D5.1b Pilot Specification – extended

Project	SWELL
Project leader	Wessel Kraaij (TNO)
Work package	5
Deliverable number	5.1b
Authors	S. van Dantzig (Philips Research), R. Achterkamp (RRD), M. Vollenbroek (RRD)
Reviewers	John Schavemaker (TNO), Wessel Kraaij (TNO)
Date	September 26, 2012
Version	Final
Access Rights	Swell Project Members
Status	Draft

SWELL Partners:

Philips Research, Roessingh Research and Development

Summary

The goal of workpackage 5 is to construct, demonstrate and evaluate well-being applications that incorporate results from user-studies and technological results from WP2. Demonstrators will be validated in several pilot studies. Deliverable 5.1a provided a description of the background of the studies, as well as their overall goal, target group, target behavior and potential outcome measures. The current deliverable will go one step further and provide a detailed description of the studies that are currently planned by Philips Research (PR) and Roessingh Research and Development (RRD).

As pointed out in Deliverable 1.3a, most current physical activity promotion services are not based on psychological insights on the factors that are relevant for behavioral change. In the current document, we introduce two strategies, based on psychological insights, that may increase the efficacy of physical activity promotion services. One strategy is focused on increasing self-efficacy, the other supports users in forming *implementation intentions,* very specific and detailed plans to execute a particular behavior. The two strategies will be tested in two separate studies, executed by RRD and PR respectively. The current document describes the background, materials and procedures of the two studies.

Contents

1 Introduction

The goal of workpackage 5 is to construct, demonstrate and evaluate well-being applications that incorporate results from user-studies and technological results from WP2. Demonstrators will be validated in several pilot studies. Deliverable 5.1a provided a description of the background of the studies, as well as their overall goal, target group, target behavior and potential outcome measures. The current deliverable will go one step further and provide a detailed description of the studies that are currently planned by Philips Research (PR) and Roessingh Research and Development (RRD).

As pointed out in Deliverable 1.3a, most current physical activity promotion services are not based on psychological insights on the factors that are relevant for behavioral change. In Deliverables 5.3a and 5.2a, several important constructs are described, such as *behavioral intentions, self-efficacy*, and *stage of change.* Behavioral intentions refer to an individual's readiness to perform a given behavior. Although intentions are an important precursor of behavior, they account for less than 30% of the variance in actual behavior. This means that other constructs are important as well. Self-efficacy is one of these constructs. It refers to an individual's level of confidence that he/she is able to to successfully change his/her behavior and maintain the improved behavior over time.

In the current document, we introduce two strategies, based on psychological insights, that have been shown to be able to increase the efficacy of physical activity promotion services. One strategy is focused on increasing self-efficacy, the other supports users in forming *implementation intentions,* very specific and detailed plans to execute a particular behavior. The efficacy of the two strategies in the context of SWELL will be tested in two separate studies, executed by RRD and PR respectively. The first is an initial, small-scale pilot study to investigate the immediate effect of various kinds of feedback on an individual's level of self-efficacy. The second is a larger-scale study to investigate if implementation intentions could improve the outcome of the future SWELL sytem. Whereas the first study will be executed in a lab setting, have a short duration, and include a limited number of participants, the second study will be a field trial, have a longer duration and include more participants. Therefore, the second study will be discussed in more detail in this document.

1.1 Outline of this document

Chapter 2 describes the study that will be executed by RRD, focusing on increasing self-efficacy. Chapter 3 describes the study that will be executed by PR, focusing on the role of implementation intentions. Chapter 4 provides a timeline, outlining the plan for the two studies.

2 Study 1. Influencing Self-Efficacy

2.1 Theoretical background

The average age of the Dutch population is rapidly increasing. This implies that a decreasing number of the working population (aged 20 to 65) has to 'finance' an increasing number of (healthcare consuming) elderly. As a consequence, the costs of healthcare are expected to rise to even higher levels and further increase pressure on healthcare professionals (CBS, 2010). Furthermore, an increasing number of people tend to live a sedentary lifestyle, which is related to a decrease in health and therefore poses a risk for numerous diseases (e.g. Bankoski et al., 2011; Warren et al., 2010). A physically active lifestyle, on the other hand, has significant positive effects on prevention of chronic diseases such as cardiovascular disease, diabetes, cancer and obesity (Warburton, Nicol, & Bredin, 2006), but also on mental health condition through reduced perceived stress and lower levels of burnout, depression and anxiety (Jonsdottir et al., 2010). This means that influencing people to change their sedentary lifestyle to a more physically active lifestyle should lead to better well-being, less chronically ill and higher life expectancy.

There is a considerable amount of literature on how to influence people and achieve behavioral change. Some well known theories on this topic, so-called Social Cognition Models, include the Social Cognitive Theory (Bandura, 1982), the Theory of Planned Behavior (Ajzen, 1991), and the Transtheoretical Model (Prochaska & DiClemente, 1983). The specific constructs that are frequently encountered in research include stage of change, process of change, behavioral intentions, social norms, attitudes, perceived susceptibility (an individual's assessment of their risk of getting a particular condition, e.g., of developing heart failure), social support and self-efficacy (Noar, Benac & Harris, 2007). Although the mentioned theories describe behavioural change as a function of different constructs, there is also considerable overlap between the theories. Intention is typically presented as the strongest predictor of behavior, as a mediating variable between social cognitive variables and actual behavior. Another important facor is *self-efficacy*, the belief that the particular behavior is or is not within an individual's control. This factor is incorporated in almost all models, although occasionally labeled differently, for example 'perceived behavioral control'. Next, the models imply a central role for health education (to change beliefs/expectancies) and the need to personalize, or tailor, health information (individuals can have different beliefs/attitudes) such that it is relevant to the specific individual (Noar, Benac & Harris, 2007).

