Behaviour change interventions in mobile health applications

Testing the potential of a gamified step counter app to affect motivation on physical activity behaviour change

Master Thesis

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Declaration

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Abstract

Objective: To target health behaviour with smartphone apps, behaviour change techniques should be used. In this thesis a prototypical health app was enhanced with different behaviour change techniques. The prototype was evaluated through a usability test and questionnaires to measure the effect on motivation for behaviour change.

Methods: A prototype of a step counter app was designed. Test participants solved several tasks in this prototype while smartphone screen and audio were recorded. Before and after the test, participants filled in questionnaires about current activity level, stages of change and the prototype.

Results: 10 participants attended the usability test. 8 of 10 participants had installed health apps on their smartphone. 50% of them use this type of apps daily. The activity levels of participants were categorized in high (n=5), moderate (n=4) and low (n=1). Participants were in the following stages of change: contemplation (n=2), preparation (n=3), action (n=1) and maintenance (n=4). 95% of all task attempts were successful and the overall mean task time was 27.40 (±12.27) seconds. The error-free rate regarding all participants was 60%. Including non-critical errors, the rate scales down to 20%. All behaviour change techniques had a positive impact on motivation. On a Likert scale from 1 (highly motivating) to 5 (not motivating) the collection of behaviour change techniques reached a value of 1.92. The categories ‘rewards and incentives’ and ‘associative learning/generalisation of behaviour’ had the biggest effect on motivation. ‘Information about health/emotional consequences’ had the lowest effect on motivation.

Conclusion: This paper provides an experimental setup to test the effect of behaviour change techniques on motivation. The rarely used techniques, chosen for this thesis, can be implemented in health apps. It seems they have a positive impact on motivation for behaviour change. The use of gamified elements in this prototype led to a motivation enhancing effect.

Kurzfassung

Ziel: Um das Gesundheitsverhalten durch Apps zu steuern, sollten Verhaltensänderungstechniken verwendet werden. In dieser Arbeit wurde ein Prototyp einer Gesundheits-App um verschiedene Verhaltensänderungstechniken erweitert und durch einen Usability-Test und Fragebögen evaluiert, um den Effekt auf die Motivation für Verhaltensänderungen zu messen.

Methoden: Es wurde ein Prototyp einer Schrittzähler-App entwickelt. Testteilnehmer erledigten mehrere Aufgaben in diesem Prototyp, während der Smartphone Bildschirm und der Ton während des Tests aufgezeichnet wurden. Vor und nach dem Test füllten die Teilnehmer Fragebögen über das aktuelle Aktivitätslevel, über die Position im Stufenmodell der Verhaltensänderung und über die Verwendung des Prototyps aus.

Ergebnisse: 10 Teilnehmer absolvierten den Usability-Test. 8 von 10 Teilnehmer hatten Gesundheits-Apps auf ihrem Smartphone installiert. 50% von ihnen verwenden diese Art von Apps täglich. Die Aktivitätsniveaus der Teilnehmer wurden in hoch (n = 5), moderat (n = 4) und niedrig (n = 1) kategorisiert. Die Teilnehmer waren in den folgenden Stufen der Veränderung: Absichtsbildung (n = 2), Vorbereitung (n = 3), Handlung (n = 1) und Aufrechterhaltung (n = 4). 95% aller Aufgaben wurden erfolgreich abgeschlossen und die durchschnittliche Bearbeitungszeit betrug 27,40 (± 12,27) Sekunden. Die fehlerfreie Quote für alle Aufgaben betrug 60%. Dabei wurden nur kritische Fehler berücksichtigt. Unter Einschluss nicht-kritischer Fehler reduziert sich die Quote auf 20%. Alle Verhaltensänderungstechniken hatten einen positiven Einfluss auf die Motivation. Auf einer Likert-Skala von 1 (sehr motivierend) bis 5 (nicht motivierend) erreichten die Verhaltensänderungstechniken einen gemeinsamen Durchschnitt von 1,92. Die Kategorien "Belohnungen und Anreize" und "assoziatives Lernen / Verallgemeinerung von Verhalten" hatten den größten Einfluss auf die Motivation. "Informationen über gesundheitliche / emotionale Konsequenzen" hatte die geringste Wirkung auf die Motivation.

Schlussfolgerung: Diese Arbeit zeigt einen experimentellen Aufbau, um die Motivationswirkung von Verhaltensänderungstechniken in Smartphone-Apps zu testen. Die selten verwendeten Techniken, die für diese Arbeit ausgewählt wurden, können in Gesundheits-Apps implementiert werden. Es scheint, dass sie sich positiv auf die Motivation für Verhaltensänderungen auswirken. Die Verwendung von Gamification in diesem Szenario lässt einen motivationserhöhenden Effekt vermuten.

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1 Introduction

Omnipresent smartphones, 24/7 connectivity and an urge to maintain a live feed of personal belongings. Nowadays the smartphone is a steady companion in the everyday life. It is used as personal assistance which holds our daily routine and keeps track of work and social life. Per definition a smartphone is "*A mobile phone that performs many of the functions of a computer, typically having a touchscreen interface, Internet access, and an operating system capable of running downloaded apps*" [1]. This technological achievement is a cornerstone in modern history and leads to countless possibilities and autonomy in health promotion, e.g. health and fitness apps like Freeletics, Runtastic, Strava and Lifesum.

In the last years the prizes for smartphones dropped globally [2]. The devices got affordable and found their way in almost every pocket. According to the report of the International Telecommunication Union (abbr. ITU) 7.2 billion people worldwide had a mobile phone subscription [3]. If we consider that 43.7% of all mobile phone users worldwide have a smartphone [4], that means 3.15 billion smartphones are in use, all over the world. One of the main aspects of smartphone use, is the ability to get internet access whether through mobile-broadband connections or WiFi access. This ability to join the worldwide web amplifies the ways of smartphone usage. The ITU report of 2015 shows that 3.2 billion people worldwide had an active mobile-broadband subscription [3]. This statistic includes people from developed and developing countries. Over 3 billion people are connected through a worldwide network and can exchange information in real-time. Conforming to the Ericsson mobility report 2016 there will be 6.1 billion smartphones in use in the year 2020 [5]. While the smartphone market in industrialised countries will reach its saturation limits, the market in emerging economies and developing countries will rise significantly. This means the network of connected smartphone users will double in size in the next few years and this results in the possibility to reach a huge part of humanity in just a few seconds. Using this channel of communication to promote health and health behaviour turns public health into global health. Before this potential can be used, it is essential to find an effective and usable way of changing health behaviour through smartphone apps.

