen & Harjumaa, 2009). When persuasive features were found within the requirements, the persuasive feature was combined with the requirements for the application. The answer to the fourth research question was found with the help of the interview questions within the examples of the application part.

## Results 1

### Sedentary behavior in the current work situation

All participants (n=13) thought that they sit too much at work before and after filling in the work schedule. From these participants, some participants (n=5) mentioned that they were aware of the consequences of sedentary behavior. However, three of these participants could mention one or more general consequences of sedentary behavior on their health. Four of the remaining participants, who were aware of the consequences gave a more detailed explanation of the negative health consequences. Table 2 shows the estimated sitting time (M=83.6%) of the participants on an average workday, with a mean estimated prolonged sitting of 1.4 hours. Besides, the majority of participants (n=12) was aware of the consequences of a bad sitting posture.

Table 2.

*Estimated sitting time on an average workday of the participants (N=13).*

| Characteristics | n | % |
|---|---|---|
| Estimated sitting time | | |
| 66.6% | 1 | 7.7 |
| 70% | 2 | 15.4 |
| 80% | 3 | 23.1 |
| 90% | 5 | 38.5 |
| 95% | 2 | 15.4 |
| Prolonged sitting (>30 minutes) | | |
| 30 minutes | 1 | 7.7 |
| 1 hour | 6 | 46.2 |
| 1.5 hour | 3 | 23.1 |
| 2 hours | 2 | 15.4 |
| 2.5 hours | 1 | 7.7 |

### Participants stage of change

Table 3 shows the stages of change for all thirteen participants. All participants (n=13) mentioned that they were willing to change their sedentary behavior at work, with the main reason to improve their physical health. An example quotation of one of the participants was: '*Omdat ik merk dat ik fysiek niet goed in mijn vel zit*.' (Participant 12). Noticeable, were the eight participants situated in the contemplation stage. The reasons they mentioned for not making a commitment to take action were the amount of work, the lack of discipline, and availability of an ergonomic office chair. Three participants explained that they did not want to change their sedentary behavior at this moment, due to the lack of health complaints or they did not know how to change their

sedentary behavior. The participants within the *determination* stage (n=4) were already trying to change their behaviour. Examples of changes they have made were taking a walk during breaks, taking the stairs instead of the elevator, or getting some coffee/tea to break up sedentary time. Remarkably, none of the participants were found within the *action stage*, because the majority of participants tried to change their sitting posture or sitting time, but did not change their sedentary behavior (sitting time and sitting posture) successfully. Only one participant mentioned that the changed behaviour felt as a new habit, which showed that the participant was situated within the maintenance stage.

Table 3.
*Participant's classification in the defined stage of change.*

| **Stage of change** | **Definition** | **Number of participants** (N=13) | **Explanatory quotes** |
|---|---|---|---|
| Pre-contemplation | Participants are not aware of the behavioral risks of sedentary behavior. | 0 | |
| Contemplation | Participants are thinking about changing their sedentary behavior, but have not yet made a commitment to take action, advantages and disadvantages are weighed. | 8 | 'Dat is wel waarbij ik soms denk van goh dat zou ik wel willen veranderen, maar die stoelen zijn er niet naar dus nja dat is dan maar zo. Maar ik kan me voorstellen dat als je last heb je daar wel iets aan doet.' |
| Determination (or preparation) | Participants are committed to changing their sedentary behavior soon. Some participants have tried to change before or have been practicing changing sedentary behavior in small steps. | 4 | 'Ik ben wel heel bewust eventjes bezig van oké, ik ben expres degene die thee gaat halen, één omdat ik graag een kopje thee wil, zodat ik ook genoeg drink. Maar ook omdat ik dan eventjes op sta.' |
| Action | Participants modify their sedentary behavior, experiences and/or environment to overcome the problem. Participants have successfully changed sedentary behavior for a period from 1 day to 6 months. | 0 | |
| Maintenance | Participants have changed their behavior for at least six months (action stage), prevent relapse and consolidate the gains attained in the action stage. The participants in this stage remain free of the problem and/or consistently engaging in the new behavior for more than 6 months. | 1 | 'Het is bij mij al een gewoonte het voelt niet als volhouden. Ik weet niet of ik het goed doe, maar het voelt niet als volhouden.' |
| Relapse | Participants have relapsed for within or after six months of changing sedentary behavior. | 0 | |

*Note*. Adapted from 'Stages of change', by Norcross, J. C., Krebs, P. M., & Prochaska, J. O. (2011). *Journal of clinical psychology*, *67*(2), 143-154.

**Requirements and persuasive features**

After analysing the data, 23 user-requirements were found for the application design of AYSA. The requirements were subdivided into the different requirement types: *(1) content requirements, (2) functional and modality*

*requirements, (3) organizational requirements, (4) usability and user experience requirements*, and *(5) service requirements* (Van Velsen, Wentzel & Van Gemert-Pijnen, 2013). The requirements for each different type of requirement with pro and con arguments from the participants can be found in appendix 5. The accompanying persuasive features from the requirements and the appliance within the application prototype are shown in Appendix 6. The main outcomes of the interviews were the values, requirements and persuasive features will be described below.

***Content requirements***

The largest group of requirements can be found within the content requirements, to specify the content that needs to be communicated via the application, persuasive approach, and accessibility demands. The content requirements can be found in table 4d. The persuasive features that were retrieved from the content requirements *were: tailoring, personalization, self-monitoring, expertise (2x), reduction, rehearsal, trustworthiness, rewards, tunnelling, competition, social comparison, social facilitation, suggestions, and reminders.*

In total sixteen content requirements were mentioned by the participants. Participants preferred a tailored application because the system should preferable think for itself, with the help of the filled in information of the user. Participant 9: '*Ik zou in de werksituatie gek zijn op iets* [een systeem] *wat zelf denkt, zonder dat ik dat hoef te plannen tijdens de dag, hoe persoonlijker het gemaakt kan worden op basis van de sensoren, hoe beter het is.*' The application should also provide personalized information about the needs, personality, interests, context sedentary behavior and other interesting factors for the behavioral change of the participant. Furthermore, the application should preferable be personalized to the workday of users. The personalized requirements focuses on the exercise plan and suggestions and reminders that the users receive. However, a standardized exercise plan could help some participants to actually perform exercises in order to change their sedentary behavior. The following quote explains how (s)he wants to adapt the exercise plan to his/her preferences:

> *Dat je keuze hebt is natuurlijk wel fijn, dan kan je misschien de intensiviteit of tijdsduur zelf bepalen, het hangt er misschien van af dat je denkt van ik heb nu heel even dus dan langer kan niet, dat je daar zelf in kan bepalen.* (Participant 12)

In addition to gaining insight into the sitting posture and performing sitting exercises, participants were interested in receiving information about the right office settings and how to sit while using a device. The following participant explained his/her opinion in the following quotation: '*Zithouding is één maar inderdaad hoe gebruik je je meubilair, hoe gebruik je je muis, hoe gebruik je je laptop, is allemaal van belang, dus eigenlijk alles wat je nodig hebt om langer gezond te blijven dat mag er wat mij betreft in meegenomen worden.'* (Participant 4). *Expertise*, or providing information showing knowledge, experience and competence is an important persuasive feature that could increase the power of persuasion of the application within this part. *Self-monitoring* was seen as an important aspect of the application by the majority of participants. Participants would like to get insight into their progress of sedentary behavior (change) over a certain period of time, this was consistent with the goal of AYSA.

Table 4a.

*Content requirements for a sedentary behavior change application.*

| **Value** | **Requirement** | **Accompanying persuasive feature** |
|---|---|---|
| Tailored information | Within the application the user will receive tailored information about their sedentary behavior and workday. | *Tailoring* |
| Insight and feedback on sedentary behavior (change) | The application gives insight into the sitting posture with the help of an image and explanatory information about your sitting posture.<br><br>There is an option to show users a general and more detailed image of their sitting posture.<br><br>The application consist of a step-by-step guide to set the right office settings.<br><br>The application shows in a statistical overview the sitting time and their behavioral change progress over different periods. | *Self-monitoring, Expertise* |
| Clear sitting exercises | Each sitting exercise consists of information about the time duration of an exercise and what body part is being trained.<br><br>The application consists of explanatory information in combination with an image of the sitting exercises. | *Reduction, Rehearsal, Trustworthiness, Expertise* |
| Levelling and unlocking | User will level up when they have collected enough points by performing exercises or achieving goals.<br><br>With the help of unlocking users can unlock more exercises by performing exercises. | *Rewards, Tunnelling* |
| Personalized exercise plan | Within the application, a standardized exercise plan for each different level is available, users have the option to personalize that exercise plan. | *Personalization* |
| Goal setting | Users can choose their own daily goals to change their sedentary behavior with the help of the application. | |
| Optional competition and social elements | A competition element is integrated in the application, a clear overview of the user's levels and/or points can be used to challenge the users.<br><br>The competition and social feature of the application are optional to use. | *Competition, Social comparison, Social facilitation* |
| Personalized suggestions and reminders | In the application, relevant suggestions and reminders are integrated to prompt the user for action and to create awareness.<br><br>The users can personalize if they want to receive a suggestion/reminder and how many times they want to receive a suggestion/reminder.<br><br>The suggestion and reminder message contains a 'not now' and 'remind me later' option. | *Suggestion, Reminders* |

Furthermore, participants mentioned that levelling and unlocking could stimulate them to perform more exercises. Unlocking can help users to perform more exercises because it will serve as a *reward*. However, not all participants will be motivated by receiving rewards, as some did want to change their behavior just for themselves. Besides, rewards will serve as an extrinsic motivation for some participants. The requirements stated

for the sitting exercises are that users level up when they have collected enough points by performing exercises or achieving goals. The persuasive feature *tunnelling* will guide users through the process of behavioral change and will gives insight into their change. For example, with the help of a bar that becomes one colour, when you complete more exercises.

Participants explained that they would like to receive a suggestion or reminder, but it must not interfere their workflow. One participant explained that (s)he does not like suggestions, because of the following reason:

> [Suggesties] *Dat zijn dan wel dingen die ik zelf weet, of die we zelf ookal doen ook, dus dat zegt voor mij niet zo heel veel, het zou wel echt iets heel nieuws moeten zijn anders negeer je dat ook en is het alleen maar irritant, weer een extra melding*. (Participant 11)

This created the requirements to give relevant suggestions and reminders to prompt the user for action and to create awareness, however users would like to personalize if they want to receive a reminder and/or suggestion and how many times a day they want to receive them. Additionally, the requirement of the participants was that the reminder message for suggestions and/or reminders should contain a 'not now' and 'remind me later' option.

***Functional and modality requirements***

Functional and modality requirements are important for programming the application, with the focus on specifying technical features, the type of device for the intervention, and the operating system for the application. There were five functional and modality requirements mentioned by the participants, these can be found in table 4a. Within the first requirement type, the persuasive features *personalization(2x)* and *reminder* were found.

The opinion of the participants differs towards the use of the application on a mobile phone or another device, for instance, a laptop. The requirement was based on the pro and con arguments of the participants who preferred to receive the information only through a mobile application, because this would be less annoying. However, some participants mentioned that it would be more effective if they receive the same information from the application on their computer/laptop. Taking into account the preferences of these types of participants, an option to use the application on another device was found as the defined requirement.

Participants described during the interviews that they want to receive silent and visual push notifications to remind them. The explanation of one participant was made clear within the following quotation: P6: '[Melding] *Ik ga niet veranderen door piepjes of alarmpjes. Vaak genoeg meegemaakt dan ga ik het piepje uitzetten.*' However, some participants preferred a sound or vibrating notification. Besides, it was found that the notification needs to be visualised to be seen by the user. Where the push-notifications (*reminders*) will help remind the user to perform the target behavior, it was also found necessary by the participants to receive reminders. All the notifications and reminders should be adjustable to the preferences of the participant, so it will fit within the workday of a user.

Table 4b.

*Functional and modality requirements for a sedentary behavior change application.*

| Value | Requirement | Accompanying persuasive feature |
|---|---|---|
| Easy and continuously accessible | The application is continuously accessible to receive real-time feedback on their sedentary behavior. | *Personalization* |
| Optional use on other devices | The application can be used on a mobile smartphone, with an option to use the program on another device (computer/laptop).<br><br>The program on other devices includes an option to show a larger image of the sitting posture and sitting exercises. | |
| Silent and visual push notifications | The user can choose the type (sound, light, text or vibration) of push notifications they want to receive on every device. | *Reminders*, *Personalization* |
| Low battery usage | The application can be used during workhours without using too much battery. | |
| Optional link with digital calendar | The application has an option to link the planning to their digital calendar. | |

***Organizational requirements***

Integration of technology within the organization structure and work routines are part of the organizational requirements. Within the organizational requirements, two persuasive features were retrieved: *normative influence* and *social facilitation*. Participants preferred an application that is integrated within the organization and ensures their privacy, as shown in table 4c.

The participants mentioned that they would be encouraged to change their sedentary behaviour when colleagues are using the application. The persuasive features *normative influence* and *social facilitation* explain the persuasion of organizational integration. As it is a sort of social support, the feature *normative influence* was found as important for the majority of participants. The following quote explains this importance: '*Misschien ook wel dat je het met z'n allen doet* [Zitgedrag aanpassen], *dat het echt een collega ding is en dat het normaal is om een oefening te gaan doen, als het normaal is dan zou ik het misschien wel gaan doen.'* (Participant 11). *Social facilitation* will add that other users are not just using the application in real-life, but also within the application with the help of an visualized overview of their performances. However, not all participants mentioned the need for social facilitation because it would not help them to change their behavior.

Most participants did not think about the consequences of privacy, but one participant gave the following reason to ensure users privacy: *'Ik denk dat het eigenlijk wel principieel gezien belangrijk is dat mijn directe werkgever daar* [data uit de app] *geen inzicht in heeft, zo'n puntensysteem zou ook relatief moeten zijn.'* (Participant 9). An aspect which should be taken into account when developing the application.

Table 4c.

*Organizational requirements for a sedentary behavior change application.*

| Value | Requirement | Accompanying persuasive feature |
|---|---|---|
| Integration within organizations | The intervention should be integrated within an organization, so that more people will use the system to change their sedentary behavior. | *Normative influence, Social facilitation* |
| Ensure user privacy | Information gathered from the system is not available for the employer. | |

***Usability and user experience requirements***

The final requirement type is usability and user experience requirements, focused on the interface and interaction design of the application and the user experience factors (trust, fun). *Liking* and *surface credibility* were the persuasive features found within these requirements. The usability and user experience requirements can be found in table 4e.

In total two requirements were mentioned within this category. The application needs a clear layout and does not interfere the workflow. Where *liking* was a frequently mentioned persuasive feature, it also influenced participants preference choice of the example applications during the first interview round. What participants found important was that the application has a clear layout, for instance, the colours, visualisation, large and appealing images, and a professional appearance. These features are represented within the persuasive feature *surface credibility*, focused on the competent look and feel an application should have on first inspection.

Besides, participants explained that there already were a lot of situations that will interrupt or disturb the workflow. So, it should be avoided to interrupt users within their workflow as much as possible. Adjusting the settings of the application could probably prevent this.

Table 4d.

*Usability & User experience requirements for a sedentary behavior change application.*

| Value | Requirement | Accompanying persuasive feature |
|---|---|---|
| Clear layout | The sitting posture of the users and exercises are recognizable and easy to understand for the users. | *Liking, Surface credibility* |
| Does not interfere the workflow | The notifications and exercises does not interfere the workflow of the user. | |

***Service requirements***

The second requirement type focuses on the surrounding of the technology, for instance, marketing or user support. Only one service requirement was found and the accompanying persuasive feature was *expertis*e, which can be found within table 4e. The defined requirement was an innovative and updated application. As participants explained that this would motivate them to use the application and it could probably increase their adherence. Creating awareness was mentioned by one of the participants as an important aspect for using the application. In combination with expertise, the application should provide information to increase knowledge, let users experience and increase competence in changing sedentary behaviour.

Table 4e.

*Service requirements for a sedentary behavior change application.*

| Value | Requirement | Accompanying persuasive feature |
|---|---|---|
| Innovative and updated application | The application is innovative and updated to stimulate usage of the application and changing sedentary behavior on the long run. | *Expertise* |

## Methods 2

### Interview round 2

Within the first two phases of the CeHres Roadmap (Gemert-Pijnen, Peters & Ossebaard, 2013) information was obtained about the potential users and their context, the user-requirements, and accompanying persuasive features. With the help of the gathered information a low-fidelity (lo-fi) prototype of the application was developed. This lo-fi prototype was used during the second interview round to find suggestions for the lo-fi prototype and implementation of the system. Usability testing was used to identify problems with the lo-fi prototype and to discover users experiences when using the lo-fi application (Gemert-Pijnen, Peters & Ossebaard, 2013). Suggestions for implementation of the system within the office could help to plan the implementation of the system within the *operationalization* phase of the roadmap.

#### Participants

In total five participants were interviewed as potential end-users of the system. Two of these participants did also attend within the first interview round. The study sample of the second interview round consisted of one female and four male participants. From which the participants worked for different offices: an IT-company, Dutch municipality organization, consulting and engineering firm, and a freelance human resource director. The youngest participant was 25 years and the oldest participant 55 years, with a mean age of 37 years.

#### Procedures & Materials

Two different sample methods were used to recruit participants for the second interview round. Within the first interview, participants were asked if they were willing to participate in the follow-up interview. All participants from the first interview round were willing to participate. The researcher asked two participants from the first interview round if they were willing to participate in the second interview. Besides three new participants were asked by the researcher through convenience sampling. The new participants were asked to participate in the second interview round, because they did not know anything about the system of AYSA. Which means that they were not biased by participating within the first interview. Furthermore, had these participants not contributed by defining the requirements for the application, so these participants could provide new information, insights, or opinions on the system. The inclusion criteria for the second interview round were the same as the criteria for the first interview round.

The researcher conducted the face-to-face interviews herself. Before the interview started, the researcher gave a short introduction of herself and a short description of the study goals when participants did not participate in the first interview round. After the explanation of the study participants had to sign, the informed consent (Appendix 2) the voice recorder was turned on. The second interview round took place at the beginning of June 2017. The interviews lasted in between 30 and 49 minutes (M=41 minutes).