In their review, Gist and Mitchell (1992) conclude that a high level of self-efficacy is a prerequisite for actual performance of the behavior. Another review labels self-efficacy as the strongest predictor of physical activity, over intention (Petter et al., 2009). Thus, when someone intends to change or perform a particular behavior, his level of self-efficacy with respect to the target behavior should be sufficient in order to be successful. Rodgers et al. (2008) developed a questionnaire assessing three different aspects of self-efficacy: task efficacy, coping efficacy and scheduling efficacy (Table 3.3.7). Bandura (1994) describes four strategies to influence self-efficacy:

- Enactive mastery experience
  This strategy of influencing self-efficacy pertains to successful performance of the target behavior. When subjects experience that they are able to execute a certain task, their level of self-efficacy will be higher than when they experience that they are not. In other words, experiencing success can lead to higher levels of self-efficacy and experiencing failure leads

to lower self-efficacy. This means that when users can set sub-goals, which are easier to attain, they will experience success more often, which may lead to a higher level of self-efficacy.

- Vicarious experience
  This source of influence refers to seeing others successfully perform the target behavior. One aspect that is of particular importance when using other individuals to model or show successful performance of a certain task is that the 'other' needs to be similar to the observer. More concretely, a patient will identify less with a healthy user than with another patient performing the target behavior.

- Social persuasion
  This strategy is concerned with expressing faith in the user's capacities. The strength of social persuasion comes from research that indicates that users exert greater effort that is sustained longer when verbal social persuasion is applied, than when it is not (Bandura, 1994). Expressing unrealistic amounts of faith, however, is usually disconfirmed quickly by failure to execute the task.

- Physiological / affective states
  This last source of influence on self-efficacy pertains to correcting misinterpretations of bodily states. For example, users who have once suffered a heart attack may become scared or anxious with the slightest increase in heartbeat. When they engage in vigorous physical activity and notice that their heartbeat increases, they may be scared that another heart attack is imminent. As a result, they may choose to perform mostly low intense activities. However, when they are provided with the correct information, i.e. that heartbeat is supposed to go up and all feelings are normal, this can lead to higher levels of self-efficacy and physical activity.

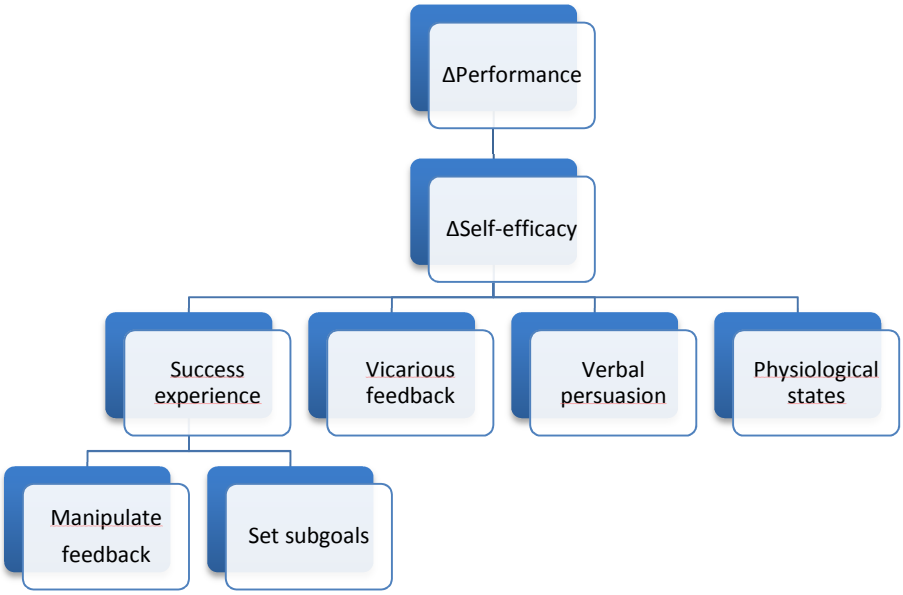

***Figure 2.1.1**. Schematic overview of Self-Efficacy and related constructs.*

As a first step towards implementing self-efficacy increasing feedback in the SWELL system, we will focus on a small scale experiment to examine whether it is possible to influence a subject's level of

Task Self-Efficacy by feedback and whether this leads to a different level of performance. The feedback is based on Bandura's first strategy, enactive mastery experience.

With respect to the task that participants have to perform, a first requirement is that it should be new to every subject, insuring an equal level of self-efficacy and experience at the start of the experiment. Second, the task should be learnable as to be able to identify a learning curve. Last, the task should be physical of nature, as cognitive tasks rely on other mental processes, but also because of our end goal of developing a service for increasing level of physical activity. These three requirements are taken into account when asking participants to walk in a straight line from traffic cone A to traffic cone B for five times, as fast as possible, wearing scuba fins and a blindfold. This, therefore, will be the task that participants have to perform during the experiment.