Apps require an internet connection for user login and for transmitting data to the provider. As reported by Yahoo in 2015, the number of users who use apps daily rose to 1.8 billion. The ranking of the most selected apps is led by messaging and social media services. The second place goes to productivity apps and further following are games, financial apps and news

services [6]. The third place is taken by the category of games and the mobile gaming sector is still evolving [7]. It seems likely to draw the conclusion that promoting health through gamified contents can reach a lot of people.

This thesis deals with the use of health apps and their impact on physical activity behaviour. Global health is the ambitious goal, but changing the world starts with changing your own behaviour. Therefore, this thesis investigates methods of behavioural change through the use of health apps. It comes up with a concept based on established behaviour change techniques and builds a prototypical app for a usability trial.

According to a publication of the Bertelsmann Stiftung there are over 100.000 health apps in the app-stores [8]. The number of these apps doubled in 2.5 years [9]. They are categorized in seven types depending on their different fields of application: strengthening of health competence, analysis and awareness, indirect intervention, direct intervention, documentation of medical history, organisation and administration, purchase and supply (see Fig. 1). The following chapter will build up on the topic of health interventions and therefore focus on type 3 and 4 of health apps, indirect and direct interventions.

Fig. 1: Seven types of health apps [8].

Aim of this thesis is to test the implementation of behaviour change techniques (abbr. BCT) in mobile health applications and to test if these techniques can enhance motivation for health behaviour change. In combination with gamification elements the motivation of users can be maintained. To test the implementation, the BCT will be presented as part of a prototype. A prototype consists of several visual designs, called ‘mock-ups’, that are linked together. For the user, it looks and feels like a programmed mobile application, of course depending on the level of details the prototype has. Through defined interactions the prototype has the same click mechanics as a real application. The test will help to analyse the requirements that are necessary to build effective and usable mobile applications in terms of health behaviour change. In addition, it will depict the influence of behaviour change techniques on motivation for health behaviour change. To give the user the most realistic experience the prototype is designed as a complete mobile application called ‘Urban Adventurer’. It is a step counter app with behaviour change techniques embedded as app features. The test participants will use these features and deliver their feedback instantly and through a questionnaire.

The following chapters will give theoretical background and highlight scientific findings in the sector of behavioural science. The methodological structure of applying behavioural science to mobile applications is outlined. The design process of specific behaviour change techniques, implemented in ‘Urban Adventurer’, can be found. The setting of the usability test will be described, and the results of this test are listed subsequently. The last chapters outline the analysis between scientific findings and the results of the conducted usability test.

2 Theoretical Background

The following literature extracts are categorized in several subchapters. These chapters help to structure the interdisciplinary field of digital health promotion.

2.1 Definition and modelling of behavioural change

The main target of digital health interventions[1] should be the human behaviour. Addressing the behaviour with interventions helps to gain sustainable and long-term results in health promotion.

There are almost 3 million apps available in app stores [10], [11]. Few of them have been evaluated in a clinical trial, or have been classified as medical product. The two major App-Stores contain more than 40.000 apps in the category ‘medicine’. Only 100 of them are regulated by the U.S. Food and Drug Administration (abbr. FDA) [12]. The majority consists of commercial health apps. These apps may use evidence-based principles to deliver health contents, but they often lack previous clinical evaluation. In the special case of effective behavioural change interventions, they should include both behavioural and cognitive strategies to improve clinical outcomes [13]. The interventions to change the behaviour of individuals are rather complex and consist of many interdependent components. Main component of these interventions are behaviour change techniques (abbr. BCT), the evidence-based elements from behavioural psychology. In addition to these active parts there are modes of delivery. These modes concern design features in mobile applications or communication skills in personal interventions. One of the difficulties in using BCT, is to find out which of them influence the targeted behaviour effectively. Another challenge is the interaction between single techniques and to find out if there is a potential for synergy [14]. The amount of actual BCT, used in behaviour change interventions, is high. The Coventry, Aberdeen and London – Refined (abbr. CALO-RE) taxonomy was developed to help classifying the psychological techniques used in behaviour change interventions [15]. This taxonomy focuses on physical activity and healthy eating. Michie et al. extended this classification and developed a hierarchically structured taxonomy of 93 techniques, clustered in 16 groups. This taxonomy works as corner stone to specify and categorize the content of behaviour change interventions. An overview of the 16 clusters is given in Table 1. The detailed results with included statistical analysis, can be found in the original paper [16].

[1] DHI, i.e. interventions delivered via digital technologies such as smartphones, websites or text messaging

Categories of behaviour change techniques	
• Feedback and monitoring	• Comparison of behaviour
• Reward and threat	• Self-belief
• Repetition and substitution	• Social support
• Goals and planning	• Shaping knowledge
• Associations	• Antecedents
• Identity	• Natural consequences
• Comparison of outcomes	• Regulation
• Scheduled consequences	• Covert learning

Table 1: The 16 clusters of behaviour change interventions based on the taxonomy of Michie et al. [16]

2.1.1 Theories of behaviour change

All behaviour change techniques rely on theories of behaviour change. A theory is defined as a systematic process of understanding events, behaviours and situations. It helps to explain behaviour, resulting in the creation of influencing methods to change behaviour. There are four theoretical models of health behaviour which were most used in different publications in the last years [17].

The **Health Belief Model** (abbr. **HBM**) is designed to explain and predict health behaviour [18]. Health behaviour as defined by HBM could be the assumption of preventive action or other medical offers. According to the HBM the feasibility to maintain current health behaviour depends on the experienced threat of disease, compared to the expectations of the preventive intervention. If the individual feels more vulnerable and estimates a severe disease, the perceived threat is higher. The expectations of the intervention are put together by the perceived benefits and the barriers. A confrontation of the threat perception and the expectations lead to a certain chance to execute the targeted behaviour.

The **Transtheoretical Model** (abbr. **TTM**) is based on the fact, that long-term changes in health behaviour take place in a continuing process of multiple steps of action [19]. A key element of TTM is the construct ‘stages of change’. This construct assumes that people need to be picked up at different stages of readiness, in order to adopt their health behaviour. It is based on five stages: Precontemplation, Contemplation, Preparation, Action and Maintenance (see Table 2). This model can be used to classify people and find out why they are not ready for behavioural change. The walkthrough of the stages is not necessarily linear. Individuals may change or return to a previous stage due to motivational issues.