## Materials

### *Lo-fi prototype of the application*

After the requirements and persuasive features were defined, the *design* process started. The user-requirements and persuasive features were sorted out for each part of the application. For each different part of the application the researcher described how the requirements and/or persuasive features should look like. This was done with the help of example applications and examples of different features within applications. The description and examples served as a framework for the application design. With the help of the framework the researcher created a paper prototype (Rettig, 1994), which can be found in Appendix 7. Paper prototyping is widely used in user-centred design processes to help develop and create software, which meets the requirements. After, the paper prototype was developed, the design was converted to an online mock-up of the lo-fi prototype. This was done with the help of Balsamiq (Guilizzoni, 2008), a computer program with tools to create and design applications and websites. A few examples of the lo-fi prototype can be found in figure 3 (a, b, c, d), the complete lo-fi prototype of AYSA is can be found in Appendix 8. Within the design, six requirements and two persuasive features could not be processed, because these requirements targeted the whole system (AYSA) or were focused on the implementation of the system.

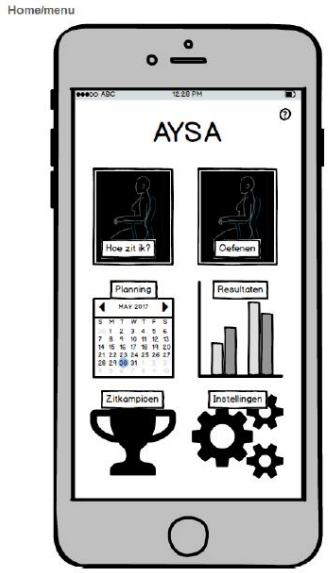


*Figure 3a.* Main menu of the application


*Figure 3b.* Practicing sitting exercise

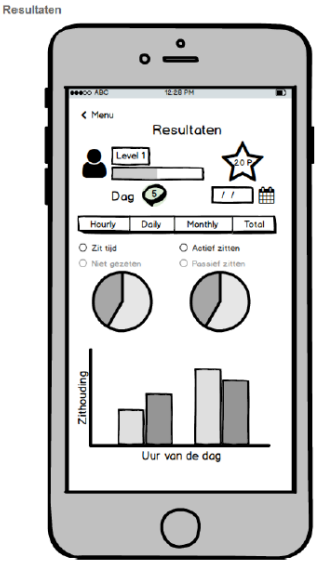


*Figure 3c.* Statistical over view

### *Interview scheme, round 2*

The second interview scheme (appendix 7) for the semi-structured interviews was developed using the results of the first interview round. The interview consisted of the following five parts: *(1) Demographical information, (2) Activate Your Sitting Awareness, (3) Scenarios, (4) User-experience, and (5) Implementation.* Demographical data questions were followed by a brief explanation of AYSA. This explanation consisted of information about the aim of the system and how the system works. The participants also could view the lo-fi prototyped application. Afterwards, the participants were asked about their first impression of the application and if the design appeals to them. Followed by a brief explanation of usability testing and an instruction to think aloud

during the performance of the tasks. The ‘ think aloud method’ (Lewis, 1982) was used to determine if participants were able to accomplish the different tasks. Participants were asked to answer questions and/or perform scenarios for each section of the application. In total, participants had to perform three scenarios: *(1) get a more detailed overview of their sitting posture, (2) perform a sitting exercise,* and *(3) create a day planning with exercises and goals*. While, participants performed the above mentioned tasks, the researcher asked questions and observed the participants. Afterwards, the participants had to answer questions about their experience while using the application. One of these questions was: ‘*What did you like/dislike about the application?*’ Finally, six questions were asked to get more insight in how AYSA could be implemented in for example different organizations. In the end, participants had the possibility to ask questions or give some more suggestions. Finally, the researcher asked again if the participants would like to receive a debriefing of the outcomes of this study.

**Data analysis**

The same researcher who conducted the first and second interview round was also the coder for the data analysis of the interviews. The interviews were not transcribed verbatim, due to the limited amount of time for conducting this study. Instead, the interviews were pre-processed by the researcher with the help of structure of the interview scheme. Deductive codes retrieved from the interview scheme were: (1) *demographical information, (2) prototyped application, (3) Scenarios, (4) user-experiences and (5) implementation*.

For answering the last two research questions two interview parts of the interview scheme were used, namely (2) *prototyped application* and (3) *evaluation and scenarios*. Within the (2) prototyped application, participants gave their first impression about the application, which was inductively coded. Some participants already mentioned suggestions for a specific part of the application, these aspects were deductively coded for each part of the application.

Within part (3) *evaluation and scenarios,* deductive codes were based on each part of the application design. The created codes that were used were: *sitting posture, office settings, sitting exercises, planning, notifications, results, competition, and suggestions*. Three *tasks* were performed by the participants, which could be analysed with the help of the number of completed tasks and suggestions for improvement. Errors and suggestions for improvements were inductively analysed. Other data within the third part were coded inductively to combine similar positive findings and suggestions of the participants for the lo-fi prototype. All data within each inductive code was evaluated by the researcher, to define suggestions for improvement of the prototype. The suggestions were classified by user satisfaction level with the help of the following codes: *high* (greatest potential for improved user satisfaction), *medium* (greater potential for improved used satisfaction), and *low* (the potential for improved user satisfaction). The researcher evaluated and coded if suggestions were relevant to improve the user satisfaction and reach the goal of the application.

The interview questions 1 until 6 about the *user experience* (4) part were used to find out the experience of using the application and different suggestions within this category. The relevant fragments about the individual user experiences were inductively coded and analysed. Finally, participants gave suggestions for implementation of the application at the office, these suggestions were coded inductively. The aforementioned data was used to answer the fifth research question.

## Results 2

### First impression of the application

The first impression of the five participants was coded with the following four codes: *clear design, need for instruction, motivation,* and *layout*. Participants (n=3) mentioned that they found the application clear and comprehensive. However, two participants explained that it felt that they needed a manual or instructions to use the application. One participant did only question what would motivate people to use the application. Other suggestions were about the layout of the application, which will be discussed during the comments and recommendations part of the results.

### Usability test of the tasks

During the interview, participants had to perform three different tasks within the application. The first task, view a detailed overview of the sitting posture, was successfully completed by all participants (n=5). However, the lo-fi prototype was not interactive, participants mentioned that they would use their thumb and index finger to zoom in on the image. The image did already consist a magnifier with a plus sign, which was recognized and used by all participants after the researcher indicated that the application is not interactive yet.

The second tasks, performing an exercise, was completed by all participants (n=5). Two participants, did ask for the meaning of the buttons '*practice*' and '*start exercise*'. Despite the fact of unclear meaning of these two buttons, it did not cause any problems for performing the task.

The last task, create a planning with exercises and goals, was completed by four of the participants. One participant had trouble to understand the screen of the planning and how to use it. After explanation of the researcher the participant did understand the screen, but suggested to improve the design and make it clearer and simpler to use.

### Suggestions on the design

The opinions towards the design of the prototype were positive, as four participants mentioned that the layout was clear. In general, participants suggested to use colours, icons, and to keep it simple when the application will be further developed. In addition, images might be enlarged and probably more icons and examples to lead the user through the application should be used. For each part of the application participants mentioned some suggestions to improve the design. Some were focused on the terms used for parts of the application or the images that were used which could be clarified. All the design related suggestions can be found in Appendix 10.

### Suggestions on the content

There were two suggestions found to increase the usability of the application. The suggestions were focused on the notifications, suggestions, and setting the office. Participants (n=4) mentioned that they had enough options to personalize the settings for the notifications within the application. However, within the setting screen, it was not clear what the difference between the buttons: '*Message*', '*Reminder*', and '*Suggestion*' were. Not all participants did understand the meaning of the different terms, which causes that they could not adjust their settings as they wanted. Besides, participants mentioned that it appealed to them to receive personalized messages, reminders, and suggestions. Additionally, participants explained that they would like to set the times within the application that they do not want to receive a message because they have a holiday or are in a work

related meeting. Furthermore, users would like to set how many minutes before an appointment or exercise they would like to receive the notifications.

Another interesting finding was that the application did not know anything about the workplace environment of the user of the application. Three participants mentioned that they would like to fill in their own office functionalities so that the application can send personalized and tailored feedback or information. However, participants explained that it is necessary that the application provides more information on how to set the office. For instance, how they can compare and adjust the office furniture to the correct settings.

Medium severe suggestions mentioned by the participants were focused on the rewards, notifications and suggestions, results and competition overviews. Rewards were appreciated by the majority of participants (n=4). In contrast with the requirements found within the first interview round, participants suggested adding real-life rewards. The explanation they gave was that it was tangible and it would make them proud. Besides, the in application reward system levelling was also appreciated. It was suggested that levelling by performing more exercises should not be too difficult, but realistic and achievable for an application which should be used within a work environment. It stood out that one participant mentioned that (s)he felt a bit overwhelmed by the two options levelling and unlocking and doubted about the effectivity of the unlocking functionality when it is used together with levelling within this application.

It was found that participants (n=3) will use a connection between the application and their digital agenda. Participants suggested that the connection of the agenda and planning from the application will be available in both of the overviews. So that the exercise planning to change sedentary behaviour and work appointments are visible in both, the agenda and application planning. It was even more interesting for participants when goals were standardized, based on the planning and level of the participant, but they still wanted the opportunity to adjust these goals. Suggested was to set a maximum number of goals for users.

The part of the sitting position was appreciated by all participants. Four participants expected that they could change their sitting posture with the help of the application. Furthermore, the detailed overview was mentioned several times as more clear, participants expected that it would give them more insight in their sitting posture. Participants wanted to know more about the seat sensors, what they measure and if they will receive real-time feedback from them.

The last medium severe suggestion for the application mentioned by the participants was to integrate an information button with answers on the commonly asked questions, but also to give information about the application, consequences of sedentary behaviour, and a bad sitting posture. Participants would also prefer to ask their questions within the application, the example given was a chat function.

The application can further be expanded with the low severity suggestions of the participants. The first suggestion which can increase office workers severity who work at home is the integration of more sitting exercises. Participants mentioned that the diversity of the sitting exercises and different time durations were a positive aspect of the application. However, some participants suggested that the exercises could be expanded with exercises to perform when not working at the office chair with the seat sensors. Most of the office workers mentioned that this could happen when they have a meeting of when they are working at their home.

The results and competition overview were clear for all the participants (n=5). A suggestion to increase reliability of the results overview was to integrate data from the mobile step counter, so that missing data, when users are not sitting on their office chair, can be filled in. For the competition overview participants suggested to

include every employer of the organisation and to integrate the time amount that a user used the application to create a fair competition overview.

**User-experiences and suggestions for improvements**

All participants were very positive after using the application. The participants mentioned that the application was clear, user-friendly, entertaining, and creates awareness. Participants described that before they could use 'AYSA', they only need the system of 'AYSA' (chair, sensors and application). Furthermore, they would like to receive more information on how they could use the chair with their desk and the application. All participants mentioned that they would use the application on the long-term, especially if the application will continuously be updated and is adapted to the user.

**Suggestions for implementation**

Finally, participants gave suggestions for the implementation of the system within their office. The suggestions that were found were: raising awareness of office workers and employers and integration of the system within an organisation.

Raising awareness was already found as an requirement during the first interview round. Another method to raise the awareness of the potential users was mentioned by one of the participants, with the help of sensor measurements to gain insight in the actual sedentary behaviour of office workers at the starting point. This information could raise awareness and should be used as a baseline to change sedentary behaviour, which could motivate employers and employees to change their sedentary behavior at the office. Furthermore, it was suggested to raise the awareness of the employer so that they will attach more value to changing sedentary behaviour of their office workers. An example to raise awareness of the employer was to provide facts and numbers of studies due to the consequences of the health situation of their employees.

Integration of the system within an organisation was expected to be more effective by the participants. This is consistent with the requirement defined after the first interview round, that participants preferred to use the application together with their colleagues. It was also found important by all participants to appoint one responsible person within the organization to integrate the system within the organisation. For example, by raising awareness, inspiring colleagues, answer questions, and to solve problems with the system.

## Discussion & Conclusion

The aim of this study was to develop a lo-fi prototype of the application for the system Activate Your Sitting Awareness (AYSA) based on behavioral change theories and techniques and the requirements with the help of the CeHRes Roadmap (Gemert-Pijnen et al., 2013). It was found that there is need for an technological system to change the sedentary behaviour at the office. There was a variation between the time spend sedentary by office workers, but all office workers sit too much and prolonged (more than 30 minutes). The majority of the office workers were situated in the contemplation stage, of the stages of change from the Trans Theoretical Model (TTM). The content requirements were the most important for the development of the application, noticeable was that most of them endorsed the goal of AYSA. Additionally, the requirements and accompanying persuasive features were mainly focused on: tailoring, personalization, long-term usage, and implementation of the system within the work situation. The usability of the lo-fi prototyped application were positive and almost all tasks

could successfully be performed. Suggestions for further development of the application were focused on the layout and content of the application, as settings, providing information, and improvements to integrate the features of the application. Suggestions for implementation of the system was to raise awareness of the office workers and integrate the system within the organisation.

Office workers reported that they thought that they sit too much at work, but they were willing to change their sedentary behaviour. Despite the fact that the majority was willing to change their sedentary behaviour, most participants were situated within the *contemplation*, or the *determination* stage of the stages of change. Which means that the office workers within this stage are not yet changing their sedentary behaviour and overweight the pros and cons of changing their sedentary behavior. These office workers mentioned that they were not aware of the negative consequences or did not know how to change it. Remarkable was that office workers suggested to integrate more information about the consequences of sedentary behavior within the application. The need for information was described by SBRN in Gardner et al. (2015) as a recently recognized health problem, that is still poorly understood. Office workers found it important before implementing the system of AYSA to raise awareness within the organisation they work in. So, health interventions can contribute to fulfil the functionalities of raising awareness within the office. This can be done by providing information about the negative consequences of sedentary behaviour and showing the positive outcomes of changing sedentary behaviour. The TTM described that within the contemplation and determination stage decisional balance, weighing potential gains and losses is done. With the help of providing information this could help office workers move to next stage. Within the determination and action stage the system of AYSA will as an mobile health intervention help office workers to decide to take action and even change the sedentary behaviour and sitting posture at the office.

Within the development process of the application the stages of change from the TTM (Norcross, Krebs & Prochaska, 2011) were used to gain insight in the behavioural change process. Remarkable was that among the participants situated in different stages of change there was no difference found between their needs, wishes, or requirements. These outcomes are in contrast with previous research findings which recommended to integrate the stages of change within intervention designs, in order to stimulate long-term usage and ensure effectiveness of the intervention (Adams & White, 2003). Adams and White (2003) indicated that individuals in different stages of change have different needs, wishes and requirements for an intervention. A plausible explanation for not finding any differences within the requirements between the stages of change could be that the office workers within this study did still work at an unadjusted office environment. The study of Biddle et al., (2011) already showed that an office environment is a high-risk situation for the habit to sit at work. This has the consequence that office workers will not change their sedentary behavior due to their unadjusted office environment. However, the information about the stages of change gave valuable insights into the processes of change. Another explanation for the results found within this research was the influence of the methodology. As this study was conducted with a small study sample, which might have caused a small variation between the participants stages of change. Besides, the questionnaire to define the individual stage of change that was used within this research was perhaps not comprehensive enough to define the stages of change of every individual. More importantly this study showed that the intervention not necessarily needs to be adjusted to each stage of change, but should rather be personalized to every individual user.

The requirements found to develop an application to change the sedentary behaviour the sitting posture of the user endorse the focus on the individual user. Namely, within the most important requirement type, the content requirements, it stood out that participants preferred a personalized and tailored application. Personalization and tailoring of a system to the individual preferences to help office workers change their sedentary behaviour can presumable contribute to successfully use the system. Providing tailored information to reduce sedentary behaviour was found as an effective component of the study of Carr et al. (2013) to reduce sedentary behaviour. This tailored information consisted of locally relevant images, messages and emails, which might have caused the high compliance of the interventional website. As well as personalized advice within an intervention to reduce sedentary behaviour was more effective compared to the control group (Shrestha et al., in Gardner et al., 2016). These findings are in line with the most important requirement found: personalization and tailoring. Dennison et al., (2013) suggested being careful with the use of reminders within mHealth interventions, because this was found as very annoying. Furthermore, office workers mentioned that the application of AYSA must not interfere within the workflow because this could lead to ignorance of the notifications. This is why, within the lo-fi application design of AYSA it is possible to adjust all settings, in particular, the frequency of the suggestions, reminders and notifications. It was highly appreciated by the office workers during the usability test. Adjustment to each individual users, with the help of a personalized and tailored application, should contribute to an increased user satisfaction to help to change behaviour at the office.

A notable functional and modality requirement for the application was that not all participants found a mobile application the best device to change their sedentary behaviour, they rather received notifications on a desktop on which they work. A wide variation between all participants was found, which shows the importance of tailoring the system to be developed. Dehkordi, Breitschwerdt, and Fellmann, (2017) suggested that a combination of using a mobile device, a web-or-browser based application or a 'usual' computer-application might be a possible solution for workplace interventions. Computers tend to be always on, and mobile health (mHealth) interventions have the intention to travel through time and space. Whereas the computer implies that participants are tethered to the device and will be more sedentary (Danaher et al., 2015). However, some of the important advantages of mHealth are that they are designed to give notifications at the right moment and are carried around with the user all the time. This makes it preferable to develop an application with a desktop version of the application which users can choose to use and will synchronize the information gathered from one of the versions.

It was interesting that office workers were concerned about the long-term usage of the system. The office workers mentioned keeping the application innovative and updated. In the literature, the long-term usage of an intervention is called adherence. Adherence is important to prevent a relapse of the changed behavior. The TTM described that changed behavior must be performed for at least six months, to continue to the maintenance stage. In the maintenance stage people are less tempted to relapse, but it still is needed to prevent a relapse in the unhealthy behavior. Therefore the intervention should be focused on maintaining the changed sedentary behaviour. Persuasive features form the PSD model (Oinas-Kukkonnen & Harjumaa, 2009) can help to improve adherence towards eHealth interventions. It was discovered that the elements of dialogue support could improve adherence within the systematic review of Kelders, Kok, Ossebaard, and Gemert-Pijnen (2012). Integration of these persuasive features could help improve the adherence towards the application of AYSA.