2.2 Hypotheses

The following hypotheses will be tested:

1. Letting subjects experience success through feedback will make subjects report higher levels of self-efficacy than subjects who do not experience success.
2. Subjects in the 'experience success' condition will have higher levels of performance than subjects who do not experience success.

2.3 Method

2.3.1 Participants

Considering the small nature of the experiment the total number of participants will be limited to 45, who will be recruited by a researcher from Roessingh Research and Development. This number should be sufficient to detect a trend, as a lead to investigate the phenomenon. Since the role of self-efficacy is considered to be universal, participants will not be limited to the personas defined in WP1. Criteria for inclusion are that volunteers are 18 years or older, healthy and Dutch speaking.

2.3.2 Materials

Participants will be fitted with scuba fins and a blindfold; various sizes of fins will be available. Furthermore, a laptop with appropriate experimentation software (e.g. E-Prime) is used to guide the participants through the experiment and to present the feedback. The participant's level of self-efficacy is assessed with the Multidimensional Self-Efficacy Scale (Rodgers, 2008).

2.3.3 Procedure

Participants will be approached by a researcher from RRD and, after accepting the invitation, be asked to sign an informed consent right before the start of the experiment.

At the start of the experiment, participants receive the instruction, informing them that they will have to walk a straight line from traffic cone A to traffic cone B wearing scuba fins and a blindfold. The goal is to do this as fast as possible. After receiving the instruction, the participant's level of Self-Efficacy will be assessed using a questionnaire. Next, they will put on scuba fins and a blindfold, to guarantee that every participant has the same level of experience. Participants are told to walk to traffic cone B as quickly as possible. The computer will start a countdown after which participants may start. At the same time, the computer initiates a stopwatch that finishes when participants

reach traffic cone B. After each trial, participants receive feedback about their performance on the laptop display. Depending on the experimental condition, feedback will contain the following information:

- For the first group, the feedback will be random (good or bad);
- For the second group, feedback will only be positive, even if their performance was bad;
- For the third group, feedback will mostly be negative, even if their performance was good.

A pilot experiment including 10 additional subjects will be used to be able to classify performance during actual experiment as 'good' or 'bad'. Furthermore, a maximum time limit will be determined; when this limit is exceeded, participants will not receive feedback. This limit is incorporated to take into account falls or other means of failure. When participants have finished the experiment, i.e. after doing 5 trials, their level of Task Self-Efficacy is assessed again.

Providing participants with only positive or negative feedback results in experience of success and failure respectively; asking subjects both before and after about their level of performance allows for investigating the effect of these messages on the participant's level of self-efficacy. This will clarify the relationship between success experiences, self-efficacy and performance on a task, which can be used as input for a larger scale study.

2.4 Outcome measures

2.4.1 Self-Efficacy score

The design described above makes it possible to test for within and between subject effects for the variable Self-Efficacy, which will be assessed using Rodgers et al's (2008) Multidimensional Self-Efficacy for Exercise Scale (Table 3.3.7) before the first and after the last trial.

2.4.2 Task performance

Another outcome measure is related to performance, which is measured objectively by the average time participants need to get from traffic cone A to traffic cone B over 5 trials. In addition, the average time per trial per group is calculated to compare each group's learning curve.

3 Study 2. Effectiveness of Implementation Intentions

3.1 Theoretical background

Each New Year's Day, millions of people vow to lead a healthier life. Healthy behaviors such as losing weight, eating more healthily, performing physical exercise and quit smoking invariably appear in the top-ten lists of New Year's resolutions. Unfortunately, although most people seriously intend to make a change, only a few of them actually succeed in maintaining their new behaviors. One of the reasons for this low success rate is that people find it very difficult to translate their good intentions into behavior. This phenomenon is called the ***intention-behavior gap***. This gap also becomes apparent in models of behavior change, such as the Theory of Planned Behavior (TPB; Ajzen, 1991). According to this model (described in more detail in D1.3a), an individual's behavior is preceded by his or her intentions, which in turn are determined by the individual's attitudes, social norms and amount of perceived control over the behavior (see Figure 1).