Stages	Characteristics	Timeframe
Precontemplation	No recognition of need for or interest in change	in the next 6 months
Contemplation	Thinking about changing	in the next 6 months
Preparation	Planning for change	within the next month
Action	Adopting new habits	for at least 6 months
Maintenance	Ongoing practice of new, healthier behaviour	over 6 months with low chance to fall back in old behaviour

Table 2: Transtheoretical Model - Stages of change based on Prochaska and DiClemente [19]

The **Social Learning Theory** was articulated by Albert Bandura [20]. It agrees with the behaviourist learning theories of classical conditioning [21] and operant conditioning [22] but extended these theories with two ideas. Bandura claims that mediating processes occur between stimuli and responses and that behaviour is learned from the environment through observational learning. Despite the fact this theory can explain complex behaviour, it cannot completely explain how miscellaneous thoughts and feelings are developed. Bandura modified and renamed his theory nine years later to the **Social Cognitive Theory** (abbr. **SCT**). The SCT explains human behaviour as an interacting triangle of personal factors, environmental influences and behaviour. It assumes that people can acquire new behaviour and knowledge not only through their own experiences, but also by observing a model. This model could be either a live model - an individual whose behaviour is observable in real life - or a symbolic model - a real or fictional character that influences behaviour. However, learning is an internal process that either leads to a behaviour or not. Another part of this theory is the topic of goal-directed behaviour. It proposes that behaviour is influenced by the setting of goals. People experience higher motivation in accomplishing their goals. The final assumptions in SCT include self-regulated behaviour, reinforcement and punishment. Self-regulation means that people eventually regulate their own learning and behaviour, without being affected by others. According to SCT, reinforcement and punishment have indirect effects on learning and behaviour. The expectations about the consequences of future responses are based on current reinforced or punished responses. Additionally, there is an influence of expectations through perceived consequences of other people's behaviour [23].

The **Social Ecological Model** (abbr. **SEM**) indicates several influencing factors ranging from the intrapersonal level up to public policy. Ecological models propose interaction across these different levels. For example, individual progress can motivate personal surroundings at workplace and may lead to the implementation of a workplace exercise program. The SEM represents the idea that behaviours both shape and are shaped by the social environment. The majority of health behaviour interventions in the past focused on individual-level factors.

However, since Bronfenbrenner articulated the theory of SEM [24], the behaviour interventions expanded their focus and included ecological parameters.

2.1.2 Proper use of behaviour change techniques

A challenge of designing digital health interventions is to apply an effective combination of behaviour change techniques (abbr. BCT). Several methods exist to identify the efficacy of BCT. One statistical method to find techniques with effective outcome, is meta-regression. It helps to scan complex interventions for effective BCT across different studies. Using this analysis comes with some limitations. First, many studies are needed to get reliable evidence about the effects of each BCT. Second, there are many factors that come along and interact with BCT in some interventions. The difficulty is to determine whether the effect was caused solely by the BCT, by some disruptive factors or by a combination of both. There could also exist some correlation between the different BCT. Furthermore, not every BCT is meant to be equally effective in every individual and a higher number of evidence-based BCT will not automatically lead to more effectiveness of the intervention [14].

2.1.3 Engagement and recruitment to digital health

One important step in promoting digital health is to recruit the individual or the public to digital health interventions. As digital technologies are part of the daily life, they have a higher potential reach than traditional interventions. One example how fast such technologies can reach millions of people and influence their daily behaviour is Pokémon Go. Althoff et al. tried to quantify the impact of Pokémon Go on physical activity and found out that engaged users increasing their activity by 1473 steps a day on average. Compared with their prior activity level this is a 25% increase. The results have also shown that Pokémon Go is able to reach low activity populations, whereas other leading mobile health apps are mostly used from an already very active population [25]. According to the magazine Forbes, Pokémon Go has actually 65 million monthly active players [26].

O'Connor et al. [27] have shown that there are numerous approaches in digital health engagement and recruitment to reach the individuals behaviour in an effective way. According to their work there are facilitators and barriers when it comes to engage people for digital health interventions. These factors were categorized in four themes: 1) personal motivation, 2) personal life and values, 3) engagement and recruitment approach, 4) quality of health intervention. Point one and two describe the pros and cons from the intrinsic view of the individual. The facilitators and barriers which originate from these themes are solely dependent by the individual user. Whereas the points three and four are controlled and specified by the developer of the intervention. The 'engagement and recruitment approach' describes the strategy that is used to allure and keep the targeted individual or the public in the destined health intervention. The 'quality of health intervention' is already determined through the

preceding development process. However, the developing process of an intervention differs when it comes to varying objectives, depending on who is the creator of the intervention. In case of behaviour change through mobile applications there are two parties concerned. Behavioural scientists on behalf of research and commercial developers on behalf of industry. There is a huge gap between research and industry when it comes to deployment speed of health interventions regarding apps [28]. Commercial developers, led by industry, aim to release their apps as early as possible to be the first reaching the masses. Subsequently there are several feedback loops in which the end users of the application contribute their opinions and prescribe the conditions for the next releases. On side of research there is a slightly different approach. Prior to distribution there is development and extensive efficacy testing. The aim of the researchers is to create an evidence-based application with significant outcomes. Randomized controlled trials (abbr. RCT) are the gold-standard when it comes to efficacy testing. However, there are time and cost issues which decelerate the development speed of mobile applications if RCT is used for efficacy testing. The commercial counterpart may not use evidence-based principles for behaviour change, but gets a lot more attention due to the early market entry. This leads to an already saturated market at the time when the science-backed mobile application is ready to launch. Pagoto and Bennett [13] propose a focus on basic features which remain available and will be employed in future mobile applications. Developing and testing strategies that have not been employed by now is a great way to reduce pressure through commercial competition. In case of testing currently available mobile apps for efficacy, the attention should go to already perfected apps which are less prone to fundamental changes.

2.1.4 Actions to alter the efficacy of health apps

One major issue in designing efficient mobile applications for digital health promotion is the unawareness of developers and employers that there is science behind behaviour change. If the application aims to produce clinical outcomes, e.g. behaviour change, scientific guidelines need to be considered all along the design and development process. The majority of health-related behaviour can be regarded as operant behaviour. This type of behaviour implies that any activity is influenced by its positive or negative consequences [22]. Dallery et al. [29] propose that technology-based methods need to change one or more components of the ‘functional unit of analysis’. This unit consists of motivating operations, discriminative stimuli, operant behaviour and consequences and the interaction between these elements (see Fig. 2). Motivating operations can increase or decrease the efficacy of consequences. Actions that increase the efficacy are establishing operations. If an event decreases the efficacy of consequences it is considered as an abolishing operation. The discriminative stimuli are split in nonverbal and verbal. The former emerges from the environment of the individual, e.g. specific locations or people which could reinforce actions in the past. Using verbal discriminative stimuli is one of the key applications of technology-delivered stimuli. These

verbal stimuli can be prompts, cues or reminders in case of digital applications. Last element of the functional unit of analysis are the consequences. There are two main approaches when it comes to addressing health behaviour-related consequences. The most common approach is to classify the consequences which are related to unhealthy behaviour and decrease their influence on behaviour. There is always a reason why unhealthy or healthy behaviour is executed. Another approach is to provide immediate desirable consequences if the individual chooses the healthy behaviour preferred to unhealthy behaviour. With this approach comes one critical issue: The consequences for healthy choices are often delayed or intermittent. In case of an intervention for weight loss, social consequences could be desired but there is no instant effect after one successful intervention unit. There are some potential reinforcers for technology-based methods, like social and monetary consequences (e.g. higher group status, vouchers) and game-based stimuli (e.g. points, level upgrade).