Finally, the suggestions for implementation of the system at work showed that office workers were interested in the consequences of their sedentary behaviour at the moment. This could motivate and stimulate the office workers to start changing their behaviour with the help of an application. Brankenbridge et al. (2016) found awareness raising techniques and visible support of the program as effective techniques for long-term behavioral change. Before the system of AYSA can be implemented it is advised to interact with potential adopters and provide tailored messages which will focus on the individual-decision process, as described within the diffusion theory of innovation by Roger (2003). This theory explains how newly developed innovation according to the degree of innovativeness will be adopted, which can help with the implementation of the system of AYSA. Where legitimization of high-status persons will serve as a cue to attention for others, which can be done with the help of one responsible person in each organisation, this was also suggested by the office workers (Dearing, 2009). Moreover, it will be more efficient to communicate the system to the early adopters, so that they will influence the vast majority of potential adopters. However, the system will also be widely adopted when the social system, the organisation, supports the use of the system. This could influence the social pressure of the potential adopters of the system (Dearing, 2009). Brakenbridge et al. (2016) found that organizational support was effective in long-term reduction of the sitting time, in their study which used activity trackers. The organizational supported programs included management support and participation to gain endorsement and promotion of the intervention. The help of organizational support and the diffusion of innovation can be in favour of successful implementation of AYSA.

**Strengths and limitations**

This qualitative study used the CeHRes Roadmap for the participatory development process of the application of AYSA. The CeHRes Roadmap is commonly used in studies to develop eHealth interventions and was proven to be worthwhile. Within this study, the roadmap was used to design the lo-fi application design of AYSA, which turned out to be user-friendly. A qualitative research was used which could give a detailed insight of the needs, wishes and requirements of the potential end-users. Understanding the behavior of the potential end-users, gave relevant information for the intervention design. Additionally, this study has a wide range of participants was used in terms of age, gender, and office jobs. However, it should keep in mind that other research on this topic might have different outcomes, due to the small study sample and different participants.

In addition, this study is based on the Trans Theoretical Model (TTM) which gave insight into the behavioural change process. The theory gave information about the decisional process, which helped with developing the intervention. However, within this study, the standardized questionnaire to define the stages of change of the participants was not used. This might have caused that the questions to determine the situated stage of change of the participant were not valid to define participant's stage of change. Future research can further interrogate participants stage of change or instead use a validated questionnaire to gain more insight into the stages of change for sedentary behavior.

One of the limitations of this study was the recruitment of the participants. Participants had to self-select for attending within this study. In the recruitment letter, it was mentioned that this study was about the sedentary behaviour of office workers with the aim to design an application. This could have led to selection bias. Because, office workers who were interested in changing their sedentary behavior or the design of an application for office

workers were participating, while the office workers who do not want to change their sedentary behaviour would have been less likely to participate.

Furthermore, within this study only one researcher did analyse and code the data of the interviews. Performing data analyses by only one researcher might have influenced the validity and reliability of this study results. Reliability could be improved with the help of inter-rater agreement when more than one researcher analyses the data. Inter-observer reliability might have occurred within the second interview round, where users had to test the lo-fi application of AYSA. This might have caused that the design of the application is influenced by the researcher. To improve the reliability the researcher tried to observe the participants as objective as possible. Besides, not only the positive findings of the usability tests were presented, but also the suggestions for improvements were shown in the results section. The lo-fi prototype still is an example prototype of the application, which means that further development of the application is needed. The aforementioned aspects should be taken into account within future research.

**Recommendations for further research and the development of AYSA**

The knowledge gathered during this development process can be relevant for future studies with the intention to change sedentary behavior. Further studies could investigate in more detail the participant's stages of change and their needs, wishes and requirements for an application to change the sedentary behaviour of office workers. The selection bias could possibly be prevented, with the help of another method to recruit participants. However, it was difficult to find enough participants within this study who meet the inclusion criteria and were willing to participate within both of the interviews. Biases can be prevented during the data analysis or the design of the application design, researchers could integrate inter-rater reliability of a qualitative study.

For the further development of the application of AYSA a few improvements could be made to the lo-fi prototyped application. The requirements and persuasive features from the potential end-users were defined within this study. However, with the information gathered during the usability test, new requirements could be defined. It is suggested to do more research on the needs, wishes, and requirements for office workers to change sedentary behavior, for instance with the help of a prototype of the application or an interactive system. It is suggested to perform this study before further developing the lo-fi application. This also applies to more information about the behavioural change theories and techniques which could be used for the development of an application. Including stakeholders relevant for the technological system design can bring more valuable information about the technological system and implementation of the system within the organisation. Subsequently, a hi-fi prototype of the application can be designed, which is preferably an interactive design which can be used during another usability test to find user-experiences and errors of the design. Furthermore, it is suggested to implement the system within an organization, but first, a pilot test should be carried out to find more information abo the implementation process of AYSA. At this moment there is not much information about the sedentary behaviour of office workers and how to change this, which means that more research on this subject can bring valuable information for the design of technological interventions.

**Conclusion**

This study found that office workers found that they sit too much, but were not aware of the consequences of their sedentary behaviour and how to change it. This emphasizes the need for an eHealth intervention to change

sedentary behavior at the office. The most important requirements for a system to change the sedentary behaviour of office workers were personalization, tailoring, and adherence. Adjustments of the settings and planning within the application design were appreciated by the office workers. The features from the PSD model, especially dialogue support, can help to improve adherence to the system of AYSA. The usability tests showed that the lo-fi application design was user-friendly but still needed a few improvements. New requirements can be stated before developing the hi-fi application prototype of AYSA. It is suggested to use more information about the stages of change from the TTM and to use inter-rater reliability for data analysis. Implementation of the system should focus on raising awareness at the office and use the early adopters, change agents, and organisational support to promote the intervention of AYSA. The lo-fi application of AYSA is developed with the help of the participatory development process from the CeHRes Roadmap. More research on sedentary behaviour can be done to discover how to change office workers sedentary behaviour with an interactive system design.

## References


Adams, J., & White, M. (2003). Are activity promotion interventions based on the trans theoretical model effective? A critical review. *British Journal of Sports Medicine*, *37*(2), 106-114.

Arboportaal (n.d.). *Zittend werk*. Retrieved on 17 February 2017 from: https://www.arboportaal.nl/onderwerpen/zittend-werk

Biddle, S. (2011). Fit or sit? Is there a psychology of sedentary behavior. *Sport & Exercise Psychology Review*, *7*(2), 5-10.

Boeije, H. R. (2005). *Analyseren in kwalitatief onderzoek: denken en doen* (pp. 152-153). Amsterdam: Boom onderwijs.

Bond, D. S., Thomas, J. G., Raynor, H. A., Moon, J., Sieling, J., Trautvetter, J., Leblond, T. & Wing, R. R. (2014). B MOBILE-A smartphone-based intervention to reduce sedentary time in overweight/obese individuals: a within-subjects experimental trial. *PLoS One*, *9*(6), e100821.

Brakenridge, C. L., Fjeldsoe, B. S., Young, D. C., Winkler, E. A. H., Dunstan, D. W., Straker, L. M., & Healy, G. N. (2016). Evaluating the effectiveness of organizational-level strategies with or without an activity tracker to reduce office workers' sitting time: a cluster-randomised trial. *International Journal of Behavioral Nutrition and Physical Activity*, *13*(1), 115.

Bryman, A. (2015). *Social research methods*. Oxford university press.

Carr, L. J., Karvinen, K., Peavler, M., Smith, R., & Cangelosi, K. (2013). Multicomponent intervention to reduce daily sedentary time: a randomised controlled trial. *BMJ open*, *3*(10), e003261.

Carr, L. J., Leonhard, C., Tucker, S., Fethke, N., Benzo, R., & Gerr, F. (2016). Total worker health intervention increases activity of sedentary workers. *American journal of preventive medicine*, *50*(1), 9-17.

Chau, J. Y., Grunseit, A. C., Chey, T., Stamatakis, E., Brown, W. J., Matthews, C. E., Bauman, A. E., & van der Ploeg, H. P. (2013). Daily sitting time and all-cause mortality: a meta-analysis. *PloS one*, *8*(11), e80000.

Cooley, D., & Pedersen, S. (2013). A pilot study of increasing nonpurposeful movement breaks at work as a means of reducing prolonged sitting. *Journal of environmental and public health*, *2013*.

Chu, A. H. Y., Ng, S. H. X., Tan, C. S., Win, A. M., Koh, D., & Müller-Riemenschneider, F. (2016). A systematic review and meta-analysis of workplace intervention strategies to reduce sedentary time in white-collar workers. *Obesity Reviews*, *17*(5), 467-481.

Dalkilinç M. (2015). Why sitting is bad for you. *TEDEd 2015*. Retrieved on 13 January 2017 from: http://ed.ted.com/lessons/why-sitting-is-bad-for-you-murat-dalkilinc.

Danaher, B. G., Brendryen, H., Seeley, J. R., Tyler, M. S., & Woolley, T. (2015). From black box to toolbox: Outlining device functionality, engagement activities, and the pervasive information architecture of mHealth interventions. *Internet interventions*, *2*(1), 91-101.

Davis, R., Campbell, R., Hildon, Z., Hobbs, L., & Michie, S. (2015). Theories of behavior and behaviour change across the social and behavioral sciences: a scoping review. *Health psychology review*, *9*(3), 323-344.

Dearing, J. W. (2009). Applying diffusion of innovation theory to intervention development. *Research on social work practice*, *19*(5), 503-518.

Dehkordi, F. N., Breitschwerdt, R., & Fellmann, M. (2017). IT-Support in Workplace Health Promotion: Mobile Apps on the Rise. In *International Conference on Exploring Services Science* (pp. 38-50). Springer, Cham.

Dennison, L., Morrison, L., Conway, G., & Yardley, L. (2013). Opportunities and challenges for smartphone applications in supporting health behavior change: qualitative study. *Journal of medical Internet research*, *15*(4).

Gardner, B., Smith, L., Lorencatto, F., Hamer, M., & Biddle, S. J. (2015). How to reduce sitting time? A review of behavior change strategies used in sedentary behavior reduction interventions among adults. *Health psychology review*, *10*(1), 89-112.

Gemert-Pijnen, J.E.W.C. van, Peters, O. & Ossebaard, H. (2013). Improving eHealth. The Hague: ElevenInternational Publishing. ISBN: 978-9462360679. All chapters

Grooten, W. J., Conradsson, D., Äng, B. O., & Franzén, E. (2013). Is active sitting as active as we think?. *Ergonomics*, *56*(8), 1304-1314.

Han, H., Gabriel, K. P., & Kohl III, H. W. (2017). Application of the transtheoretical model to sedentary behaviors and its association with physical activity status. *PloS one*, *12*(4), e0176330.

Hamilton, M. T., Healy, G. N., Dunstan, D. W., Zderic, T. W., & Owen, N. (2008). Too little exercise and too much sitting: inactivity physiology and the need for new recommendations on sedentary behavior. *Current cardiovascular risk reports*, *2*(4), 292-298.

Hamper, A., Wendt, J., Zagel, C., & Bodendorf, F. (2016). Behavior Change Support for Physical Activity Promotion: A Theoretical View on Mobile Health and Fitness Applications. In *System Sciences (HICSS), 2016 49th Hawaii International Conference on* (pp. 3349-3358). IEEE.

Hadgraft, N. T., Healy, G. N., Owen, N., Winkler, E. A., Lynch, B. M., Sethi, P., Eakin, E. G., Moodie, M., LaMontagne, A. D., Wiesner, G., Dunstan D. W., & Willenberg, L. (2016). Office workers' objectively assessed total and prolonged sitting time: individual-level correlates and worksite variations. *Preventive medicine reports*, *4*, 184-191.

Healy, G. N., Eakin, E. G., LaMontagne, A. D., Owen, N., Winkler, E. A., Wiesner, G., Gunning, L., Neuhaus, M., Lawler, S., Fjeldsoe, B. S., & Dunstan, D. W. (2013). Reducing sitting time in office workers: short-term efficacy of a multicomponent intervention. *Preventive medicine*, *57*(1), 43-48.

Hendriksen, I. J. M., Bernaards, C. M., Commissaris, D. A. C. M., Proper, K. I., Mechelen, W. V., & Hildebrandt, V. H. (2013). Langdurig zitten: een nieuwe bedreiging voor onze gezondheid. Position statement. *TSG: Tijdschrift voor gezondheidswetenschappen*, *1*, *91*, *22-25*.

Kelders, S. M., Kok, R. N., Ossebaard, H. C., & Van Gemert-Pijnen, J. E. (2012). Persuasive system design does matter: a systematic review of adherence to web-based interventions. *Journal of medical Internet research*, *14*(6).

King, A. C., Hekler, E. B., Grieco, L. A., Winter, S. J., Sheats, J. L., Buman, M. P., Banerjee, B., Robinson, T.N. & Cirimele, J. (2013). Harnessing different motivational frames via mobile phones to promote daily physical activity and reduce sedentary behavior in aging adults. *PloS one*, *8*(4), e62613.

Klasnja, P., & Pratt, W. (2012). Healthcare in the pocket: mapping the space of mobile-phone health interventions. *Journal of biomedical informatics*, *45*(1), 184-198.

Lehto, T., & Oinas-Kukkonen, H. (2011). Persuasive features in web-based alcohol and smoking interventions: a systematic review of the literature. *Journal of medical Internet research*, *13*(3), e46.

Lewis, B. A., Napolitano, M. A., Buman, M. P., Williams, D. M., & Nigg, C. R. (2016). Future directions in physical activity intervention research: Expanding our focus to sedentary behaviors, technology, and dissemination. *Journal of Behavioral Medicine*, 1-15.

Mohr, D. C., Cuijpers, P., & Lehman, K. (2011). Supportive accountability: a model for providing human support to enhance adherence to eHealth interventions. *Journal of medical Internet research*, *13*(1).

Norcross, J. C., Krebs, P. M., & Prochaska, J. O. (2011). Stages of change. *Journal of clinical psychology*, *67*(2), 143-154.

Oinas-Kukkonen, H., & Harjumaa, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems*, *24*(1), 28

Owen, N., Healy, G. N., Matthews, C. E., & Dunstan, D. W. (2010). Too much sitting: the population-health science of sedentary behavior. *Exercise and sport sciences reviews*, *38*(3), 105. DOI:10.1097/JES.0b013e3181e373a2

Owen, N., Leslie, E., Salmon, J., & Fotheringham, M. J. (2000). Environmental determinants of physical activity and sedentary behavior. *Exercise and sport sciences reviews*, *28*(4), 153-158.

Parry, S., & Straker, L. (2013). The contribution of office work to sedentary behavior associated risk. *BM C public health*, *13*(1), 296.

Prochaska, J. O. and Norcross, J. C. (1999) Comparative conclusions: toward a transtheoretical therapy. *Systems of Psychotherapy: A Transtheoretical Analysis*. Brooks/Cole, Pacific Grove, CA, pp. 487–528.

Proper, K. I., Singh, A. S., Van Mechelen, W., & Chinapaw, M. J. (2011). Sedentary behaviors and health outcomes among adults: a systematic review of prospective studies. *American journal of preventive medicine*, *40*(2), 174-182.

Redding, C. A., Rossi, J. S., Rossi, S. R., Velicer, W. F., & Prochaska, J. O. (2000). Health behavior models. In *International Electronic Journal of Health Education*Rogers, E. (2003). *Diffusion of Innovations*. Fifth edition. Free Press: New York.

SR-Motion (n.d.) *Activate Your Sitting Awareness*. Retrieved on 24 March 2017, from: http://www.sr-motion.nl/

Straker, L., Abbott, R. A., Heiden, M., Mathiassen, S. E., & Toomingas, A. (2013). Sit–stand desks in call centres: Associations of use and ergonomics awareness with sedentary behavior. *Applied ergonomics*, *44*(4), 517-522.

Sudholz, B. (2014). *Understanding desk-based employees' and managers' workplace sitting and sitting-breaks* (No. Doctor of Philosophy). Deakin University.

Van der Ploeg, H. P., Chey, T., Korda, R. J., Banks, E., & Bauman, A. (2012). Sitting time and all-cause mortality risk in 222 497 Australian adults. *Archives of internal medicine*, *172*(6), 494-500.

TNO (2016). *Factsheet Sedentair Gedrag*. Retrieved on 16 February 2017, from: https://www.fysiekebelastingbeoordelen.tno.nl/download/Factsheet%20Sedentair%20Gedrag%202016 pdf

Tobin, R., Leavy, J., & Jancey, J. (2016). Uprising: An examination of sit-stand workstations, mental health and work ability in sedentary office workers, in Western Australia. *Work*, (Preprint), 1-13.

Van Velsen, L., Wentzel, J., & Van Gemert-Pijnen, J. E. (2013). Designing eHealth that matters via a multidisciplinary requirements development approach. *JMIR research protocols*, *2*(1), e21.

Viir, R., & Veraksitš, A. (2012). Discussion of "Letter to the Editor: Standardized use of the terms sedentary and sedentary behaviors"—Sitting and reclining are different states. *Applied Physiology, Nutrition, and Metabolism*, *37*(6), 1256-1256.

Webb, T. L., Joseph, J., Yardley, L., & Michie, S. (2010). Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of medical Internet research*, *12*(1).

WHO (2016). *Physical Activity Factsheet*. Retrieved on 16 December 2016 from: http://www.who.int/mediacentre/factsheets/fs385/en/

Woods, C., Mutrie, N., & Scott, M. (2002). Physical activity intervention: a transtheoretical model-based intervention designed to help sedentary young adults become active. *Health education research*, *17*(4),451-460.

Wu, W. H., Wu, Y. C. J., Chen, C. Y., Kao, H. Y., Lin, C. H., & Huang, S. H. (2012). Review of trends from mobile learning studies: A meta-analysis. *Computers & Education*, *59*(2), 817-827.

## Appendix 1. Recruitment letter

Hoi!

Even voorstellen: mijn naam is Ellis (dochter van Annelies), op dit moment ben ik aan het afstuderen voor de masteropleiding gezondheidspsychologie (Health Psychology and Technology). Voor mijn afstudeeronderzoek ben ik opzoek naar kantoormedewerkers die willen deelnemen aan het onderzoek.

**Het onderzoek**
Deelname aan een interview zullen inzicht geven in de behoeftes van kantoormedewerkers voor een gezondheid bevorderende APP. Ik ben vooral geïnteresseerd in jouw werkzaamheden, dagindeling, zitgedrag en voorkeurskenmerken van de APP. Uiteindelijk zal ik met behulp van deze informatie een APP vormgeven om gezond gedrag op werk te bevorderen. Het zou natuurlijk zonde zijn als er straks een APP ontwikkeld is en niemand er gebruik van maakt. Het is een interactief interview en zal ongeveer een half uurtje duren. De uitkomsten zullen anoniem worden verwerkt en enkel gebruikt worden voor mijn afstudeeronderzoek.

Ik kom graag dinsdag 20 december bij u langs om het interview af te nemen. Laat je alvast weten hoelaat je beschikbaar bent?