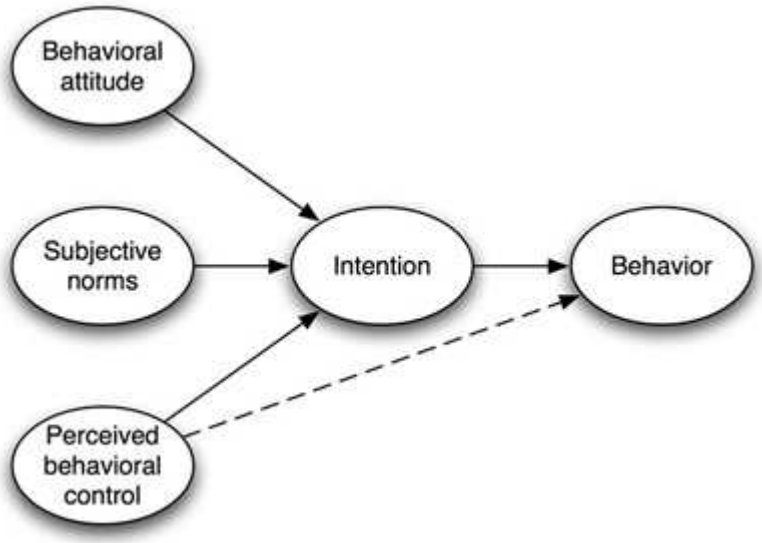

Figure 1. *Theory of Planned Behavior (Ajzen, 1999).*

Meta-reviews, covering hundreds of studies, showed that intentions account for less than 30% of the actual behavior (Armitage & Conner, 2001; Sheeran, 2002). Thus, while someone's behavior is predicted by his or her intentions to some degree, it is mostly influenced by other factors. One way to bridge the intention-behavior gap, and to enhance the likelihood that intentions are translated into behavior, is by formulating very specific and detailed intentions, so-called ***implementation intentions***. Implementation intentions specify exactly when, where and how the behavior will be performed, as well as what will be done to overcome potential barriers. Implementation intentions have the form of an if-then-plan; "When situation *x* arises, then I will perform behavior *y*". For example, a typical implementation intention may be "When I enter the office building in the morning, I will take the stairs instead of the elevator". Such detailed plans stand in stark contrast to most New Year's resolutions, which are typically formulated rather vaguely; for example, "I intend to exercise more" or "I want to eat more healthily". Most New Year's resolutions are so-called *goal intentions,* they specify a certain end point that may be a desired behavior (e.g., exercising more) or an outcome of that behavior (e.g., becoming fitter or thinner). However, they don't specify in detail how this end goal is to be reached.

Implementation intentions are more easily translated into behavior than goal intentions, through several processes. Specifically, implementation intentions realize two different things:

a. **Implementation intentions define which future situations are opportune for action**. By thinking of particular situations, the mental representations of these situations become highly activated and more easily accessible. This increased accessibility makes it easier to detect the critical situation in the surrounding environment and to attend to the critical situation. For example, consider someone who formulates the implementation intention "When I enter the office building in the morning, I will take the stairs instead of the elevator". Because the critical situation *entering the office building* is now highly activated in the person's mind, the person is more likely to distinguish this situation as a separate and relevant event, instead of just another part of his regular morning routine. As a result, when the situation is encountered, it stands out more, and is more likely to receive attention, even when the person is busy doing other things (e.g., talking to a colleague).

b. **Implementation intentions create situation-action associations;** they explicitly specify which behavior is associated with the critical situation. As a result of the situation-action association, the behavior is automatically activated when the critical situation occurs. As mentioned by Gollwitzer (1999), "action initiation becomes swift, efficient, and does not require conscious intent" (p. 495). In other words, it becomes automatic. This process facilitates the formation of new habits, which essentially are automatic situation-action links (Adriaanse et al., 2011).

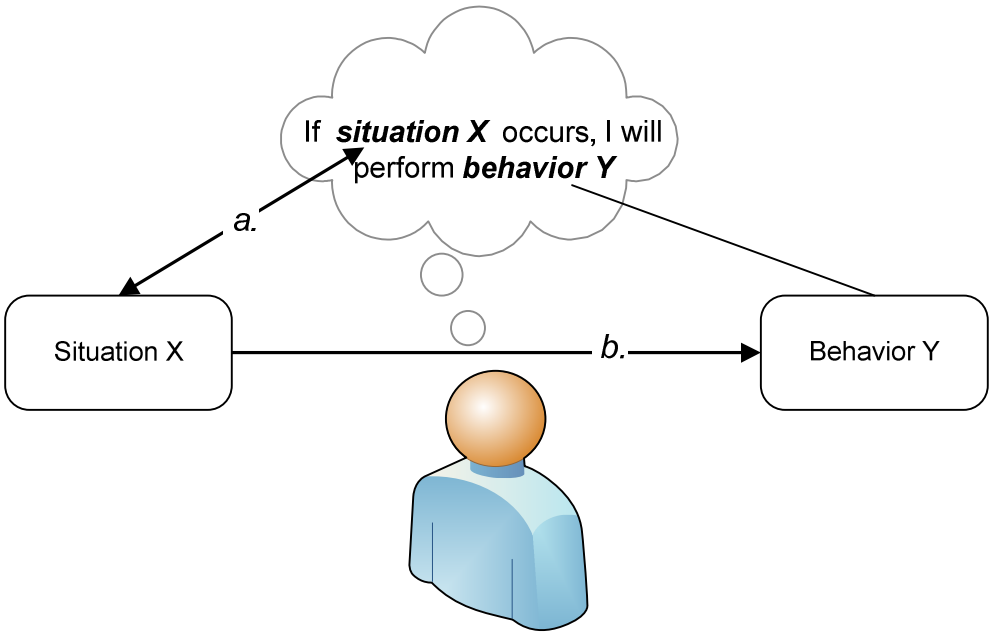

Figure 2. *The two underlying processes of implementation intentions;* a. *activation of the mental representation of the critical situation, and* b. *creation of an automatic situation-action association.*

According to Gollwitzer (1999), implementation intentions function by 'passing the control of one's behavior on to the environment' (p. 495). Someone who has formed implementation intentions switches from conscious and effortful control of behavior to direct, automatic control by the critical situation. Because the behavior becomes automatic and situation-driven, little conscious effort is needed to execute the behavior, and it is more likely to be maintained when barriers arise.

People who successfully form implementation intentions experience that they can actually change their behavior. This may increase their confidence that they will be able to successfully change their behavior in the future as well. In other words, their self-efficacy may increase. Indeed, a study by

Murray, Rodgers and Fraser (2009) showed that forming implementation intentions has a positive effect on people's level of self-efficacy. Thus, apart from facilitating the translation from intentions into behavior, implementation intentions may also promote behavioral change by increasing the level of self-efficacy.