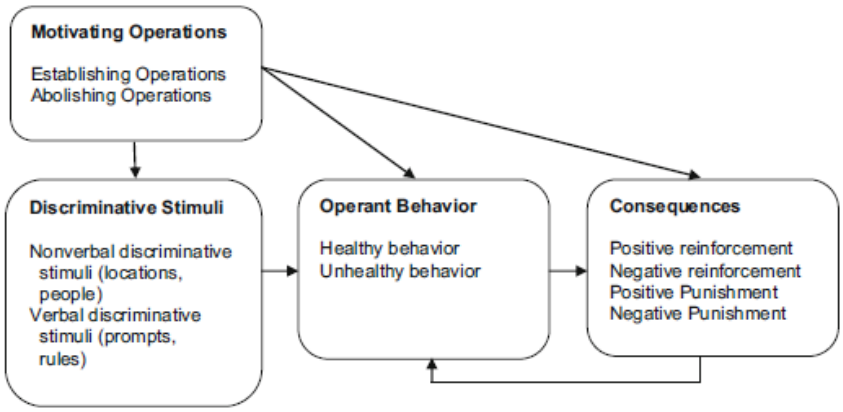


Fig. 2: Four-term functional unit of analysis relevant to health behaviour interventions by Dallery et al. [29]

2.2 Gamification

One proper way of designing apps, regarding high motivation in users and a high user retention, is considering gamification approaches. Gamification is the use of game design elements in non-game contexts [30]. It can be implemented either in real-world context or in a digital environment. The most common domain where gamification is applied, is the domain of health and fitness. The process of gamification is not meant to create a video-game about every aspect of daily life. It rather describes the process of providing game design elements to situations in which game-playing is not common [31]. The benefit of building game-playing behaviour is higher motivation due to the ‘fun factor’, while prompting behavioural change on a subconscious level. Deterding et al. [32] suggest walking through five levels of game design to bring on game-playing behaviour in users. The first level is called *game design interface patterns* and refers to the user interface (abbr. UI) which includes game design elements that

the player sees on a screen. A player is a user who is engaged in a gaming context. The UI is only one part of game design interface patterns. Elements experienced in nonelectronic games and the interaction between latter and the UI belong also to this first level. *Game design patterns and mechanics* build the second level of game design. It refers to the interaction of players and game elements within the meaning of influencing the style of game-play, competition or character levels. In the third level, *game design principles and heuristics*, the rules are set and give the player a frame to act within. The *game models* are approaches to understand the game experiences from the players point of view. Finally, the *game methods* refer to existing strategies of designing games. These levels define the process of game design that leads to game-playing behaviour. Morford et al. [31] introduce some characteristics in their paper which describe the definition of game-playing behaviour:

- **Direct impact on the game outcome and results**
  In games, the behaviour of a player creates immediate or delayed impact on the outcome of the game.
- **Clear Goals and/or end conditions**
  The player can reach a goal or fulfil an end condition. These goals are either pre-set or develop over the course of time.
- **Rules and barriers**
  The player behaves within a frame of rules or barriers that limit the variability of the players options in reaching a goal.
- **Probabilistic outcome**
  Various ways exist to reach the goals and players are unable to predict the outcome of the game.
- **Strategy development and heuristics**
  Players can develop strategies. This serves two purposes: Evaluating the state of the game and navigate the game to approach a desired outcome.
- **Noncoerced initiation**
  A player must not be forced to initiate a game. Forced participation in a game, would not count as game-playing behaviour.

If individuals fall into game-playing behaviour, there are some variables which could be responsible for the maintenance of this behaviour. *Novelty* seems to be an element responsible for the retention of game-playing behaviour once it is adopted. One possible reason are the repetitive reinforcer presentations in games which cause responses from the player. Other potential variables of influence are *cooperation and competition*. They express in social reinforcements through the interaction of players. In terms of competition there is always a negative reinforcement involved in games (e.g. avoiding damage in video games or avoid

losing points in a table top game). Some players see competition as a motivating factor, in contrast other players see it as aversive stimulus. The third big variable are *strategies and heuristics*. They will develop as the player walks through the game and get increasingly complex and convey the feeling to control the game environment, thus it serves as reinforcer. Furthermore, these strategies and heuristics can alter the probability of a specific outcome and again give the feeling of more control.

Implementing a gamification design can bring a huge benefit, especially because health behaviour change techniques (abbr. BCT) are easily set up as gamification elements [33]. Edwards et al. [34] screened 1680 apps in the categories medical, health and wellness or health and fitness. They found 64 apps that met their inclusion criteria. The main criterion was the use of gamification techniques such as rewards, avatars, badges, competitions and health related challenges in reviewed apps. To categorize the included BCT they used the current Behaviour Change Taxonomy v1 [16]. The most common BCT included in these apps were 1) feedback and monitoring, 2) comparison of behaviour and 3) reward and threat [34]. The self-regulatory BCT had the highest number of uses, but Edwards et al. suggest that some of the techniques may be preferably implemented due to their easier implementation in smartphone apps and their ability to connect to the internet. One example to mention is the category of social support. Sharing activities with a peer group on social networks is easily integrated into apps and is often used by physical activity apps [35]. There is an average of fourteen BCT used in health apps [34], thus the question how the single BCTs interact is an essential one. Dusseldorp et al. [36] examined combinations of health behaviour change techniques through meta-analysis of 101 studies. They categorized the BCTs in 3 groups: 1) motivational enhancing, 2) planning and preparation and 3) goal striving and persistence. It was found that the combination of *Provide information on the consequences*, *Provide information about behaviour-health link* and *Use of follow-up prompts* was most successful in achieving behaviour changes. In the category of motivation-enhancing there was another combination that found to be successful. It was the mix of *Prompt intention formation* and *Provide information about behaviour-health link*. No significant interdependent effects have been found in categories two and three. None of the apps which were screened by Edwards et al. have passed through systematic evaluation. This indicates an urgent need of a systematic assessment scheme to measure and compare the effectiveness of health apps towards health-related outcomes.