Met vriendelijke groet,
Ellis Aten

## Appendix 2. Informed consent interview round 1 and 2

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**Toestemmingsverklaringformulier (informed consent)**

**Titel onderzoek**: Active Your Sitting Awareness
**Verantwoordelijke onderzoeker:** E. C. Aten
**Afstudeerbegeleider:** S.M. Kelders / N. Köhle

In te vullen door de deelnemer:
Ik verklaar op een voor mij duidelijke wijze te zijn ingelicht over de aard, methode en doel van het onderzoek. Ik weet dat de gegevens en resultaten van het onderzoek alleen anoniem en vertrouwelijk aan derden bekend gemaakt zullen worden. Mijn vragen zijn naar tevredenheid beantwoord.

Ik begrijp dat geluid-, foto, en videomateriaal of bewerking daarvan uitsluitend voor analyse en/of wetenschappelijke presentaties zal worden gebruikt.

Ik stem geheel vrijwillig in met deelname aan dit onderzoek. Ik behoud me daarbij het recht voor om op elk moment zonder opgaaf van redenen mijn deelname aan dit onderzoek te beëindigen.

Naam deelnemer: ……..

Datum: …… Handtekening deelnemer: …..…….

---

In te vullen door de uitvoerende onderzoeker:
Ik heb een mondelinge en schriftelijke toelichting gegeven op het onderzoek. Ik zal resterende vragen over het onderzoek naar vermogen beantwoorden. De deelnemer zal van een eventuele voortijdige beëindiging van deelname aan dit onderzoek geen nadelige gevolgen ondervinden.

Naam onderzoeker: ……..……..

Datum: …… Handtekening onderzoeker: ...…….

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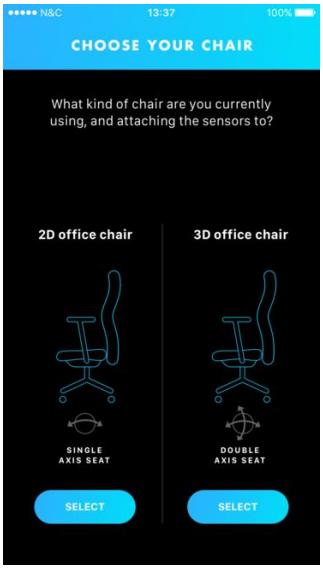
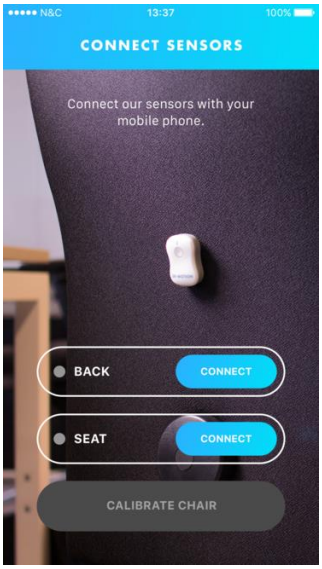
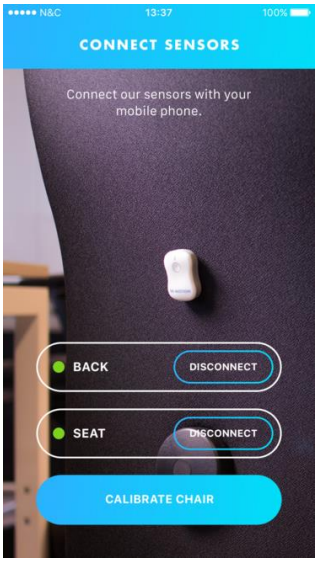
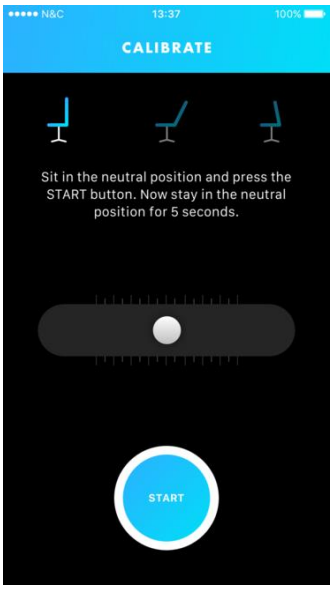
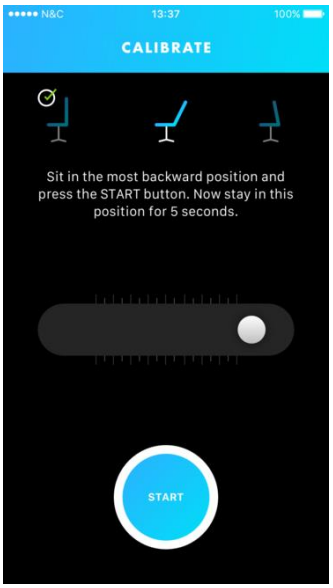
## Appendix 3. Application design ‘AYSA’

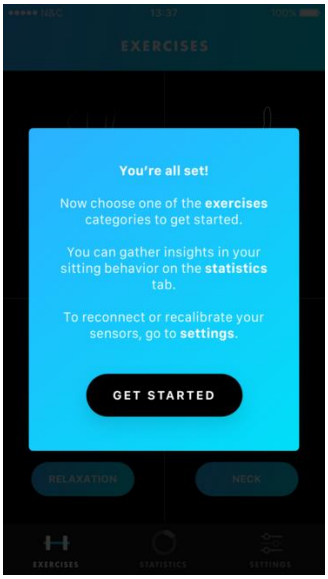


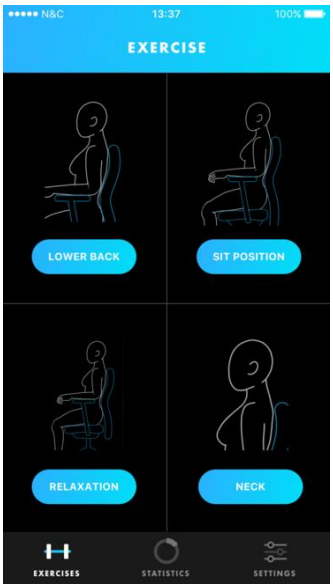



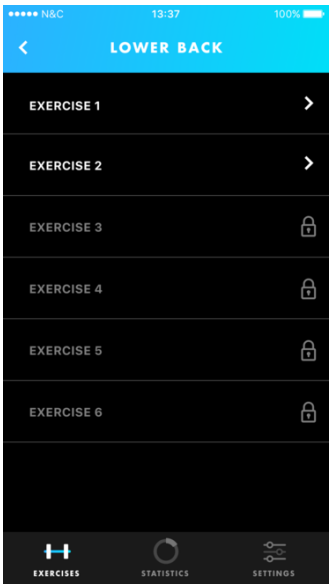



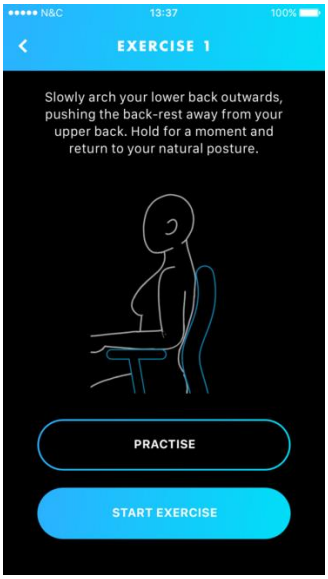



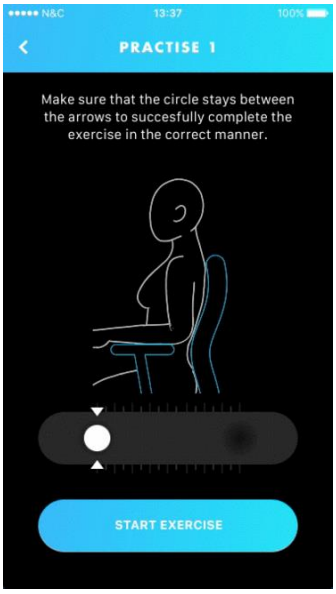



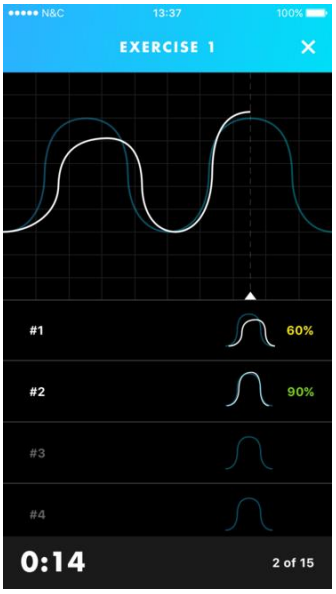



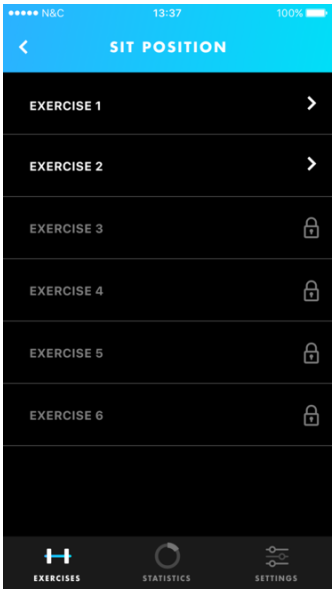



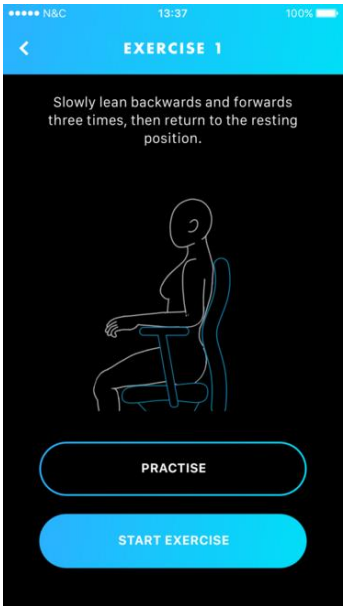



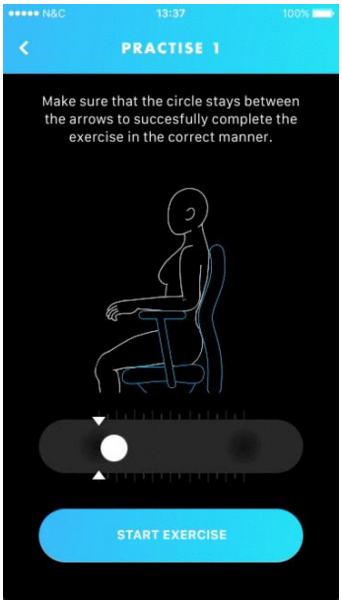



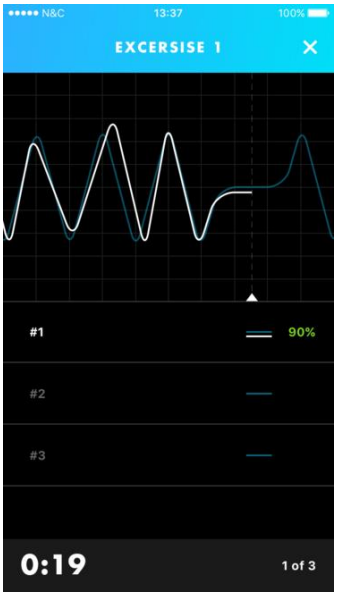

PRACTISE 1
Make sure that the circle stays between the arrows to succesfully complete the exercise in the correct manner.
START EXERCISE

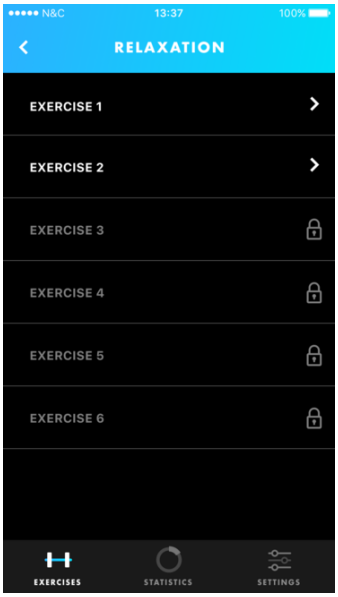

EXERCISE 1
#1
60%
#2
90%
#3
#4
0:14
2 of 15

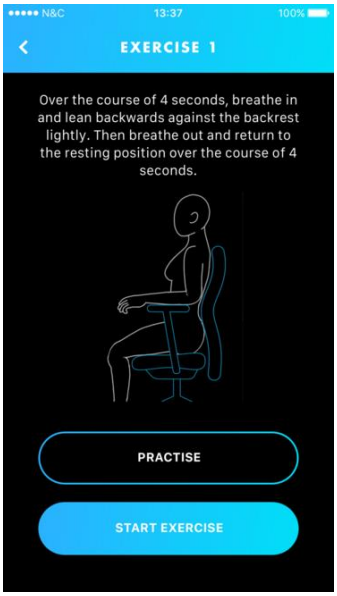

SIT POSITION
EXERCISE 1
EXERCISE 2
EXERCISE 3
EXERCISE 4
EXERCISE 5
EXERCISE 6
EXERCISES
STATISTICS
SETTINGS

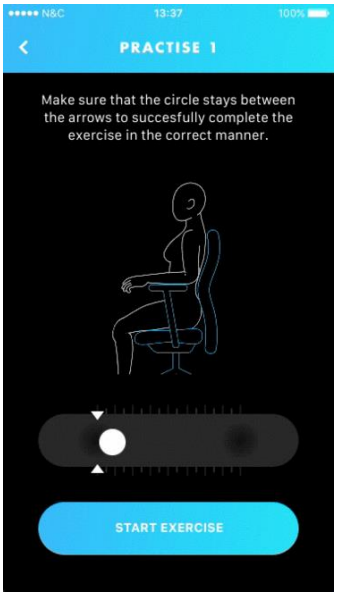

EXERCISE 1
Slowly lean backwards and forwards three times, then return to the resting position.
PRACTISE
START EXERCISE

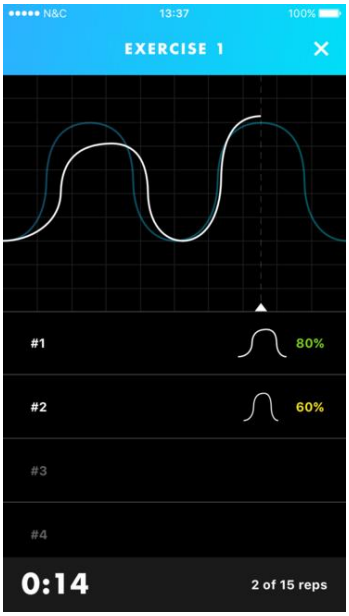

PRACTISE 1
Make sure that the circle stays between the arrows to succesfully complete the exercise in the correct manner.
START EXERCISE

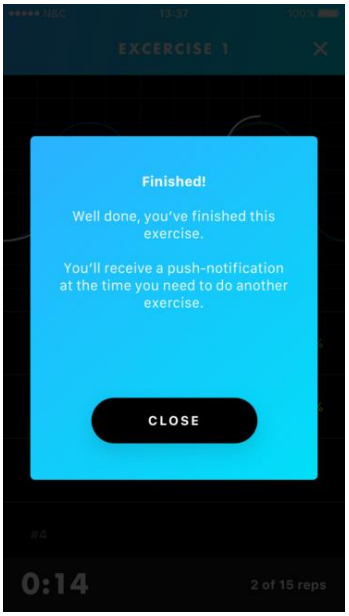

EXCERSISE 1
#1
90%
#2
#3
0:19
1 of 3

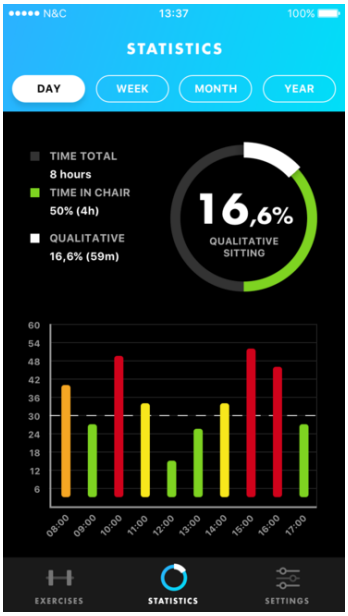

RELAXATION
EXERCISE 1
EXERCISE 2
EXERCISE 3
EXERCISE 4
EXERCISE 5
EXERCISE 6
EXERCISES
STATISTICS
SETTINGS

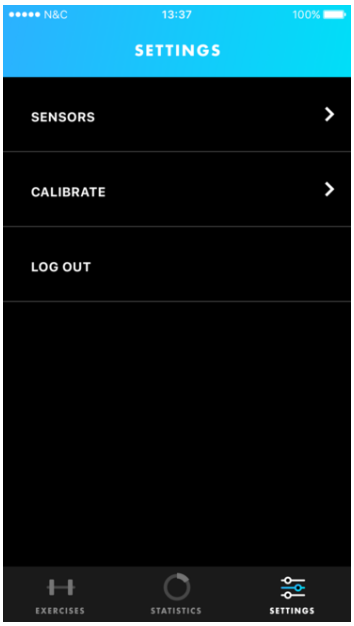

EXERCISE 1
Over the course of 4 seconds, breathe in and lean backwards against the backrest lightly. Then breathe out and return to the resting position over the course of 4 seconds.
PRACTISE
START EXERCISE

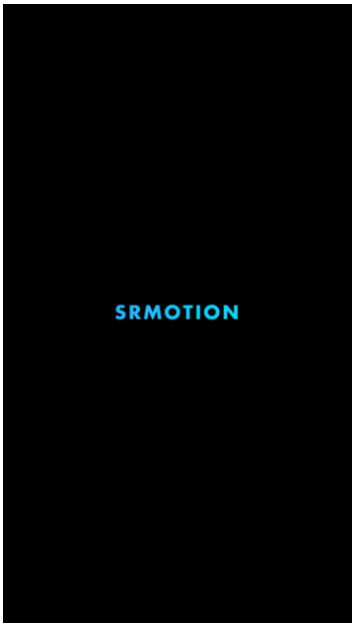

PRACTISE 1
Make sure that the circle stays between the arrows to succesfully complete the exercise in the correct manner.
START EXERCISE


N&C
13:37
100%
EXERCISE 1
#1
80%
#2
60%
#3
#4
0:14
2 of 15 reps


Finished!
Well done, you've finished this exercise.
You'll receive a push-notification at the time you need to do another exercise.
CLOSE
0:14
2 of 15 reps


N&C
13:37
100%
STATISTICS
DAY
WEEK
MONTH
YEAR
TIME TOTAL
8 hours
TIME IN CHAIR
50% (4h)
QUALITATIVE
16,6% (59m)
16,6%
QUALITATIVE SITTING
EXERCISES
STATISTICS
SETTINGS


N&C
13:37
100%
SETTINGS
SENSORS
CALIBRATE
LOG OUT
EXERCISES
STATISTICS
SETTINGS


SRMOTION

## Appendix 4. Interview scheme, round 1

## Interview scheme, round 1

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**Study goal:** The goal of this research is to develop a prototype of the application for users of Activate Your Sitting Awareness (AYSA) that fits the requirements of the end-users and can be implemented in the daily workday of office-workers.
**Target Group:** Office workers
**Time duration:** +/- 30 minuten
**Interviewer:** Ellis Aten
**Instruments:** Semi-structured interview schedule
**Materials:** Interview schedule, informed consent, clean work schedule, example images applications, markers, voice-recorder

---

Thank you for participating in this study about the needs and requirements for a health promoting application.