Implementation intentions have been proven to be quite effective, across a wide range of behavioral domains. Gollwitzer and Sheeran (2006) executed a meta-review of 94 empirical studies on implementation intentions in various domains. The measure of effect size was Cohen's *d,* the difference between the means for two groups divided by the pooled standard deviation. The average *d* for the 94 studies was .65, with a 95% confidence interval between .60 and .70 (Total range was from .02 to 2.20). A *d* of .65 can be regarded as a medium to high effect size. In the domain of healthy behavior, the average *d* was .59, with a 95% confidence interval between .52 and .67.

Given the efficacy and applicability of implementation intentions, it makes much sense to incorporate this strategy in the SWELL system. The aim of the current study is twofold; First, the study aims to investigate whether implementation intentions can be implemented in the DirectLife program, and whether they lead to a more prominent increase in physical activity than the regular program. If the beneficial effects of implementation intentions can be proven in the DirectLife environment, they are likely to be effective in the future SWELL system as well. Second, the study aims to provide answers to the following scientific questions:

Do implementation intentions lead to increased physical activity, objectively measured by an activity monitor?
Many previous studies have used self-reports to measure the result of implementation intentions. These self-reports are likely to be inaccurate and they may be subject to a reporting bias in favor of implementation intentions. Participants who have formed implementation intentions have actively defined in which situations they planned to be more active (their *critical situations*), which become more accessible in memory. As a result, these participants may find it easier to retrieve their moments of physical activity, and therefore report more physical activity than participants who have not formed implementation intentions. To avoid this bias, participants in our study will be asked to wear the DirectLife activity monitor continuously, in order to provide accurate and objective measurements.

Can the effect of implementation intentions be measured in a field study with a low level of experimental control?
Most previous studies have asked participants to form implementation intentions for a specific type of activity (e.g., going to the gym, walking, cycling), thus giving them little freedom in defining their own behavior. The question that we will address is whether implementation intentions are still effective when embedded in a general activity program, in which participants are given the freedom to specify their own critical situations and target behaviors, thus creating ideosyncratic situation-action associations.

To answer these questions, we will extend the DirectLife environment with several features that promote the formation and use of implementation intentions. The extension consists of:

- An instructional text about the use and benefits of implementation intentions.
- A detailed activity planner, enabling participants to define their own implementation intentions. The activity planner helps them to specify when and where they will execute a particular behavior.
- The option to receive SMS reminders before or during the critical situations.
- Feedback visualizing how successful a participant is in performing the planned behavior.

These features will be described in more detail in section 3.3.2. Half of the participants will be assigned to the *Implementation Intention* condition, in which they will use the extended DirectLife environment. The other half of the participants will be assigned to the control condition; they will use the regular DirectLife environment.

3.2 Hypotheses

The following hypotheses will be tested:

1. Implementation intentions will lead to increased physical activity, objectively measured by an activity monitor. Thus, participants in the Implementation Intention condition are expected to have higher levels of physical activity than participants in the control condition.
2. In the Implementation Intention condition, we expect an increase in physical activity especially during the critical situations.
3. The efficacy of implementation intentions is related to the participant's level of self-efficacy. Participants with a high level of self-efficacy will be more successful in performing the planned behavior.
4. Successfully forming and executing implementation intentions will lead to an increase in self-efficacy.

3.3 Method

3.3.1 Participants

In total, 140 participants will take part in the study, equally divided over the Implementation Intention condition and the Control condition. To determine the number of participants, a power analysis was executed. We selected 8 studies of implementation intentions and compared their participant numbers and effect sizes (see Table 3.3.1). The average effect size of these studies was approximately 0.6. Based on this effect size, a power analysis was performed with G*Power (Erdfelder, Faul, & Buchner, 1996) to estimate how many participants are required to reach a power of at least 0.8. At an alpha level of 0.05 (two-sided), G*Power estimated the required total sample size at 90 participants. Given that the average drop-out rate of a DirectLife plan is approximately 35%, we aim to start with 140 participants, in order to have 90 participants who will complete the plan.

Study	N	K	Cohen's *d*	Effect size
Murray, Rodgers, & Fraser (2009)	72	2	0.41	medium
Milne, Orbell & Sheeran (2002)	248	3	0.42	medium
Prestwich, Lawton & Conner (2003)	86	4	0.68	med/high
Prestwich, Perugini, & Hurling (2009)	154	5	0.9	high
Prestwich, Perugini, & Hurling (2010)	95	3	0.5	medium
Rise, Thompson & Verplanken (2003)	112	1	1.58	high
Sniehotta, Scholz, & Schwarzer (2002a)	74	2	0.61	med/high
Sniehotta, Scholz & Schwarzer (2002b)	65	2	0.7	med/high

Table 3.3.1. *Effect sizes of studies selected for power analysis. N = total sample size, K = nr of groups.*

Participants will be healthy Dutch volunteers, who will be recruited through an external agency. Criteria for inclusion in the study are: native Dutch speaker, older than 30 years; in possession of a smart phone with Internet connection; no known physical handicap or other condition that makes moderate physical activity impossible; not participating in any other activity promotion intervention. The age limit will be used because earlier studies in our lab have shown that people above 30 benefit most from an activity promotion program.