2.3 Implementing behavioural elements in mobile applications

Before the specific techniques of behaviour change can be applied in digital applications, there must be basic knowledge about the mechanisms that lead to new behaviours in humans. Dr. Stephen Wendel describes in his book “Designing for Behavior Change” the process from the idea to building a product with behavioural impact [37]. This chapter contains a walkthrough of this process, outlines the requirements and the corresponding arrangements that need be fulfilled to change behaviour. To give a tangible illustration of the planned interventions a designed prototype is used as an example in the following chapters. The prototype is called ‘Urban Adventurer’.

When humans decide to act, there are two types of processes the brain runs through. For actions that are very familiar and require almost no thinking, the brain creates mechanisms called ‘habits’. If actions are unfamiliar and need intensive thinking to evaluate whether to act or not, it is a conscious and calculated decision. Wendel describes five preconditions for conscious action: detecting a cue, reacting to it, evaluating it, checking for the ability to act and deciding on the right timing. A **cue** is a trigger that draws your attention to a specific decision. Cues are very important because the human brain is not able to handle all information around us. The mental filters of our brains protect our mind from being overloaded. External cues are something in our environment that triggers us. That could be a text message or an object lying around reminding someone of an action that is connected to this object. Internal cues can occur if there are any associations which are activated when another cue is recognized. Feelings like hunger or pain are also internal cues that can lead to associations and actions. The **reaction** to a cue is dependent on our associations. If the triggered behaviour can be accomplished with a very familiar action the process of “thinking” ends here and the action will be initiated. If a new behaviour is triggered our mind start searching our network of associations and activates memories and thoughts about possible related scenarios. If the mind is cued to act and the reaction led to conscious awareness the state of **evaluation** is reached. In this stage, our brain executes a cost-benefit calculation. In our mind, we review the benefits, compare them to the perceived costs and consider the alternatives of the evaluated action. If the decision to act has been made, the individual must be able to take the action immediately. The **ability** to act consists of four elements. The person needs to know what steps are required to take the action, a so-called *action plan*. The person must have the *resources* and the necessary *skills* to execute the action. The last element is known as self-efficacy and was originally defined by Albert Bandura [38]. The person needs to belief in the own success. The person must be sure that he or she can be successful at the action. The last precondition for conscious action is **timing**. If the person conquered the previous step and feels able to accomplish the action, but decides at the last second to do it later, the action is not performed. Acting immediately can be driven by urgency, specificity and consistency. Urgency is the most

vigorous attribute to force immediate action. It is split in external and internal urgency. Specificity means to put a specific time on an action. This works as a reminder and pretends the moment when to act. When telling others about our commitment, people determine the 'when' and stay with it, due to personal consistency.

The Create Action Funnel

The five preconditions for conscious action can be illustrated as a leaky funnel: the CREATE[2] action funnel by Stephen Wendel [37]. It describes different activities the mind must perform to execute the desired action. For example, if there is a population of people who go through the theoretical funnel to enforce a target behaviour, not everyone will pass all stages of the funnel. In each stage people can drop out because of distractions or better alternatives. Each time people either drop out or make it through every stage, the next time they consider an action they start the process from the beginning. The different stages are not strictly separated and actually interact with one another. The weakness of one stage can be compensated by the others. Passing a stage highly depends on the person and on the particular situation. In addition, there is a variation every time the person passes the funnel. There are few things that may have changed since the last funnel walkthrough: the relationship to the action, the person itself or the environment. The CREATE Action Funnel acts as a manual to show where your potential users are dropping off. Preventing these drop-off needs further analysis.

Fig. 3: The CREATE Action Funnel by Stephen Wendel [37]

[2] **C**ue, **R**eaction, **E**valuation, **A**bility, **T**iming, **E**xecute action = **CREATE**

3 Defining a model for behavioural change – Urban Adventurer

3.1 Conceptual Design

Based on the CREATE formula follows a conceptual design for a prototype mobile app called **Urban Adventurer**. This app represents how behavioural techniques can be implemented in a mobile application and tests the utilized techniques in terms of usability. The application is basically a step counting app but with specially designed features to give the user the best premises for completing the target behaviour. Giving the premise of a realistic app, the following steps depict the design process, of course with a focus on behaviour change.

Outcome, Action and Actor

In case of behavioural change products, it is essential to predefine specific parameters that influence behaviour. Defining the product vision helps to specify the outcome of the experimental mobile application. In this case the product vision is ‘helping people to exercise more’. When working out the details in later stages of development, it can be adjusted to ‘helping people to do more low intensity endurance training’. Reaching the target outcome means, the user will get healthier in a motivating and fun way. The concrete change is a better state of health. To clarify the outcome there are a few questions that need to be answered:

(1) Which type of change is the application targeted on?

(2) What will be affected through the behaviour change?

(3) What parameter changes using the application?

(4) When should the product make an impact?

In the case of Urban Adventurer, the application is targeted on a biological change (1), more precisely on a change of health parameters in the human body (2). Regarding later steps of evaluation, the outcome should be carefully worded and measurable. Metrics must be defined to determine if the product is successful or not in later steps. For this example, the resting heart rate was chosen as a meaningful criterion to measure success (3). Naturally this biological value changes in a few months (4). Regarding this outcome there are several actions for users to take. A lower resting heart rate can be achieved by doing any kind of regular endurance

training. Examples are running, riding a bike, taking the stairs, hiking or just walking. In the process of finding the ideal target action a ranking between the single actions is recommended (see Table 3). Even if it has not the highest impact on the target outcome, yet the method of walking was chosen to be the target action because user see it as an eligible method which is easy to perform.

Action	Impact on outcome	Motivation for user	Ease for user	Score	Ranking
Running	high	high	middle	8	1
Cycling	middle	middle	low	5	3
Hiking	middle	high	low	6	2
Walking	high	middle	high	8	1

Table 3: Ranking of different actions on the target outcome. Ranking: high(3), middle(2), low(1)

The impact on outcome is classified by the amount of stress the particular sport causes. It can be specified by the metabolic equivalent of task (abbr. MET) and depends on the participating muscles in each sport. Performing the activity ‘running’ involves more muscles than cycling and therefore has a higher energy expenditure and a higher impact on the outcome [39]. Another specification for the impact on outcome is the training scale, consisting of training frequency and duration. The motivation a user brings to different sports was conveyed through a survey that was conducted in Germany from 2015 to 2017 [40]. The ease for users to perform the different sports is determined by needed equipment and physical requirements. Walking is the most feasible activity. No equipment is needed and everybody can perform a walk. This suggests that a health and fitness app focusing on the activity ‘walking’ is most likely to change the behaviour of users.