**Introductie:**

- My name is Ellis Aten. At the moment, I am graduating for the Master of Health Psychology and Technology at the University of Twente. A final part of my study is this master thesis (graduate research). My graduate research is in collaboration with SR-Motion, a small company currently working on developing a product to improve the health of office workers.
- The purpose of this qualitative research is to design an app that matches the needs and requirements of office workers, so that office workers will use the app. The system is intended to ensure that people take an active sitting posture and sit less.

**Informed consent**

Participant can ask question about the study and sign the informed consent.

For the elaboration of the interviews, I would prefer to record this conversation. Do you agree to this? Then I turn on the voice recorder.

1. **Demographical information**
    1. Male / Female
    2. What is your age? …...

The following questions will focus on the time you are at work (9:00 AM-5:00 AM):

2. **Sedentary behavior at work**
    3. Do you think you sit a lot at work?
    4. How many hours do you work per day?
    5. Could you give an indication in percentages, on how much you sit at work?
    6. How often do you spend more than 30 minutes of sitting? And for how long do you sit prolonged?

### 3. Work schedule

By completing the work schedule, I will get an understanding of your average workday. Hereby we fill in what your proceedings are, where your work takes place, with whom you perform your work and for how long you carry out your proceedings. You can use colored pins to fill in the schedule.

More in-depth questions:
• What are your proceedings on a normal working day?
• How many minutes / hours do you spend on that task or meeting?
• In which locations do you perform these activities?
• How do you perform your work?
• How many breaks do you take on an average working day?
• What are you doing during breaks?
• Do you take measures to stay physically active during your work? If yes which one?

Work schedule:

| Time of the day | What (Proceedings) | Where (office, home) | With whom? (collegae, cliënt etc.) | How (sitting/standing/walking etc.) | Moving moments |
|---|---|---|---|---|---|
| 7:30 | | | | | |
| 8:00 | | | | | |
| 8:30 | | | | | |
| 9:00 | | | | | |
| 9:30 | | | | | |
| 10:00 | | | | | |
| 10:30 | | | | | |
| 11:00 | | | | | |
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| 13:30 | | | | | |
| 14:00 | | | | | |

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|---|---|---|---|---|---|
| 14:30 | | | | | |
| 15:00 | | | | | |
| 15:30 | | | | | |
| 16:00 | | | | | |
| 16:30 | | | | | |
| 17:00 | | | | | |
| 17:30 | | | | | |

**4. Stages of Change:**

| Stages of change: | Answer: | Stage: | Continue question per stage: |
|---|---|---|---|
| 1. Do you still think you sit a lot at work (after completing the work schedule)?<br>2. Are you familiar with the consequences of sitting prolonged?<br>3. Are you familiar with the consequences of a wrong sitting position? | No → Stage 1<br>Yes → Question 4 | **(1) Precontemplation**: You are not aware of the risks involved in sedentary behavior (Long-term sitting without interruption is bad for your health, even if you get enough physical exercise). Participant is not considering any change. | - Would you like to know what the negative consequences of sedentary behavior are?<br>- How would you like to know this?<br>- What reasons can motivate you to adjust your sedentary behavior? |
| 4. Do you consider changing your sedentary behavior at work?<br>5. Why?<br>6. Are you familiar with the pros and cons of adjusting your sedentary behavior at work? | No → Stage 1<br>Yes → Question 7 | **(2) Contemplation:** Pros and cons of behavior are weighed. At this stage, the participant is not yet planning to take action. When this is the case, the next phase begins. | - What would you like to change from your sitting behavior at work?<br>- What are the benefits of adjusting your sedentary behavior?<br>- What are disadvantages of adjusting your sedentary behavior?<br>- At what times in the work schedule do you see these advantages or disadvantages?<br>- What is stopping you at this moment to change your sedentary behavior at work?<br>- What do you need to change your behavior?<br>- When in the work schedule do you need this? |
| 7. Are you willing to take action to adjust your sedentary behavior?<br>8. Why? | No → Stage 2<br>Yes → Question 9 | **(3) Determination / Preparation:** One sees the benefit of changing their own behavior and wants to try it (similar to intention). | - Why do you not adjust your sedentary behavior at this moment?<br>- What do you need to adjust your sedentary behavior?<br>- At what moments do you need this, looking at the work schedule?<br>- How do you need this looking at your proceedings and work environment?<br>- At what times in the work schedule do you intend to adjust your sedentary behavior and / or sitting posture?<br>- Why at these moments? |

| | | | |
|---|---|---|---|
| | | | - At what times in the work schedule do you think you cannot adjust your sedentary behavior and/or sitting posture?<br>- Why not at these moments?<br>- Are you currently missing something that will not motivate you to adjust your sedentary behavior?<br>- What can you help to find this motivation at work? |
| 9. At this moment, are you adjusting your sedentary behavior? | No → Stage 3<br>Yes → Question 10 | **(4) Action:** The new behavior is being attempted. | - How do you change your sedentary behavior at this moment<br>- What is your experience with changing your sedentary behavior?<br>- At what times in the work schedule are you changing your sedentary behavior?<br>- At what times in the work schedule do you find it difficult to adjust your sedentary behavior?<br>- What do you need at this moment to maintain your changed sedentary behavior?<br>- Do you miss something at this time, which means that you will not be motivated to adjust your seating behavior?<br>- What can help you to find this motivation at work? |
| 10. For how long did you change your sedentary behavior?<br>11. Has your changed sedentary behavior become a habit? | Less than 6 months → Stage 4<br><br>More than 6 months → Stage 5<br><br>Tried more than 6 months, but stopped maintaining it → Stage 6 | **(5) Behavioral retention:** New behavior maintained for at least 6 months and has become a habit. | - How do you still maintain your sedentary behavior?<br>- Are you adjusting your sedentary behavior differently than 6 months ago? How did that happen?<br>- Where in the work schedule do you always manage to maintain the changed sedentary behavior?<br>- Where in the work schedule are you not always able to adjust your seating behavior?<br>- Do you need something at this moment |

| | | | |
|---|---|---|---|
| | | | to stay motivated for maintaining your changed sedentary behavior?<br>- What can help to find this motivation at work?<br>- Have you tried to change your sedentary behavior, which was not successful?<br>- Yes, what have you done differently like the previous time?<br>- What would you advise to others when they start adjusting their sedentary behavior?<br>- How can you prevent a relapse? |
| 12. Have you stopped changing your sedentary behavior after 6 months or more? | Yes → Stage 6 | **(6) Relapse:** one falls back to the old behavior. | - Why did you fall back in your old behavior?<br>- Would you like to try again to adjust your sedentary behavior?<br>- What would you change? (To prevent a relapse)<br>- What do you still need and at what time?<br>- Looking at the work schedule, at what times would you be able to adjust your sedentary behavior? |

5. **AYSA:**

At the moment, my client has developed the system Activate Your Sitting Awareness (AYSA). AYSA consists of two parts: office chair sensors to measure your seating behavior and a matching app. In this app, at least three functionalities are included: displaying your posture, number of hours and different exercises to stimulate active posture.

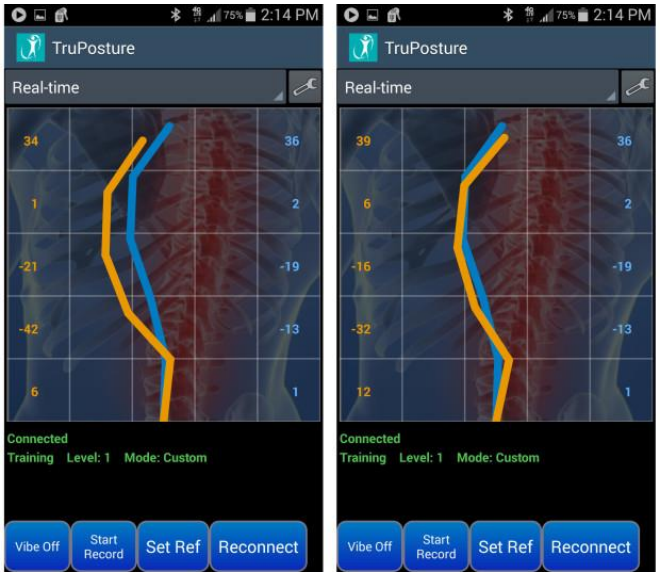
- What is your first impression of AYSA?
- Do you think you can use AYSA at work? Why?
- At what times in the work schedule can you use AYSA?
- What functionalities would you like to see integrated within the app?
- Why?

6. **App components:**

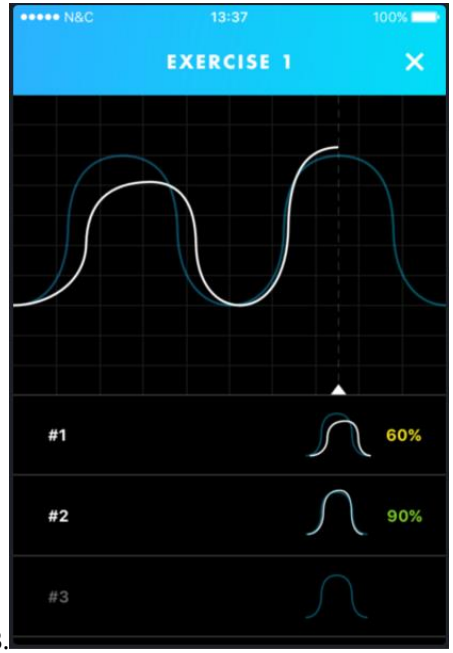
With the help of the following examples, I would like to discuss the various options of an application. The applications are not always focused on application to change your sedentary behavior, but it is about the layout and functionalities that are integrated in the example applications.

**6.1 Sitting posture:**

1. To understand how you sit, the data measured with the help of the sensors on your office chair, can be displayed in an app in various ways. For example, it could look like this:

2. 

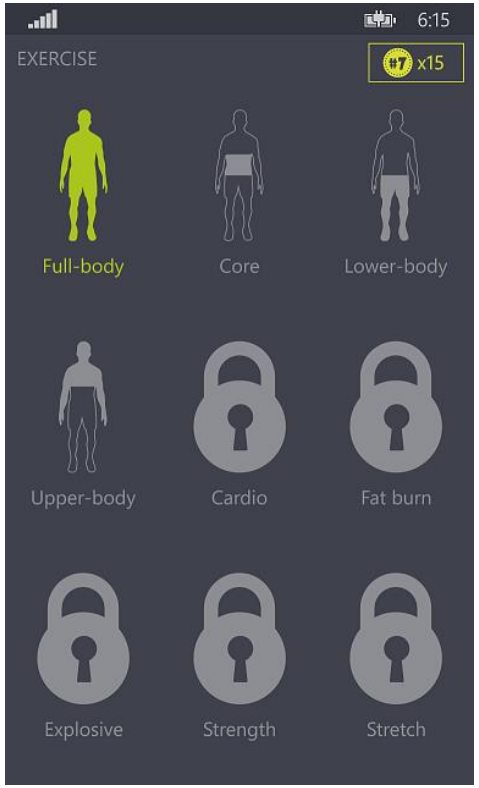

2. 

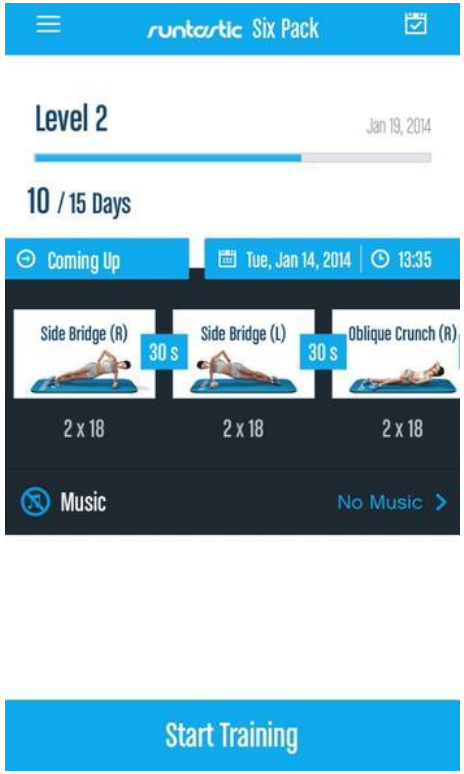

3. 

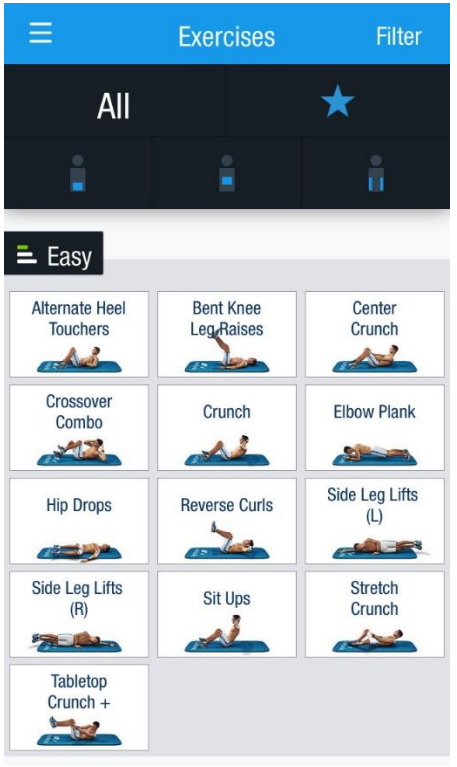

1. What do you think of examples 1, 2 and 3?
2. What are the positive / negative aspects you notice?
3. Which example would you prefer to show your sitting posture?
4. Do you have any other ideas to reflect your posture?

**6.2 Sitting exercises**

As I have already mentioned, there will also be several exercises integrated within the app to sit actively. These exercises can be displayed in different ways:

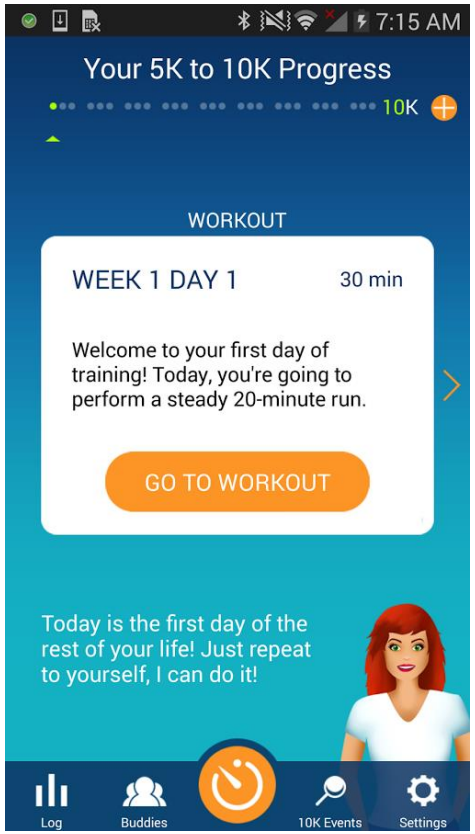
1. 

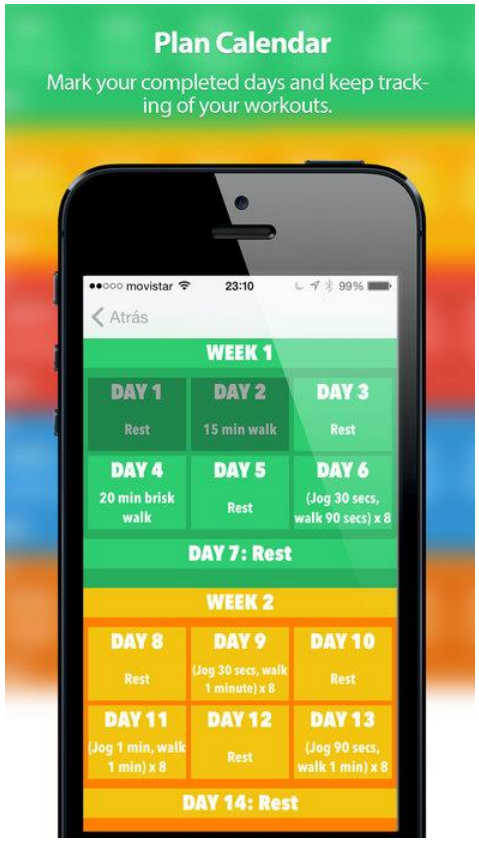

2. 

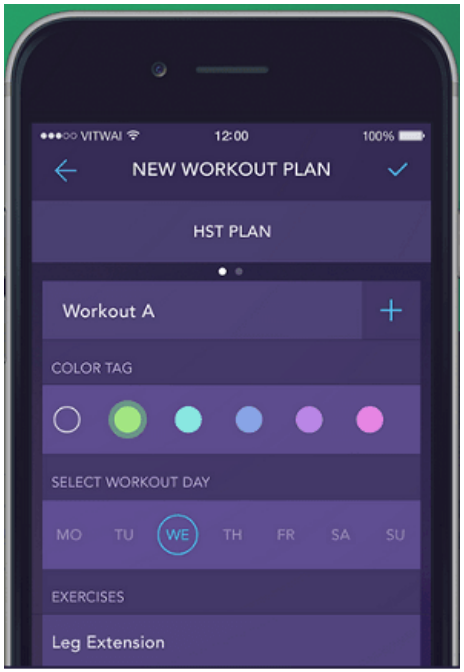

3. 