3.3.2 Materials

DirectLife activity monitor and coaching service

Participants will be enrolled in a modified version of the Philips DirectLife activity program (www.directlife.philips.com). This is an online coaching service, aimed at supporting users to incorporate more physical activity in their daily routines. Physical activity is measured by the DirectLife activity monitor (Figure 3.3.1), a triaxial accelerometer for movement registration. It measures 31 x 33 x 11 mm, weighs 23 g, and has a sampling rate of 20 Hz. The monitor can be attached to clothing, put in one's pocket, or be worn as a pendant around the neck. The activity monitor is waterproof and has a battery life of approximately three weeks. Data from the activity monitor can be uploaded to the computer via the USB port, after which users can view their results on their personal DirectLife web page.

Figure 3.3.1. *Philips DirectLife Activity Monitor*

DirectLife offers a 13-week activity program. The program starts with an assessment period of one week, to measure the user's baseline activity level. During the assessment period, users are instructed to follow their regular routines and to wear the activity monitor continuously in order to obtain an accurate baseline measurement. After completing the assessment period, users are invited to participate in a twelve-week *Activity Plan*, during which they are encouraged to gradually

increase their level of activity. Based on the outcome of the assessment period and the user's ambitions and preferences, a personalised activity goal is suggested. An average goal entails a 15% increase in activity over the course of twelve weeks (Figure 3.3.2). The user can accept this goal or set a different goal. Once the end goal is set, daily activity targets are defined, which gradually increase week by week.

***Figure 3.3.2**. Personalised activity plan with gradually increasing daily activity targets*

During the plan, users are encouraged to meet their daily activity targets. Simple, direct feedback about target achievement is given by means of a row of blinking LEDs on the activity monitor. More extensive feedback is provided on the web portal, where users can get an overview of their past activity on multiple timescales (averages per hour, day, week or month, see Figure 3.3.3). In addition, the service offers coaching by a human coach, an online community and general advice about physical activity and healthy behavior.

Figure 3.3.3*. Feedback about daily target achievement presented on the web portal*

Implementation intentions module

The DirectLife platform will serve as the basis for our study. Participants in the control condition will follow the regular DirectLife activity program. Participants in the experimental condition will follow a modified version of the program, which will be extended with an ***implementation intentions module,*** comprising several elements:

Instructional text

The instructional text will describe the benefits of forming implementation intentions, and provide instructions on how to do it. The text is described in Box 3.3.4.

> Regelmatig nemen mensen zich voor om meer te bewegen, maar vaak komen ze er niet toe om het ook echt te doen. Het is wetenschappelijk bewezen dat het makkelijker is om meer te bewegen als je vantevoren een duidelijk plan hebt gemaakt over wat je precies zal gaan doen, en waar en wanneer je dat gaat doen. Als je zo'n plan hebt gemaakt, is de kans kleiner dat je vergeet of er niet toe komt om te gaan bewegen.
> Neem daarom de tijd om te bedenken op welke manieren en op welke momenten je meer beweging kunt inpassen in je dagelijks leven. Bedenk eens welke dagelijkse activiteiten je kunt vervangen door gezondere alternatieven, zoals de fiets nemen in plaats van de auto, of de trap in plaats van de lift. En op welke momenten zou je iets extra's kunnen doen, bijvoorbeeld een wandeling maken?
> Om je te helpen bij het maken en het volhouden van je plan, kun je gebruik maken van de **activiteiten-planner** (hyperlink) van DirectLife. Hierin kun je eenvoudig activiteiten plannen. Je ziet direct hoeveel calorieën deze activiteiten je opleveren. De geplande activiteiten zie je ook terug in je **beweeg-overzicht** (hyperlink), zodat direct duidelijk wordt in hoeverre je je aan je plan hebt gehouden.

Box 3.3.4. *Instructional text.*

Activity planner

The activity planner enables the user to formulate his or her own implementation intentions. The activity planner will be implemented in the following way. After completing the assessment period, participants are shown their end goal. In the experimental condition a pop up window will appear, explaining what the goal means in terms of extra activity (see Figure 3.3.5). Since calorie expenditure during a particular exercise depends on the person's physical characteristics (e.g., gender, weight and age), the provided information will be tailored to these characteristics.