Target audience and Personas

The target action is defined and needs to be applied on several user types. Personas were created to categorize different user profiles which can be addressed through the mobile application. The process of creating these personas began with some research in the scope of mobile health. According to a survey of Deloitte and bitkom, conducted in Germany, there are 16 million overweight people which are partly active [41]. This means that a lot of people do some physical activity because they want to get healthier. With a mobile application like Urban Adventurer, that aims to alter motivation and gives support, this group of people may get healthier in an easy and entertaining way. The survey also found out that already active people are more likely to pay for an app, with money or data. This means that our step counter app can be extended through a premium package with more features that are endorsed by

users. Another relevant survey was taken by Accenture. They commissioned a seven-country survey with 7,840 consumers to assess their attitudes toward healthcare technology among other things [42]. The survey was conducted between November 2015 and January 2016. Their results show that the use of health apps in the United States is most pronounced with consumers aged between 18-54. The HealthMine Digital Health Survey draws on data collected from users of internet-connected health devices and/or applications [43]. It was conducted in March 2016. The top findings include that the most popular tools among digital health users are fitness-, exercise- and pedometer apps. Furthermore, it shows that 32% of the respondents use their digital health tools 2 or more times per day. The respondents were also asked if the use of mobile health apps changed their behaviour regarding their health management. 76% of the people said it made them healthier. There is a perceived positive impact of health applications.

Based on these statistics three personas were created. In a classical user-centred design approach a persona is a fictional representative with a picture and a name. It is described in a narrative form to accomplish two goals. First, the persona should suggest a real person and secondly the narrative delivers a story and draws the needs of the persona in the context of the intended product [44]. The persona includes a description of the character, the desires, the dislikes, the specific needs and the personal goals. With this information, the designer can approve his design decisions in the first step, or he/she can ask the question what the persona would do or not do in a specific situation. A well elaborated persona is the equivalent of a specification sheet. It is a better imaginable version of the specification sheet.

Unlike traditional user personas, the personas used in the design process of behaviour change products are built differently. The aim of the method is the same, a better understanding of the user. But in this case, they are considered as groups of users who operate the application and interact differently. Furthermore, they are likely to respond differently to behaviour change interventions. Each of the personas should have information about the following topics: *prior experience with the action*, *prior experience with similar products and channels*, *relationship with the company or organization*, *existing motivation* and *physical, psychological or economic impediments to action* [37]. In the case of Urban Adventurer three different personas were created (see Table 4). In addition to the above-mentioned topics the personas were also examined in terms of self-efficacy, behavioural bridges, essential information to act and necessary skill-building exercises. Determining the self-efficacy of users can help to choose the right interventions for them. One factor that influences self-efficacy is the internal story or self-concept/self-narrative someone has. Within this self-concept we verify who we are. A method to affect the self-concept is called ‘story-editing’. The idea behind this method is that we can reinterpret the events that happened to us in the past by changing the story we tell ourselves about it [45]. We can change our self-narratives and shape our future behaviour.

	Couchpotato	Part-time athlete	Middle Ager
Experience with similar actions	Not really. Drives with public transport to work and back. No sports in spare time.	Takes the dog out once a day for a short walk.	In the warmer seasons he's hiking on the weekends with his wife.
Experience with similar products	Has heard of Runtastic and similar apps. Installed it once but never uses them.	Uses the free version of runtastic once in a while, but has no structured training schedule.	Uses a smartphone. Don't uses mobile applications for tracking.
Relationship to the company	None.	None.	None.
Existing Motivations around walking/exercising	No intrinsic motivation. But friends keep trying to motivate him and also his doctor said he should start to exercise.	Tries hard to keep in shape, but only makes it once a week to the gym.	He likes to hike, and experiences it as a pleasant outdoor activity. He's into low-intensity physical activity to stay healthy.
Hard barriers to action	Once he is at home, he turns on his laptop and starts gaming.	Tight daily routine (full-time office job, household, pet)	Although he uses his smartphone on a daily basis, he needs a clean and intuitive application to avoid early dropout and frustration.
Sample bio	John is 26, single, knows he should do something for his health but can't motivate himself. He is slightly overweight, has a high pulse due to inactivity and he likes computer games.	Jane is 33, engaged with her boyfriend, has no time (perceived) for a regular training schedule. She tries to stay healthy, in order to appeal to her fiancé. Due to moderate stress her heart rate is a bit too high.	Richard is 45, married, works as department manager and likes to show his fellow workers pictures from his weekend hiking trip. He knows that reaching a certain age demands a focus on activities to promote health.
Self-efficacy of users	low Story-editing (short): "Starting from Lvl 1 can be difficult, but it starts with one little step to achieve continuous progress!"	medium Story-editing (short): "You are already managing multiple tasks successfully. Now it's time to merge these tasks and create time for exercise!"	high Story-editing (short): "You are already an enthusiastic hiker. Now it's time to become an *Urban Adventurer*!".
Behavioural bridge: positive experiences -> target action	Level-up like in computer games	walking with the dog	experience something new while hiking
Essential information before taking the action	Information about the pursued goal. Remaining steps for today.		
Skill-building exercises or experiences for later steps	Motivating oneself and others to carry on the newly acquired behaviour.		

Table 4: Specific Personas for the design process of a behaviour change product

Behavioural Plan and User Journey

To get a better understanding of the user, a behavioural plan and user journey was created. It is the described process of steps the user must take to perform the target action. It contains both characteristics within the application and characteristics in the environment outside of the application. Additionally, it draws out what the application must do to encourage the user for the necessary steps. It is the path a user takes through your application or website [46]. In this case the user journey is adapted to behaviour change and illustrates the stages the user goes through until the target action of walking is achieved and subsequently maintained as new behaviour (see Fig. 4). Partitioned to the different stages are steps that describe the environmental and in-app arrangements. These steps are preliminary to reach the certain stage. The first stage is *awareness*. Users may be aware of an issue if they experience any associations to it through their own thinking. This thinking can be initiated through environmental cues and/or through cues and reminders out of an application. In this application, the environmental cues may be the look on the scale, a fitness test or the daily stress of squeezing into public transport vehicles. The second stage is *consideration*. This stage could be skipped if there is no conscious decision to be made because the behaviour is already a habit. If not, conscious thinking is required. A lot of issues must be concerned to raise the chance of reaching the next stage. The application can support this process by showing achievable goals and short-term benefits of the new behaviour. If the user leaves the consideration stage with a positive attitude of the target behaviour he enters the *action* stage and performs the target action for once. While executing the action, the application gives feedback about the current step counts and shows milestones. If the user builds intrinsic motivation and regularly receives reinforcements, he/she reaches maintenance state.