1. What do you think of examples 1, 2 and 3?
2. What are the positive / negative aspects you notice?
3. Which example would you prefer to show sitting exercises?
4. Do you have any other ideas to reflect sitting exercises?

**6.3 Schedule**
Making a schedule can be done or done in different ways.

1. 


2. 

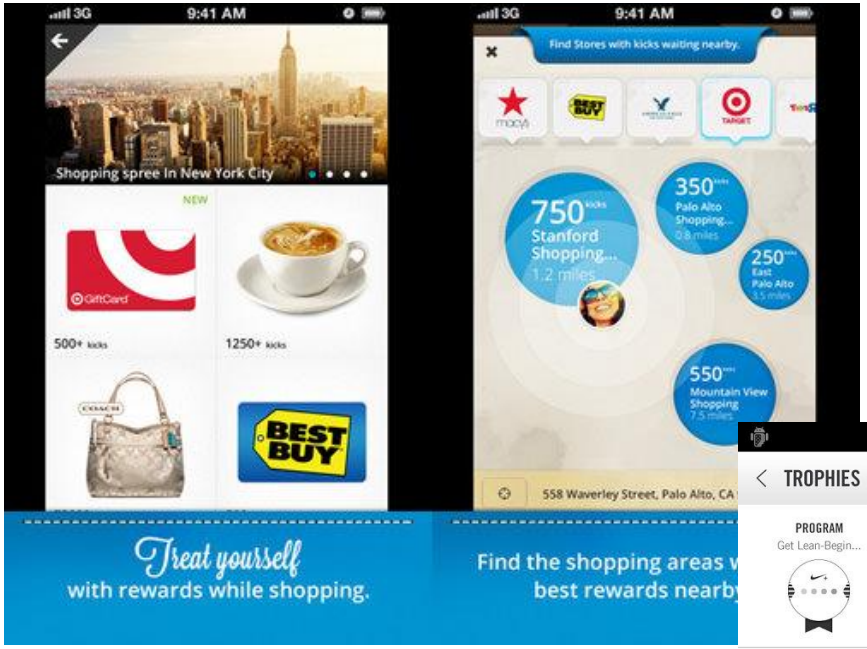

3. 

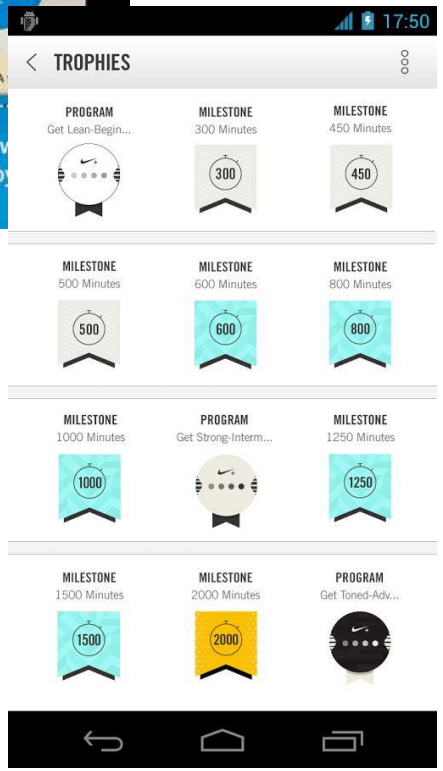

1. What do you think of examples 1, 2 and 3?
2. What are the positive / negative aspects you notice?
3. Which example do you prefer? (Standardized exercise plan or scheduling yourself?)
4. Do you have any other ideas for the exercise schedule?

### 6.4 Rewards

Giving rewards and compliments can encourage you to keep using the app.

1. 


2. 

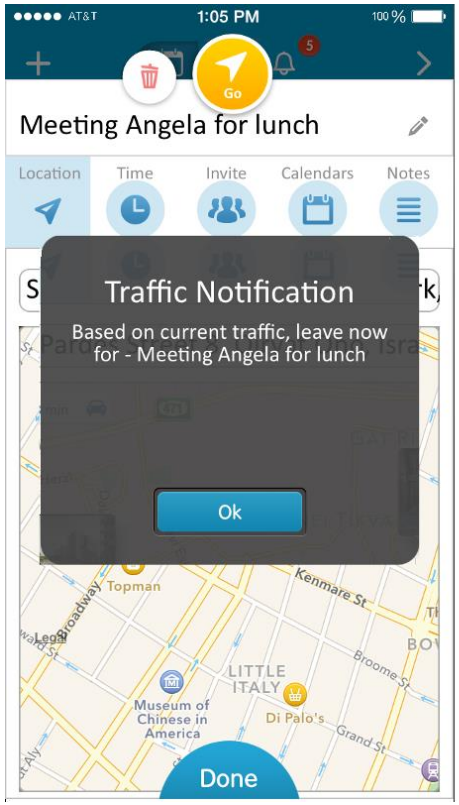

3. 

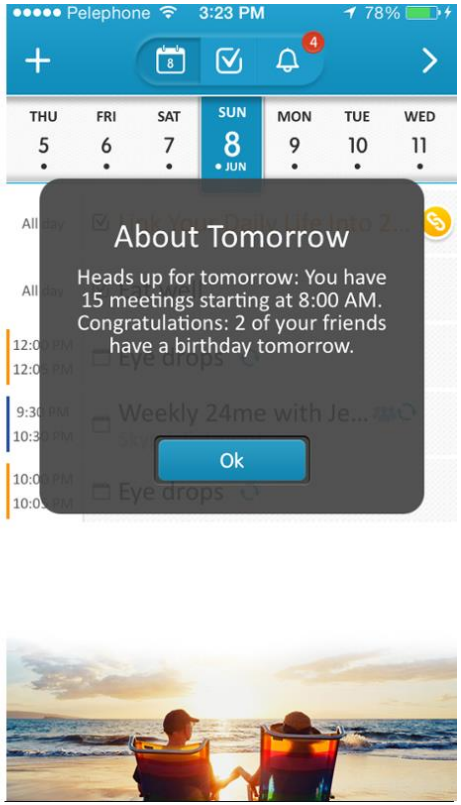

1. What do you think of examples 1, 2 and 3?
2. What are positive/negative aspects you notice?
3. Which example do you prefer?
4. What do you think of receiving rewards?
5. Do you have any other ideas to receive rewards?
6. Would you prefer to receive prices by means of a point system?
7. Would this motivate you to keep on using the app?
8. If not, what can you motivate to keep using the app?

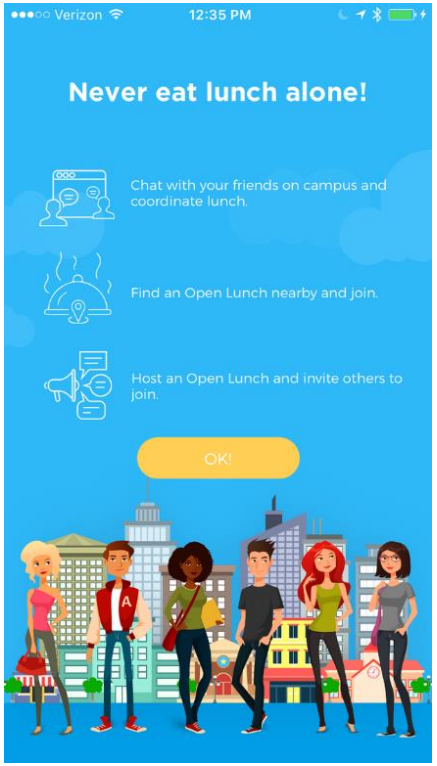
### 6.5 Suggestions and reminders

In addition, an app can help remind you of a goal or perhaps give a suggestion to fit your workouts better in a workday.

1. 


2. 


3. 


9. What do you think of examples 1, 2 and 3?
10. What are the positive / negative aspects that you notice?
11. Which example do you prefer?
12. Do you have any other ideas to send a reminder or suggestion?

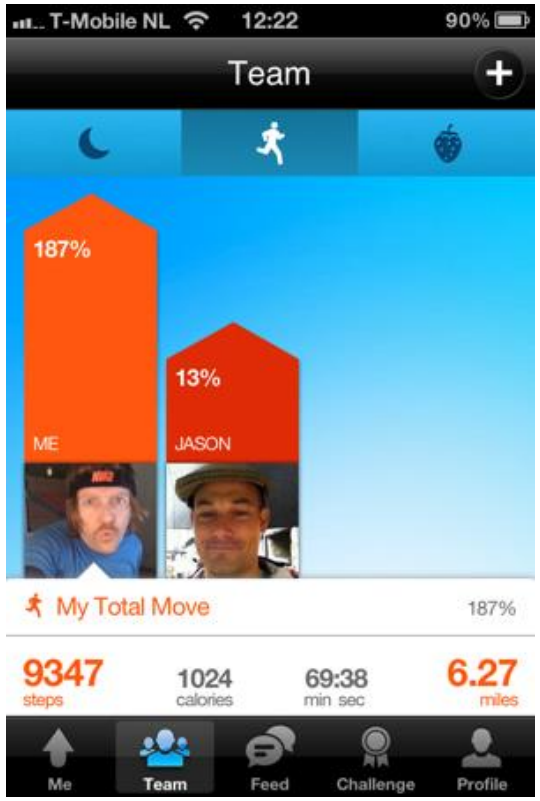
**Receiving notifications:**

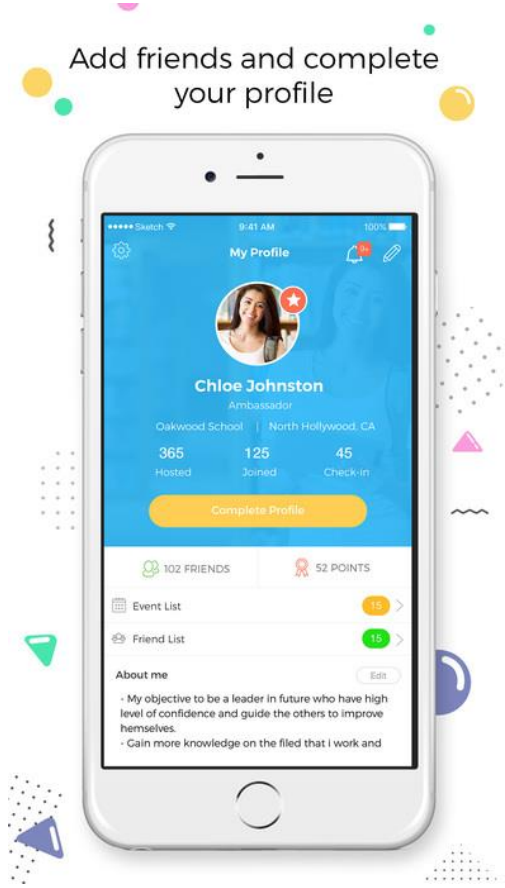
13. How would you like to receive notifications at work? (Visual (light or read), sound, feel (vibration), etc.)
14. On which device would you like to receive the notification? (Computer, sensors, mobile)
15. Do you want to enable these notifications? How long may this notification come? And in what way?

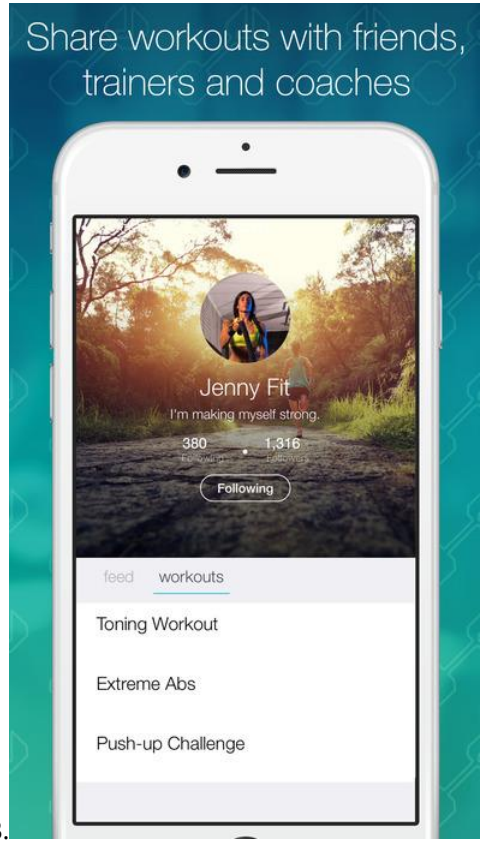
16. The standard is to sit no longer than 30 minutes prolonged, would you like to receive a notification every 30 minutes?
17. Would you like to receive reminders if you do not respond directly to a notification?

**6.6 Social**

Adding friends and a competition elements can motivate you to keep going with changing your seating.

1. 


2. 


3. 


18. What do you think of examples 1, 2 and 3?
19. What are the positive / negative aspects you notice?
20. Which example do you prefer?

21. Do you have any other ideas to add a social/competition element within this app?
22. How do you face a social element in the app at work?
23. How do you face a competition element in the app at work?

After seeing all the examples, you have an idea of the possibilities for developing an app.
- Which examples do you prefer to add to the application? Why?

**7. Health promotion at work**

• Does your employer give you the opportunity to participate in health-promoting interventions?
• If yes, do you use this?
• Would you like to use it when your employer give the opportunity to use AYSA?
• Would you also like to use it if you have to purchase AYSA yourself?
• How do you think about the system's privacy and your data when AYSA is used at work?

**Closing interview:**

• Do you have add-ons any other ideas for adjusting your sedentary behavior or the app development?
• Do you want to participate in a follow-up interview for this research in January? It will be about 30 minutes later, with the app being developed further with the input from these interviews.
• Do you want to be informed about the results of the research? Then I will send a summary report by e-mail when the graduation research is completed.
• If there are any questions or things to do, you can always email me!
• Thank you very much for your participation!

## Appendix 5. Requirements and persuasive features (with user expressions)

**Table 4a.** Functional and modality requirements for a sedentary behavior change application.

| User expressions (positive) | User expressions (negative) | Value | Requirement | Persuasive feature |
|---|---|---|---|---|
| P4: 'Inderdaad de mogelijkheid om [de app] continu te raadplegen, van joh wat is een goede zithouding, hoe moet ik nou zitten, hoe hoog moet mijn beeldscherm.' | | Easy and continuously accessible | The application is continuously accessible to receive real-time feedback on your sedentary behavior. | Personalization |
| P10: 'Ik vind het een beetje intensief worden op het moment dat je ze allebei zou kunnen, of verplicht allebei [app en webversie] moet, ik zou graag de optie willen. Ik vind dat zoiets, althans de app stand alone zou kunnen worden gebruikt en dat op de computer toevoegen een optie is.' | P2: 'Mobiel dat hoor je ook wel, maar dan zet je hem op stil, en als je hem op je beeldscherm hebt [melding] dan popt die elke keer op en wordt het irritant en leid het af dat je telkens denkt oh ja ik moet nog even bewegen.' | Optional use on the computer/laptop | The application can be used on a mobile smartphone, with an option to use the program on a computer (web version).<br><br>The program on the computer includes an option to show a larger image of the sitting posture and sitting exercises. | |
| P4: '[Melding]Als het maar stil is, ik heb mijn telefoon altijd op stil staan, een trilling en een lampje bijvoorbeeld.' | P6: '[Melding] Ik ga niet veranderen door piepjes of alarmpjes. Vaak genoeg meegemaakt dan ga ik het piepje uitzetten.' | Silent and visual push notifications | The user can choose what types (sound, light, text or vibration) of push notifications they want to receive on each device. | Reminders |
| P3: 'Het zou mooi zijn als het [de app] niet te veel batterij kost!' | | Low battery usage | The application can be used without using too much battery. | |
| P4: 'Automatisch inplannen [Oefeningen] is helemaal prima, ik doe alles in mijn digitale agenda dus dan zie ik precies wat ik allemaal heb.' | P11: 'Ik gebruik een papieren agenda dus dat is lastig koppelen, maar ik denk dat ik het liever zelf in de hand wil hebben, dus liever niet met agenda's koppelen.' | Optional link with digital calendar | The application has an option to link the planning to your digital calendar. | |

**Table 4b.** Service requirements for a sedentary behavior change application

| User expression (positive) | User expression (negative) | Value | Requirement | Persuasive feature |
|---|---|---|---|---|
| P13: '[Langer gebruik van de app] Je app vernieuwend houden, na vieren weken hetzelfde dingetje gedaan te hebben dan ben ik er wel klaar mee.' | P10: 'Weet ik niet, ik denk dat het op de lange termijn niet zou werken. Ik denk op de lange termijn vooral moet richten om te zorgen dat mensen zelf beseffen dat het belangrijk is. Die trofee zijn leuk voor in het begin en kan mensen over de drempel helpen om het net eventjes iets langer te gebruiken en ik denk dat het uiteindelijk belangrijk is om de mensen zelf gemotiveerd te houden.' | Innovative and updated application | The application is innovative and updated to stimulate usage of the application and changing sedentary behavior on the long run. | |

**Table 4c**. Organizational requirements for a sedentary behavior change application.

| User expression (positive) | User expression (negative) | Value | Requirement | Persuasive feature |
|---|---|---|---|---|
| P5: 'Als je het met je hele organisatie zou doen en meer mensen krijgen het dat stimuleert ook wel van oh zullen we gezellig gaan wandelen.' | | Integration within organizations | The intervention should be integrated within an organization, so that more people will use the system to change their sedentary behavior. | Normative influence and social facilitation |
| P4: '[Gebruikers gegevens] Nee, niet zoveel moeite mee, dat mag mijn werkgever rustig weten.' | P9: '[Gebruikers gegevens] Ik denk dat het eigenlijk wel principieel gezien belangrijk is dat mijn directe werkgever daar geen inzicht in heeft, zo'n puntensysteem zou ook relatief moeten zijn.' | Ensure user privacy | Information gathered from the system is not available for the employer. | Trustworthiness |