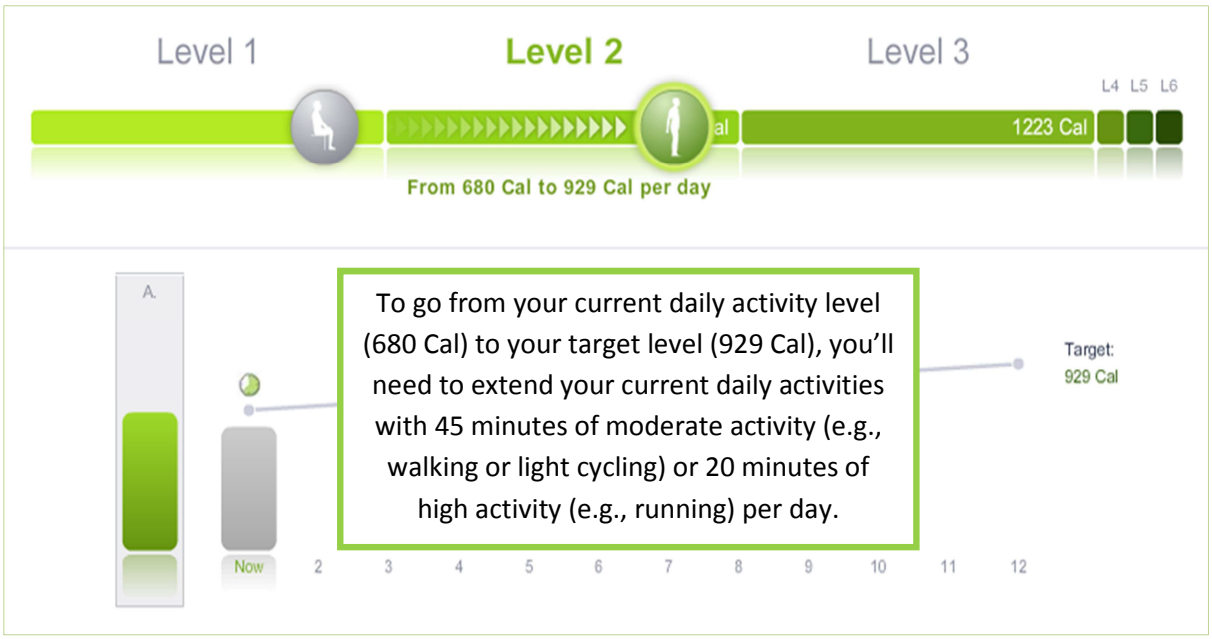

Figure 3.3.5. *Example of popup window, translating a goal specified in calories into minutes of moderate and high activity.*

Based on the amount of suggested extra activity, the user is encouraged to make a concrete plan (implementation intention) to reach this goal on a daily basis. The user can specify when and where he will perform a particular activity. When planning an activity, the user can directly see how this activity will contribute to his/her daily goal. An example of how the activity planner could be implemented is shown in Figure 3.3.6.

Figure 3.3.6. *Example of how the activity planner can be implemented.*

SMS reminders

The user can opt for the possibility to receive a reminder (by SMS) before a planned activity. Depending on type of activity and the user's preference, the reminder will be sent at the most appropriate moment. In some cases (e.g., when the user planned to take a lunch walk), the reminder

can be sent immediately before the activity. In other cases (e.g., when the user planned to go to the gym immediately after work), the reminder should be sent earlier, to give the user the chance to prepare properly for the activity (e.g., to bring his sport outfit to work).

Feedback

The graphs showing a person's activity statistics will be supplemented with feedback about the achievement of the implementation intentions. For example, in Figure 3.3.7, blue bars indicate the planned activity. Green bars indicate the realized activity. It is clear that the plan to take a lunchwalk has not been reached on this day. This enables users to identify their 'weak spots', the moments during which they did not manage to follow up on their plan. If a user consistently fails to perform the planned activity, the system could trigger the user to identify the barriers that prevent him from performing the planned activity, and to think of ways to cope with these barriers. If this does not lead to a higher success rate, the system could suggest to change the plan and to form new implementation intentions.

Figure 3.3.6. *Activity statistics supplemented with information about the achievement of the implementation intentions. Blue bars indicate the planned activity. Green bars indicate the realized activity*

3.3.3 Procedure

Candidates for the study will be approached by an external agency. They will be sent an information package with information about the study and an informed consent form.

Upon giving their consent for participation, participants will be sent a DirectLife package, containing an activity monitor, a USB connector that connects the activity monitor to the computer, and computer software, which enables the user to upload data from the activity monitor and to view his or her activity history on a personal webpage.

All participants will follow the DirectLife program, which starts with a one-week assessment period, during which baseline activity is measured. Following the assessment period, participants will be requested to fill in several short questionnaires, assessing their stage of change and main motives for becoming more active. These questionnaires are standardly used in the DirectLife program.

In addition, participants will be asked to fill in a custom Self-Efficacy questionnaire, based on the Multidimensional Self-Efficacy for Exercise Scale (Rodgers et al., 2008) and the Exercise Self-Efficacy (ESE) scale (Bandura, 2006). The Multidimensional Self-Efficacy for Exercise Scale contains nine items, addressing three different aspects of self-efficacy: task efficacy, coping efficacy and scheduling efficacy (see Table 3.3.7). Each item is preceded by the stem 'How confident are you that you can…', followed by a sentence addressing a particular task, coping or scheduling aspect of

exercise behavior (e.g., " … exercise when you are too tired,"). Answers are given on a confidence scale ranging from 0% = not confident at all, to 100% = completely confident.

Factor	Item
Task efficacy	… complete your exercise using proper technique
	… follow directions to complete exercise
	… perform all of the required movements
Coping efficacy	… exercise when you feel discomfort
	… exercise when you lack energy
	… exercise when you don't feel well
Scheduling efficacy	… include exercise in your daily routine
	… consistently exercise three times per week
	… arrange your schedule to include regular exercise

Table 3.3.7. *The original Multidimensional Self-Efficacy for Exercise Scale (Rodgers et al., 2008).*

The ESE consists of 18 items, listing a number of situations that may provide barriers to sticking to an exercise routine. People are asked to rate on a scale from 0 to 100 (or from 0 to 10) how certain they are that they can get themselves to perform their exercise routine regularly (three or more times per week).