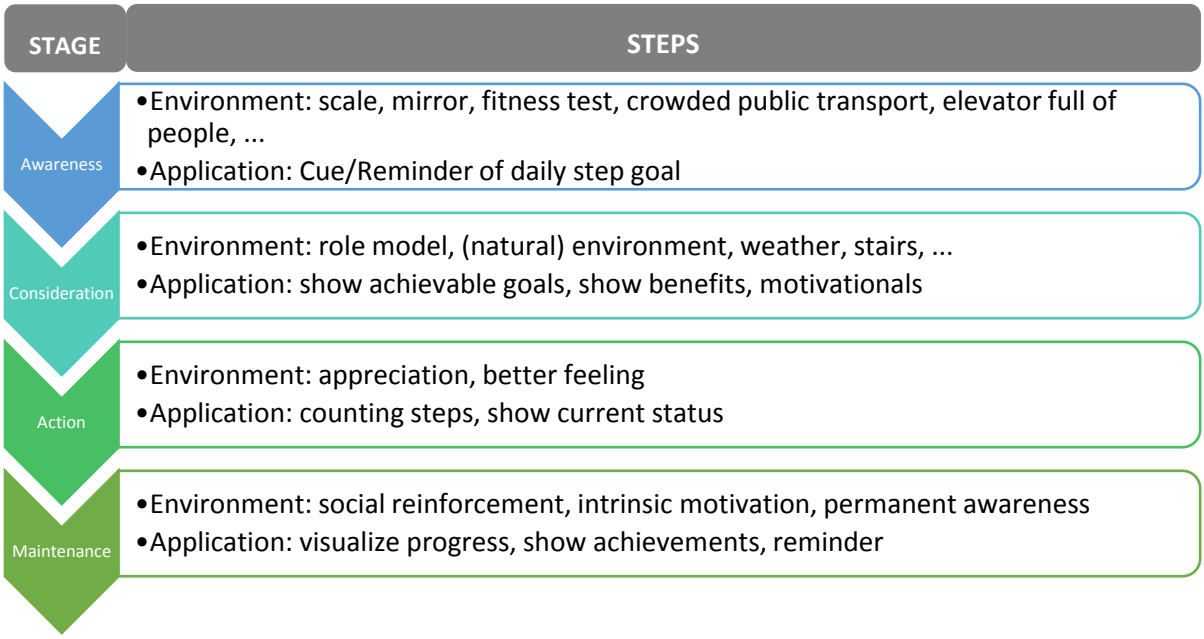


Fig. 4: Modified user journey for behaviour change. Based on the use of Urban Adventurer

3.2 Designing the application

The program that was used to develop the prototype of Urban Adventurer is called ‘Mockplus’. It is a rapid prototyping tool which allows to drag and drop design elements into templates of web- and/or mobile applications. To create an interactive design, the single elements can simply be linked by drawing a line. In the following chapter are some screens out of the application to illustrate the implementation of different behaviour change techniques (abbr. BCT). With all the information gathered through research in the field of behaviour change and product design, the mock-up of Urban Adventurer can be made. As already mentioned there is a taxonomy of 93 behaviour change techniques [16] that can be used in a mobile application. Based on this taxonomy Edwards et al. screened all top-rated medical, wellness and health and fitness apps that include gaming elements to find out which behaviour change techniques (abbr. BCT) were used [34]. They found out which behaviour change techniques are used the most and illustrated each of the techniques and their incidences in health apps. They also found the most common technique combinations used in these apps. The mostly used combination is goal setting, self-monitoring, non-specific reward and non-specific incentive. To examine the full range of BCT, it was considered to implement the rarely used techniques in the prototype. The following list shows rarely used techniques according to Edwards et al. [34]. Beneath the explanation of each technique [16] an example will be given in the circumstance of the experimental prototype. The prototype of the mobile application was designed in German language due to the reason that it is more comfortable for the German speaking test users.

List of rarely used behaviour change techniques - Implementation in the test design

(1) Review outcome goals

- Review the outcome goals together with the user and consider modifying their daily goals or even add additional goals.
- Example: Examine how much steps the user has walked and consider modifying their daily goal.

(2) Monitoring of behaviour by others without feedback

- Observe or record the number of steps the user takes, with the user’s knowledge.
- Example: User knows that his steps are recorded and tries to reach the goal.

(1)

(2)

(3)

(3) Monitoring of outcome(s) of behaviour without feedback

- Observe or record the resting heart-rate (= outcome) with the user's knowledge.
- Example: User can measure heart-rate and sees the history of the last measurements.

(4) Social support (emotional)

- Advise on, arrange or provide emotional social support
- Example: Give an opportunity to build teams with friends and co-workers.

(5) Information about health consequences

- Provide information about health consequences of performing the behaviour.
- Example: Explain that walking daily decreases the resting heart-rate which leads to longer life expectancy.

(6) Information about emotional consequences

- Provide information about emotional consequences of performing the behaviour.
- Example: Explain that daily activity increases happiness and satisfaction.

(7) Associative Learning

- Use an already positive stimulus to change a neutral stimulus to a positive one.
- Example: The user can invite his friends to a coffee in the city and everyone gets there by foot.

(8) Generalisation of target behaviour

- Advise to perform an already learnt, wanted behaviour, in another situation.
- Example: Often at the café? Invite your friends to walk with you there.

(9) Self-reward

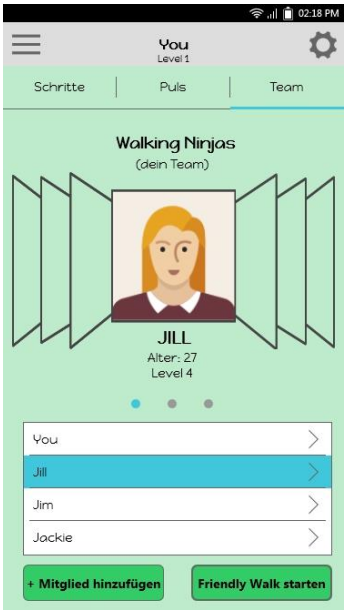
- Plan to reward oneself in the future if there has been progress in performing the behaviour.
- Example: User can set a 100,000 step goal (goal setting, behaviour), to remain motivated a reward can be purchased after the goal is reached.

(10) Incentive (outcome)

- Inform the user that a reward will be delivered if there has been progress in achieving the behavioural outcome.
- Example: Inform the user that he will earn a badge when the resting heart-rate is lower than before.