**Table 4d**. Content requirements for a sedentary behavior change application.

| User expression (positive) | User expression (negative) | Value | Requirement | Persuasive feature |
|---|---|---|---|---|
| P9: 'Ik zou in de werksituatie gek zijn op iets wat zelf denkt, zonder dat ik dat hoef te plannen tijdens de dag, hoe persoonlijker het gemaakt kan worden op basis van | | Tailored information | Within the application the user will receive tailored information about their sedentary behavior and workday. | Tailoring |

| | | | |
|---|---|---|---|
| de sensoren, hoe beter het is.’ | | | |
| P4: ‘[Inzicht in het zitgedrag] Uiteraard wel voor mezelf hoe zijn de ontwikkelingen en hoe ben ik bezig, over een soort van periode, van de afgelopen weken, afgelopen maanden of half jaar mogelijk, dat zou ik wel willen een soort resultatenoverzicht.’ | Insight and feedback on sedentary behavior (change) | The application gives insight in the sitting posture with the help of an image and explanatory information about your sitting posture.<br><br>There is an option to show users a general and more detailed image of their sitting posture.<br><br>The application consist of a step-by-step guide to set the right office settings.<br><br>The application shows in a statistical overview the sitting time and their behavioral change progress over different periods. | Self-monitoring and expertise |
| P3: ‘Dat je ook gericht ziet welk lichaamsdeel je traint zeg maar, ik weet niet of dat voor kantoor ook toe te passen is maar dat je de keus hebt en ook wel uitgedaagd word om verder te gaan, door dingen te unlocken. Misschien dat je ook bewust, als je bijvoorbeeld een zwakke nek hebt dat je gericht daarop kunt trainen.’<br>P7: ‘[Uitleg over de zit houding/oefening] Misschien is dat wel handig, omdat je niet meteen in één oogopslag ziet wat de goede is en wat jouw eigen is, dus misschien dat het nog eventjes met woorden ook nog uitgelegd wordt, wat jij verkeerd doet zeg maar.’ | Clear sitting exercises | Each sitting exercise consists of information about the time duration of an exercise and what body part is being trained.<br><br>The application consists of explanatory information in combination with an image of the sitting exercises. | Reduction, rehearsal, trustworthiness and expertise |
| P9: ‘Ik vind [unlocken] één het leukst, dan komt de spelletjes liefhebber in mij naar boven, want dan wil ik ze dus allemaal unlocken, ik realiseer me | Levelling and unlocking | User will level up when they have collected enough points by performing exercises or achieving goals. | Rewards and tunneling |

| | | | | |
|---|---|---|---|---|
| gewoon dat ik daar dan gewoon van die beloning achtige dingen achter zitten ik daar heel gevoelig voor ben.’ | | | With the help of unlocking users can unlock more exercises by performing exercises. | |
| P12: ‘[Planning maken] Dat je keuze hebt is natuurlijk wel fijn, dan kan je misschien de intensiviteit of tijdsduur kun je dan zelf bepalen, het hangt er misschien van af dat je denkt van ik heb nu heel even dus dan langer kan niet, dat je daar zelf in kan bepalen.’ | P13: ‘Voor mij in ieder geval zelf zo’n week inplannen gaat em niet worden, omdat een week wordt toch altijd anders.’ | Personalized exercise plan | Within the application, a standardized exercise plan for each different level is available, users have the option to personalize that exercise plan. | Personalization |
| P7: ‘Misschien is het ook wel fijn om zelf een doel te stellen om te kijken hoe je daar in zit. Maar dat je die doelen wel opstelt aan de hand van informatie die goed zou zijn.’ | | Goal setting | Users can choose their own daily goals to change their sedentary behavior with the help of the application. | |
| P6: ‘Het mooist is als je dan een soort schemaatje maakt van je collega’s, van wie doet er ook mee, wie staat waar en hoeveel punten heb je, dan krijg je een soort concurrerend systeem.’<br>Vervelend competitief zijn, maar gewoon gezellig voor de grap.’ | P4: ‘Als optie [competitie], prima, voor mensen die het leuk vinden om het te doen, maar ik zou er geen gebruik van maken.’ | Optional competition and social elements | A competition element is integrated in the application, a clear overview of the user’s levels and/or points can be used to challenge the users.<br><br>The competition and social feature of the application are optional to use. | Competition, social comparison and social facilitation |
| P3: ‘Dat je misschien inderdaad een half uurtje leeg hebt in je agenda, dat er dan misschien een suggestie komt van goh ik ga even wandelen. Vaak denk ik aan het eind van de dag, van oh ik had wel even kunnen lopen vandaag, maar op dat moment denk je er niet aan, dan vergeet je de tijd of ben je lekker aan het werk.’<br>P1: Ik denk dat het wel goed is dat er een reminder komt, maar wel dat je net als je bij outlook hebt, dat je als je het niet uitkomt kan zeggen herhaal over tien minuten of herhaal over een kwartier, dat die dan wel | P11: ‘[Suggesties] Dat zijn dan wel dingen die ik zelf weet, of die we zelf ookal doen ook, dus dat zegt voor mij niet zo heel veel, het zou wel echt iets heel nieuws moeten zijn anders negeer je dat ook en is het alleen maar irritant, weer een extra melding.’<br>P4: ‘[Herinner me later] Nee, ik klik hem dan bewust weg, dus dan wil ik hem niet na vijf minuten nog een keer krijgen, dan mag die volgende | Personalized suggestions and reminders | In the application, relevant suggestions and reminders are integrated to prompt the user for action and to create awareness.<br><br>The users can personalize if they want to receive a suggestion/reminder and how many times they want to receive the suggestion/reminder.<br><br>The suggestion and reminder message contains a ‘not now’ and ‘remind me later’ option. | Suggestion and reminders |

| | | | | |
|---|---|---|---|---|
| terugkomt, maar dat je hem niet per se hoeft uit te voeren. | half uur weer zeg maar.' | | | |

**Table 4e.** Usability & User experience requirements for a sedentary behavior change application

| **User expression (positive)** | **User expression (negative)** | **Value** | **Requirement** | **Persuasive feature** |
|---|---|---|---|---|
| P7: '[Layout zithouding] Ik denk dat ik dit het fijnst zou vinden, dat ik gewoon iemand duidelijk zie zitten, ietsje naar voren en ietsje naar achteren en dat er gewoon duidelijk bij staat wat ik moet doen.' | | Clear layout | The sitting posture of the users and exercises are recognizable and easy to understand for the users. | Liking and surface credibility |
| P3: 'Ik ken bijvoorbeeld een programma dat heeft mijn vriend op zijn werk, om de twee uur wordt zijn computer voor zoveel minuten gelocked, dat hij even koffie moet halen of in elk geval in beweging moet komen. Maar dat lijkt me voor hier niet heel praktisch want als je net even bezig bent of iets aan het opzoeken voor de cliënt, dan zou je hem al moeten uit kunnen stellen.' | | Does not interfere the workflow | The notifications and exercises does not interfere the workflow of the user. | |

## Appendix 6 Persuasive features

**Table 5a**. Persuasive features (primary task support).

| Persuasive feature | Explanation | Application |
|---|---|---|
| *Reduction* | A system that reduces complex behavior into simple tasks helps users perform the target behavior, and it may increase the benefit/cost ratio of a behavior. | To reduce the effort that users expand in changing sedentary behavior, users can find an exercise plan, to perform different sitting exercises and set goals belonging to each different level within the application. |
| *Tunnelling* | Using the system to guide users through a process or experience provides opportunities to persuade along the way. | To guide users in the attitude change process, the application consists of a statistical overview, so users can see that performing exercises and achieving goals will bring them closer to their target behavior. |
| *Tailoring* | Information provided by the system will be more persuasive if it is tailored to the potential needs, interests, personality, usage context, or other factors relevant to a user group. | The application provides tailored information about sedentary behavior (change), environmental factors, and their workday/exercise plan. |
| *Personalization* | A system that offers personalized content or services has a greater capability of persuasion. | The application provides personalized information, exercise plan, suggestions, and reminders. |
| *Self-monitoring* | A system that keeps track of one's own performance or status supports the user in achieving goals. | The application provides means for users to track their performance or status in changing their sedentary behavior and sitting posture. |
| *Rehearsal* | A system providing means with which to rehearse a behavior can enable people to change their attitudes or behavior in the real world. | The application provides means for rehearsing the active sitting posture and breaking up periods of prolonged sitting. |

*Note*. Adapted from 'Persuasive systems design: Key issues, process model, and system features', by Oinas-Kukkonen, H., & Harjumaa, M. (2009). *Communications of the Association for Information Systems*, *24*(1), 28.

**Table 5b.** Persuasive features (dialogue support).

| Persuasive feature | Explanation | Application |
|---|---|---|
| *Rewards* | System that reward target behaviors may have great persuasive powers. | The application provides virtual rewards (points) for users in order to give credit for performing the target behavior. |
| *Reminders* | If a system reminds users of their target behavior, the users will more likely achieve their goals. | The application reminds users of their target behavior during working hours. |
| *Suggestion* | System offering fitting suggestions will have greater persuasive powers. | The application gives the user suggestions so that they carry out the target behavior during working hours. |
| *Liking* | A system that is visually attractive for its users is likely to be more persuasive. | The application has a clear layout, in view of colours, visualisation, large and appealing images, and a professional appearance. |

*Note*. Adapted from 'Persuasive systems design: Key issues, process model, and system features', by Oinas-Kukkonen, H., & Harjumaa, M. (2009). *Communications of the Association for Information Systems*, *24*(1), 28.

**Table 5c.** Persuasive features (system credibility support).

| Persuasive feature | Explanation | Application |
|---|---|---|
| *Trustworthiness* | A system that is viewed as trustworthy will have increased powers of persuasion. | The application provides information that is truthful fair and unbiased. |
| *Expertise* | The system that is viewed as incorporating expertise will have increased powers of persuasion. | The application provides information showing knowledge, experience, and competence of sedentary behavior (change). |
| *Surface credibility* | People make initial assessments of the system credibility based on a first-hand inspection. | The application should have competent look and feel. |

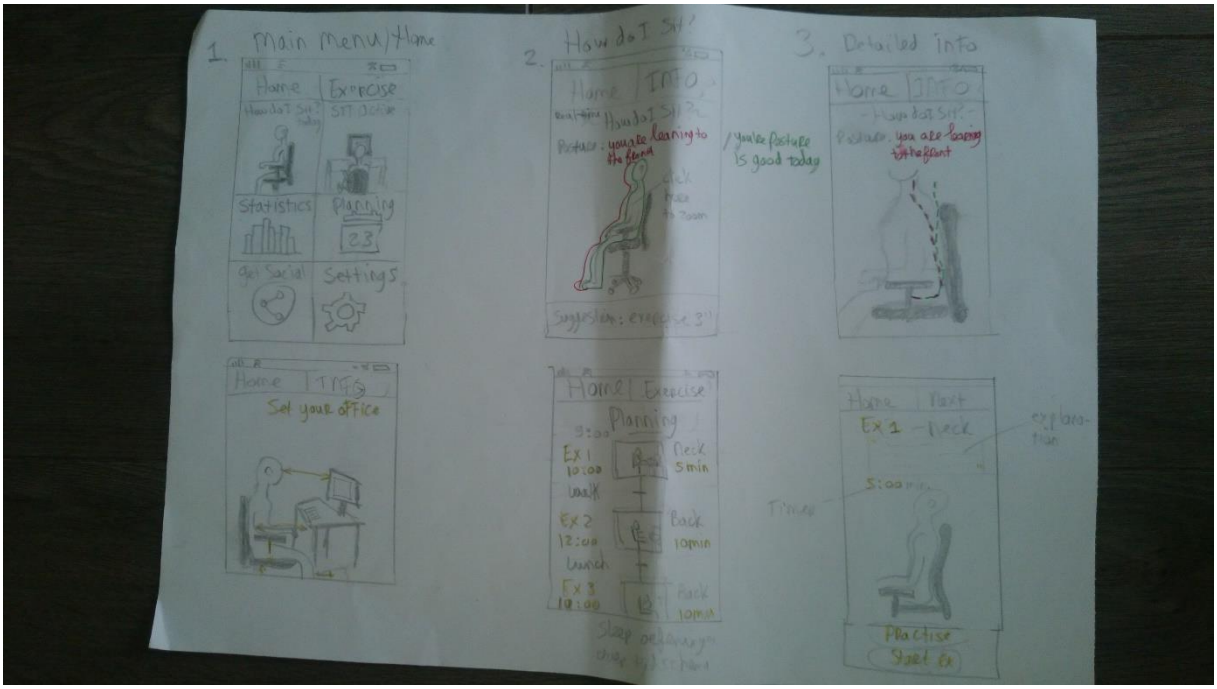
*Note*. Adapted from 'Persuasive systems design: Key issues, process model, and system features', by Oinas-Kukkonen, H., & Harjumaa, M. (2009). *Communications of the Association for Information Systems*, *24*(1), 28.

**Table 5d.** Persuasive features (social support).

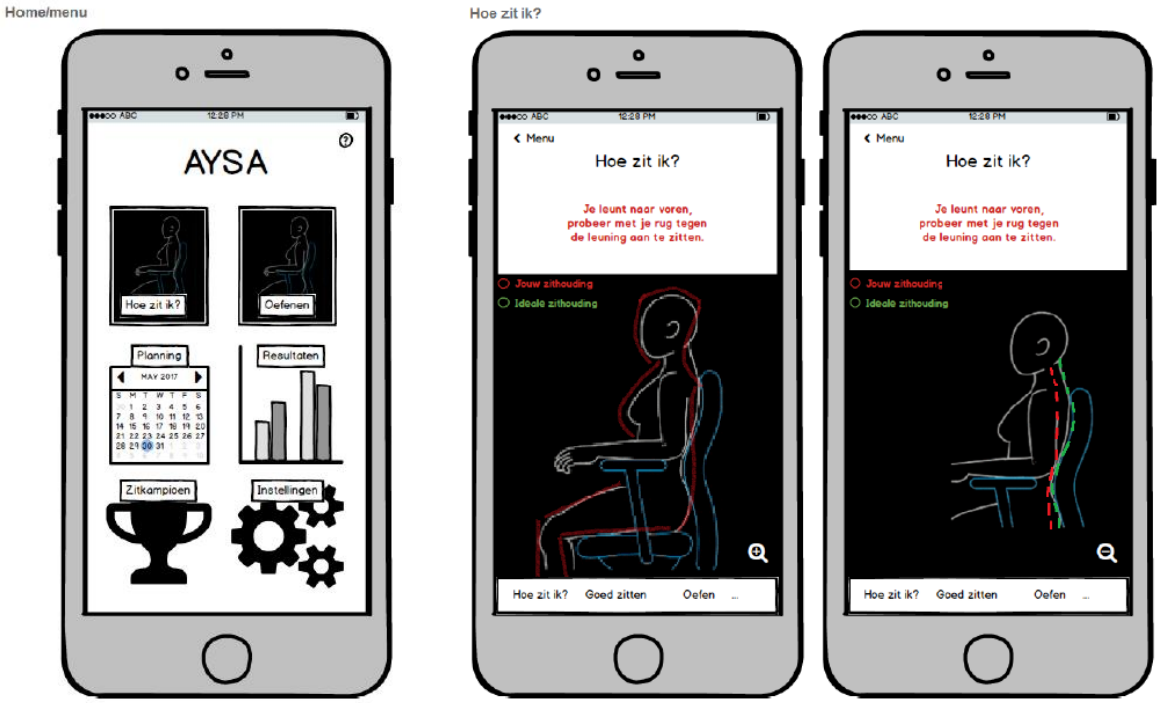
| Persuasive feature | Explanation | Application |
|---|---|---|
| *Social comparison* | System users will have a greater motivation to perform the target behavior if they can compare their performance with the performance of others. | The application provides means for comparing performance with the performance of other users by levelling and within the statistical overview/competition overview. |
| *Normative influence* | System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them. | The application provides means for gathering together people within an organization, who have the same goals and make them feel norms. |
| *Social facilitation* | System users are more likely to perform target behavior if they discern via the system that others are performing the behavior along with them. | The application provides means for discerning other users who are performing the behavior. |
| *Competition* | A system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to compete. | The application provides means for competing with other users. |

*Note*. Adapted from 'Persuasive systems design: Key issues, process model, and system features', by Oinas-Kukkonen, H., & Harjumaa, M. (2009). *Communications of the Association for Information Systems*, *24*(1), 28.

## Appendix 7 Paper prototype of ‘AYSA’

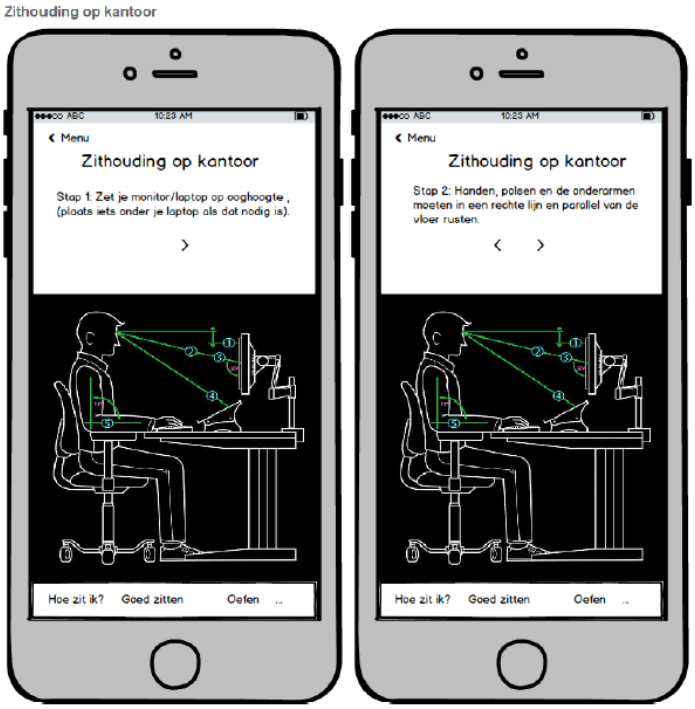



## Appendix 8 Lo-fi prototype of 'AYSA'

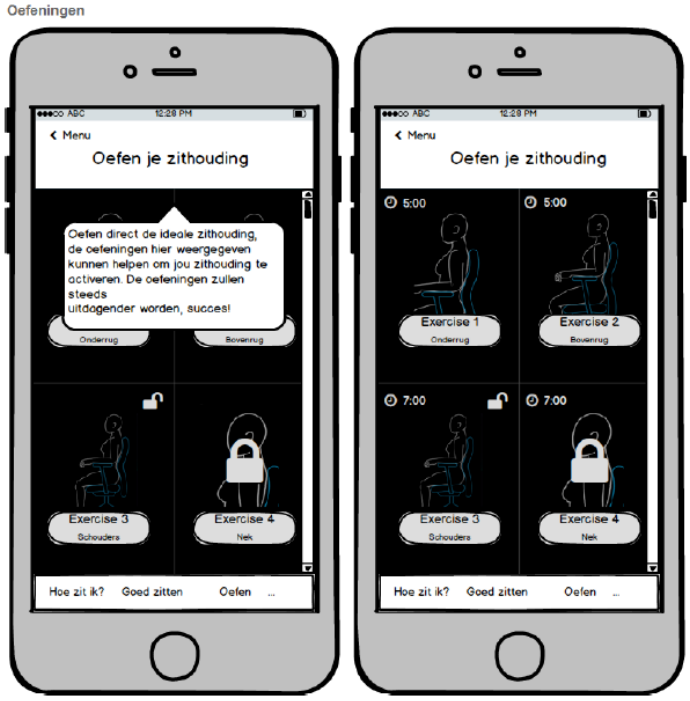



In the main menu users can choose between six different options. By clicking on the buttons, the next screen will appear.