Participants are given the following instruction:

Rate your degree of confidence by recording a number from 0 to 100 using the scale given below

0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
Cannot do at all					Moderately can do					Highly certain can do

Item	Confidence (1 – 100)
When I am feeling tired	…
When I am feeling under pressure from work	…
During bad weather	…
After recovering from an injury that caused me to stop exercising	…
During or after experiencing personal problems	…
When I am feeling depressed	…
When I am feeling anxious	…
After recovering from an illness that caused me to stop exercising	…
When I feel physical discomfort when I exercise	…
After a vacation	…
When I have too much work to do at home	…
When visitors are present	…
When there are other interesting things to do	…
If I don't reach my exercise goals	…
Without support from my family or friends	…
During a vacation	…
When I have other time commitments	…
After experiencing family problems	…

Table 3.3.8. *The original items of the Exercise Self-Efficacy Scale (Bandura, 2006).*

From the two questionnaires, a number of items were selected, based on their relevance for the current domain. Task coping was not addressed, since this is less relevant for daily activities. The original items were translated and modified slightly in order to refer not only to exercise behavior, but to physical activity in general.

The general stem was “Hoe zeker ben je dat je…”. The translated and modified items are presented in Table 3.3.9.

Factor	Item
Coping efficacy	… kan bewegen als je weinig tijd hebt
	… kan bewegen als je moe bent of weinig energie hebt
	… kan bewegen als je je niet lekker voelt
	… kan bewegen als het slecht weer is (bijvoorbeeld als het regent of sneeuwt)
Scheduling efficacy	… meer beweging kan inpassen in je dagelijkse routine
	… consequent meerdere keren per week kan bewegen
	… je planning zodanig kunt aanpassen dat je regelmatig kunt bewegen
	… kan bewegen als je veel andere dingen te doen hebt

Table 3.3.9. *The translated and modified questionnaire.*

After completing the questionnaires, the two programs will diverge. Participants in the control condition will continue with the regular DirectLife program, whereas II participants will continue with the extended DirectLife program. Participants are encouraged to complete the twelve-week plan. However, it is known that approximately 35% of the participants (in the regular DL program) drop out prematurely. A user is labeled as a drop-out when he or she has not docked for 30 consecutive days.

The complete procedure is summarized in Table 3.3.10.

Step		Group	Description
1	Invitation	both	Candidates are approached by external agency, they receive an information package and an informed consent form
2	Give consent	both	Participant returns informed consent form
3	Receive DL package	both	Participant receives DirectLife package
4	Start DL plan	both	Participant starts DL plan
5	Assessment week	both	Participant follows assessment week to measure baseline activity level
6	Questionnaires	both	Participant completes questionnaires assessing self-efficacy, stage of change and motives
7	Choose target	both	Participant selects target for DirectLife plan
8	Impl Int module	II	Participant reads instructional text and fills in activity planner
9a	Complete regular DL plan	control	Participant completes regular 12-week DL plan (unless he drops out earlier)
9b	Complete extended DL plan	II	Participant completes extended 12-week DL plan (unless he drops out earlier)
10	SE Questionnaire	Both	After completion of plan (or after drop-out) participant is asked to fill in SE questionnaire for second time.

Table 3.3.10. *Summary of the procedure.*

3.4 Outcome measures

As described in Deliverable 5.1a, we will adhere to the staged approach of DeChant et al. (1996) when evaluating the success of a system. DeChant et al proposed that the assessment of technological health solutions should be performed in four subsequent stages, each focusing on different aspects of the solution (Table 3.4.1). The current study entails a stage 2 evaluation, using a small sample to assess the user experience and behavioral outcomes.

Stage	Focus	Description
Stage 1	Technical quality	Focus on reliability and accuracy of the system
Stage 2	User experience	Use small samples to assess user experience and behavioral/clinical outcomes
Stage 3	Overall effect of the system	Use large samples to assess the overall effects of the system
Stage 4	External validation	Test the system in another healthcare domain

Table 3.4.1. *Overview of the four stages of DeChant et al. (1996).*

To assess the success of the intervention, several dimensions will be analyzed; engagement with the (extended) DirectLife program, level of physical activity and psychological outcomes (e.g., self-efficacy).

3.4.1 Engagement

How engaged are users with the system? Are II participants more engaged than control participants? Engagement will be assessed with the following measures:

Wearing days

the proportion of days during which users wear the activity monitor.

Docking frequency

The frequency with which users dock the activity monitor to upload their data.

Use of the activity planner

Do people use the planner or not? How many different activities do they plan?

Retention rate

How long do participants keep using the system before they drop out of the program? A DirectLife user is defined as a drop-out when he has not docked his activity monitor for 30 consecutive days.

3.4.2 Physical activity

Physical activity will be recorded by the activity monitor at a granularity of a minute.

PAL level over the course of the program

How does the physical activity level (PAL) develop over the course of the program?

Compliance to the planned activities

To what degree do users succeed in performing the planned activities?

3.4.3 Psychological outcomes

Self-efficacy

Self efficacy will be assessed by means of a questionnaire at two points in time; 1. after completing the assessment, and 2. after completing the 12-week program (or after drop-out).

4 Timeline

Year	Period	Activity
2012	September	Prepare experiment (gather equipment and invite participants)
	October	Test system and run study
	November	Analyze data and write report
	December	Write report

Table 4.1. *Timeline of Self-Efficacy study, to be performed at Roessingh Research & Development.*

Year	Period	Activity
2012	September	Submit research plan to Philips ICBE (ethical committee)
	October November	Prepare experiment (program extra features in DirectLife Labs platform)
	December	Test the system (including small pilot test)
2013	January February March April	Run study
	May June July	Analyze data and write report/publication

Table 4.2. *Timeline of Implementation Intention study, to be performed at Philips Research.*

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