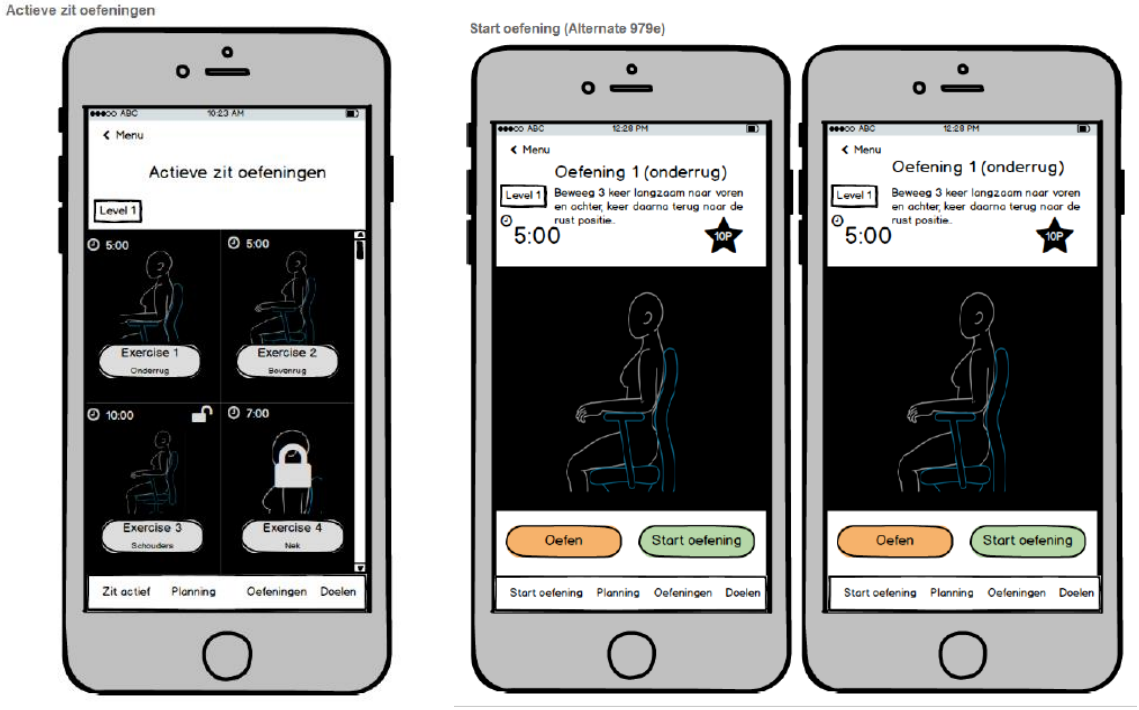
By clicking on the image '*Hoe zit ik?*', the screen with a sitting person will appear. In this screen users can find out what their sitting posture is. If their sitting posture is incorrect, they receive some advice so they can change their sitting posture. Ideally, this image shows real-time feedback of the sitting posture.



To set up the office, office workers can consult a step-by-step guide to set up the office in the right position.



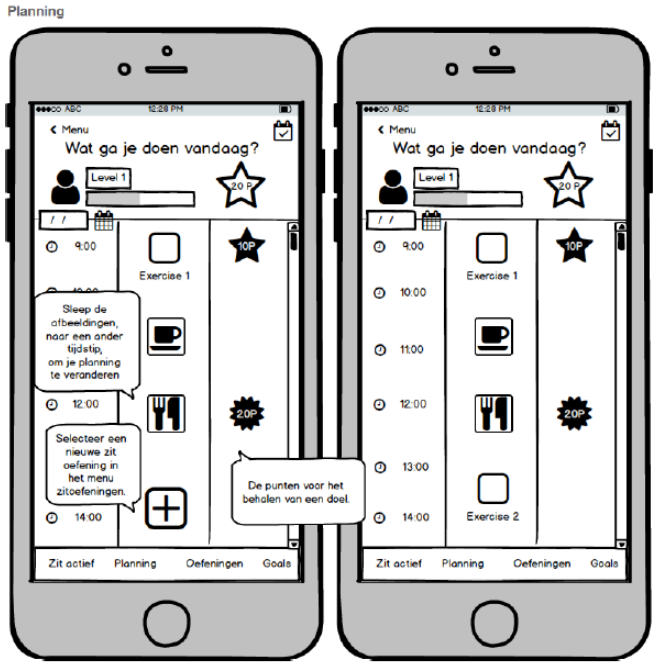

Users can practice their sitting posture, by choosing one of the exercises within the application.



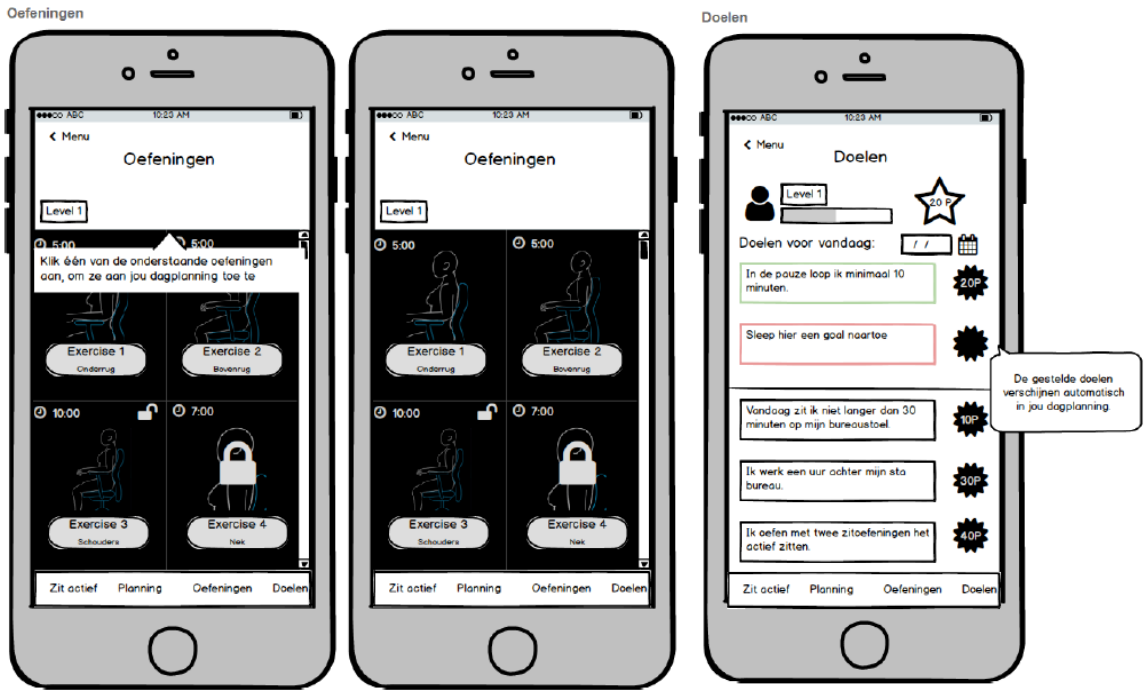

When user click in the main menu on the image '*Zitoefeningen*'. The screen with an overview of sitting exercises will appear. Users can choose different sitting exercises, which target different body parts. The persuasive feature unlocking is integrated within the exercise overview.

When users start an exercise the screen of the exercise will appear, with a brief explanation of the exercise. The user can choose to practice the exercise or directly start the exercise.

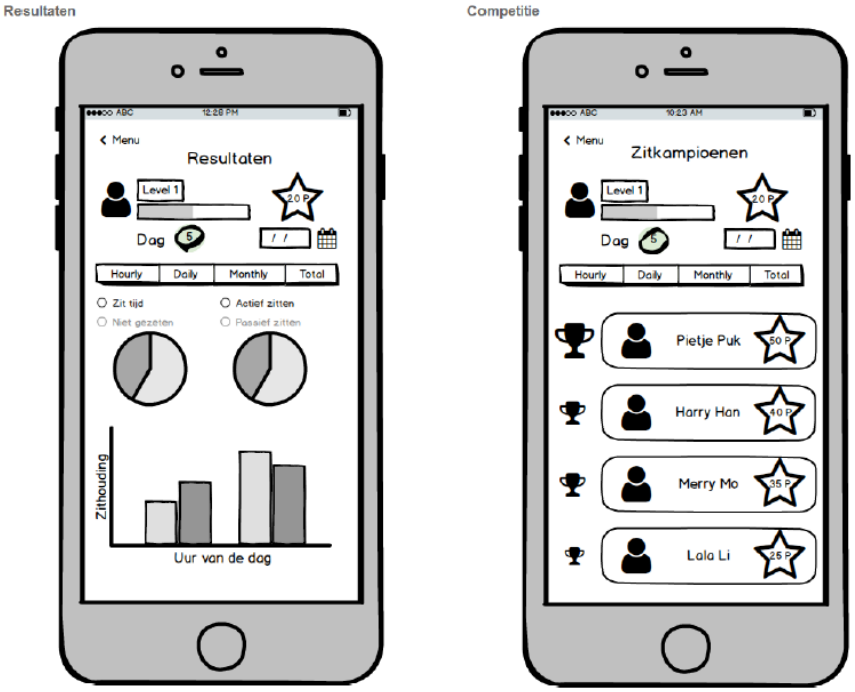

Users can practice an exercise to get used to the exercise. After they practiced enough, they can start the exercise to earn points.




When users click in the main menu on '*Planning*', a screen with a fixed exercise plan will appear. Within the fixed exercise plan, users have the opportunity to change the planning by choosing at what time they want to perform the exercise, their own exercises, and to create their own goals. This can be done with the help of the buttons at the bottom bar.



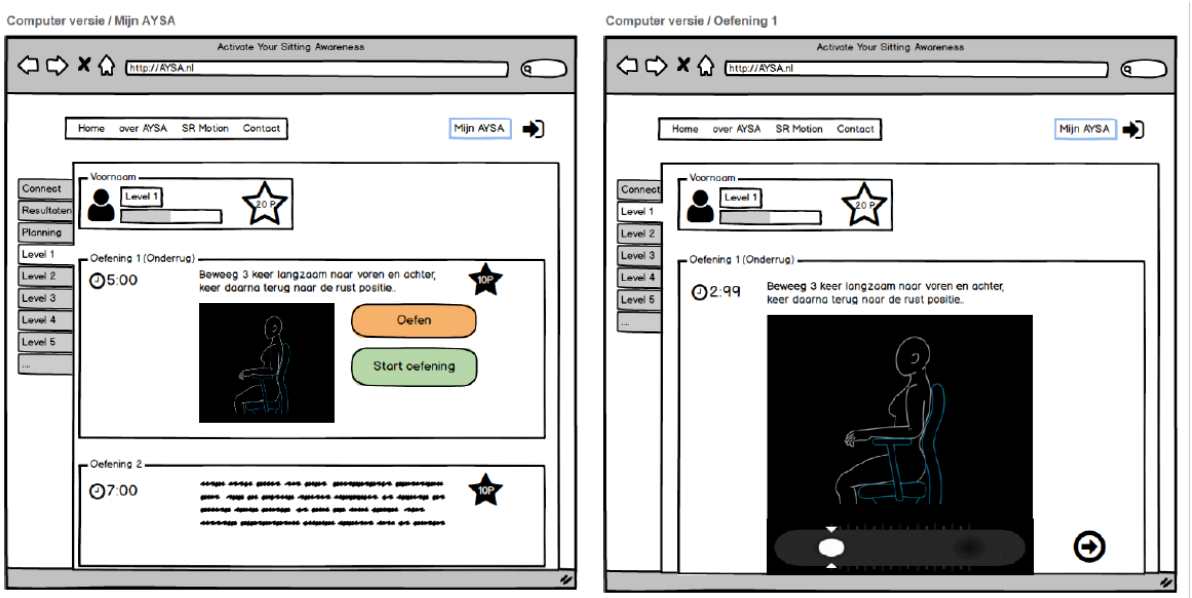

By clicking at the bottom bar within the screen of the planning, the exercise overview will show the exercises users can choose. When the button '*Doelen*' is selected, the user will see an overview of different goals. They can choose a goal they would like to work on.




In the main menu the user can choos the get insight in their sedentary behavior change and performence over different time periods. Users can also choose in the main menu the option '*Zitkampioen*', to evoke an overview of all the users of the system within the organization. A competition overview shows a ranking of the users.


To adjust the settings to users own personal preferences, users can click in the main menu on the image '*Instellingen*'. The following screen will appear with the option to set notifications, suggestions and reminders.

An example of a suggestion is displayed in the right screen. This suggestion can appear on the screen, for example to stir the user during his/her lunchbreak. The user has the option to click on '*not now*' or '*remind me later'*.




A desktop version is created, so that users can approach the sitting exercises and watch them on a bigger screen. The users also have the option to receive notifications on their computer or laptop instead of their mobile phone.

## Appendix 9 Interview scheme, round 2

### Interview scheme 2

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**Study goal:** The goal of this research is to develop a prototype of the application for users of Activate Your Sitting Awareness (AYSA) that fits the requirements of the end-users and can be implemented in the daily workday of office-workers.
**Target Group:** Office workers
**Time duration:** +/- 40 minutes
**Interviewer:** Ellis Aten
**Instrument:** Semi-structured interview schedule
**Materials:** Interview schedule, informed consent, application prototype AYSA, voice-recorder

Thank you for participating in this study about the needs and requirements for a health promoting application.

**Introductie:**

*(When participants participate fort the first time:)*

- My name is Ellis Aten. At this moment, I am graduating for the Master of Health Psychology and Technology at the University of Twente. A final part of my study is this master thesis (graduate research). My graduate research is in collaboration with SR-Motion, a small company currently working on developing a product to improve the health of office workers.
- The purpose of this qualitative research is to design an app that matches the needs and requirements of office workers, so that office workers will use the app. The system (AYSA) is intended to ensure that people take an active sitting posture and sit less.

- This interview is a follow up of the first interview round. A prototyped application is developed based on the outcomes of the first interview round. This second interview round has the aim to test whether the prototype meets the needs and conditions of end users. In addition, how the system can be implemented within different organizations.

**Informed consent**

- Participant can ask question about the study and sign the informed consent.

For the elaboration of the interviews, I would prefer to record this conversation. Do you agree to this? Then I turn on the voice recorder.

1. **Demographical Information**
    1. Male/Female
    2. What is your age?

2. **Activate Your Sitting Awareness:**

AYSA consists of two parts: office chair sensors to measure and change your sedentary behavior and a matching app. At this moment, a lo-fi prototype is developed based on the outcomes of the first interview round.

- *The prototype of the application is showed to the participant.*
    1. What is your first impression of the application?
    2. Does the design/layout appeal to you?

3. **Scenario's**

For this part of the interview, I will ask you to answer some questions and perform tasks for different sections of the application. When I ask you to perform a task, this could be for instance: 'start the application'. It is your intention to say aloud what you would do to start the application. I will ensure that the next screen appears. You can just pretend that the application responds directly.

***Task 1:*** View your sitting position and zoom in on your sitting position for a more detailed overview.
1. Did you get a clear picture of your posture?
2. Would you be able to adjust your sitting position with this information so that you have a good sitting position?

The following illustrations shows you how to set up your desk, laptop, chair and sitting position.
1. Would this roadmap help you set up your office correctly?

2. Would you like to consult this overview more than once?
3. Would you like to know more about setting up your office furniture?

***Task 2:*** Perform a sitting exercise
1. How did you feel about carrying out an exercise?
2. Was it clear what you had to do during the exercise?
    a. If not, what would you need to be able to do the exercise?
3. Does unlocking new exercises encourage you to do more exercises?

***Task 3:*** Make a day planning by setting your own exercises and goals.
1. How was it like to make a day planning within the application?
2. Do you still miss information in your schedule or planning?
3. How many exercises would you like to perform daily?
4. What do you think of setting your goals within the application?
5. Are these goals realistic and achievable for you at work?
    a. Why / not?

The following image shows the settings for setting notifications you would like to receive. You can set which notifications you want to receive, for example, with a light or just textual.
1. Do you still miss settings?
2. Would this ensure that you are not disturbed in your workflow?
    a. Why / not?

In the results overview you can see results over different times.
1. Do you get a clear picture of your session and change of behavior in this overview?
2. Is receiving points and higher appear in levels rewarding to you?
3. Would you like to receive other rewards?

In the competition overview, you can find a ranking of the other users in your organization
1. How do you think it is possible to see colleagues in a competition overview?
2. Does this motivate you to keep using the app?
3. Does the overview provide a clear picture of who is in what location and why?

The following illustration shows an example of a suggestion.
1. What do you think of receiving suggestions when you are sit too long or have a blank space in your schedule?
2. When would you like to receive more suggestions?
3. When do you not want to receive any suggestions?
4. Are the settings you currently have enough to prevent you from receiving suggestions that you would not want?

**4. User-experience**
1. How did you find it to use the app?
2. What did you like/dislike about the application?
    a. Why?
3. Do you still have suggestions for the application after performing the tasks?
4. Would you like to receive more information about the consequences of bad or too long sitting?
5. What information would you like to receive about adjusting your seating behavior?
6. Would renewing the exercises and setting goals make sure you keep using the app in the long run?
    A. If not, what would help you to keep on using the application?

**5. Implementation**
1. Could you use the app during your work?
    a. Why / not?
2. When would you use 'AYSA' at work?
    a. When / not?
3. What would you need before you can use 'AYSA' at work?
4. Do you think it is important that your colleagues use AYSA?
    a. Why / not?
5. Do you have suggestions about how the application implementation within your organization?
6. What do you think when appointing a responsible person within the organization so that "AYSA" will be used in the workplace?

**Closing interview:**

- Do you have add-ons any other ideas for adjusting your sedentary behavior or the app development?
- Do you want to stay informed about the results of the research? Then I will send a summary report by e-mail when the graduation research is completed.
- If there are any questions or things to do, you can always email me!
- Thank you very much for your participation!