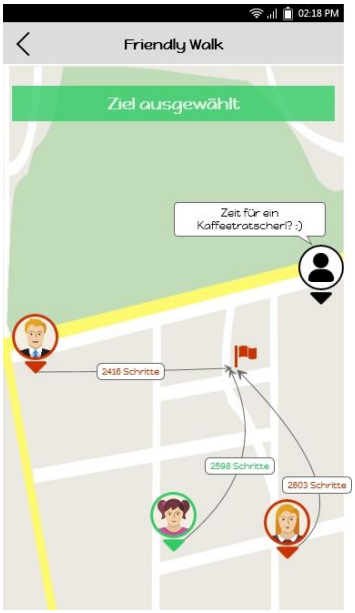
(11) Identification of self as role model

- Inform that the user's behaviour may influence the behaviour of friends and family in a positive way.
- Example: Inform the user that if they reach a higher level they can influence other team members.



(4)

(5) (6)

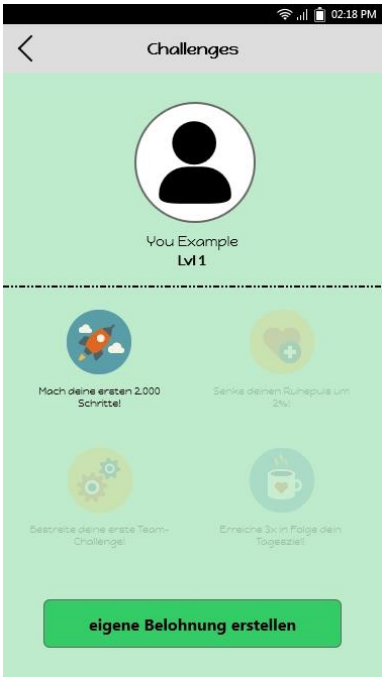


(7) (8)

(12) Reward approximation

- Arrange for reward if the user makes progress towards the target behaviour, gradually rewarding only if the user gets still closer to the target behaviour.
- Example: Arrange reward for any increase in step counts, gradually requiring the step goal to become closer to the planned/committed daily goal.

(9)



(10) (12)

(11)

4 Usability testing of the behavioural change prototype

4.1 Test design

One of the major issues of this usability test is to meet the special requirements of a technical and behavioural analysis of the participants way of proceeding. The test will be separated in two parts. The first one is the technical part which consists of tasks to be solved in the prototype. These tasks are designed to analyse standard usability metrics like scenario completion, critical/non-critical errors and time on task. The results will show if the implementation of behaviour change techniques is effective and user-friendly. The second part of the test consists of short questionnaires to gather intentions and background information of the participants minds while performing the tasks and afterwards. The guidelines and usability metrics used in this test are based on the usability guidelines of the U.S. Department of Health & Human Services [47].

Target group and focus

The participants of the usability test must meet the inclusion criteria. The test addresses people who use their smartphone for personal health and fitness issues. With their knowledge and experience they should be able to fulfil the tasks successfully. The test will be carried out with 10 people that meet the inclusion criteria. The testing process will be documented through video and audio capture. While performing the tasks in the prototype a screen and voice capture will be running on the test device.

Test process

- Welcoming the participant and describe the major goal of the test situation. Before the test starts there is a short briefing about the process of testing.
- If there are any questions from the participant regarding the test process itself, they will be settled before the test starts.
- The user will answer two questionnaires. One of them is the short, self-administered version of the International Physical Activity Questionnaire (abbr. IPAQ) [48]. The other one is a two item questionnaire based on an algorithm to define the stages of change in physical activity [49], [50].
- Before the practical part of the test starts, the test supervisor explains the necessity of audio and video recording for later analysis and hands over the declaration of consent.

- The supervisor hands out the task list and points out that the participant should read and think loudly while performing the test.
- If all the tasks are completely performed, the participant must answer one last questionnaire which aims to gather demographics, information about smartphone and app usage and information about the perception of behaviour change interventions.

Screen recording

The subsequent analysis reconstructs the participants way of proceeding and measures the stated metrics. This can be done through the recorded screen and the audio captures of the test device. If the participant followed the instructions and thought loudly there is additional evidence for analysing usability.

4.2 Usability metrics in detail

These metrics help to measure user performance on specific tasks.

- Scenario completion

  The participants get specific scenarios to fulfil. The scenario will be marked as completed when the participant indicates the goal has been obtained, whether it is successfully or not.

- Critical errors

  If the participant gets the wrong data or the prototype reports the wrong data due to the participants workflow, it is considered a critical error.

- Non-critical errors

  These errors may stay undetected by the participant or if they appear they can be recovered by the participant. They have no impact on the final output, but they highlight a task as less efficient.

- Subjective evaluations

  These evaluations concern the ease of use and the satisfaction and can be determined through questionnaires. In this special case the questionnaire aims to evaluate the impact on health behaviour.

- Scenario completion time (time on task)

  Indicates the time the participant needs to complete a specific scenario.

4.3 Measurements and analysis

This chapter gives a brief overview about the process of measuring and analysing the captured data in the usability test. The data acquisition is performed through recording the screen and microphone signals while participants do the practical part of the test. Furthermore, the participants fill in questionnaires before and after the usability test. Prior to the test they fill in two short questionnaires about their current physical activity level [48] and their actual position in the adapted 'Stages of Change'-model for physical activity [49], [50]. After the test, the participants fill in a questionnaire about smartphone usage, app usage and specific questions about the tested prototype. The questions about the prototype aim to evaluate the perception of the behaviour change interventions implemented in the prototype.

4.3.1 Usability Goals

Further analysis will reference to usability goals listed below. The tested prototype is in experimental stage and its purpose is to measure usability metrics but also to highlight the potential impact on physical activity behaviour. Therefore, no specific goals are given yet. The measured datasets are compared among each other and may reveal connections between usability metrics, activity, readiness for behaviour change and behaviour change interventions.

Completion rate

Describes the percentage of test participants who successfully complete the required task without critical errors. Successful means that participants must reach the correct output. Tasks where the participant requires assistance count as critical errors.

Error free rate

The error-free rate is the percentage of participants who complete the task without critical or non-critical errors.

Time on Task (ToT)

The 'time on task' is the time to complete a scenario. It starts at the moment when the participant has read the scenario or task and ends when he/she signals the completion of the task.

4.3.2 Measurement

The usability metrics are measured through the analysis of the synchronised audio and screen capture within the test device. The scenario is marked as complete when the participant reaches the predetermined goal, which was specified by the test supervisor. The 'scenario completion time' or 'time on task' is defined as follows: The time the participant needs between

completely reading the task and his/her acoustic signal of completion. While the participant is taking the test, the supervisor identifies critical and non-critical errors. In addition, the supervisor takes notes for further subjective evaluations. A data table was created to capture the information from the usability test for each participant. The columns show the four usability metrics which are measured. The rows indicate the task itself and the category of behaviour change intervention the task belongs to (see Table 5).

P001		Scenario Completion (yes/no)	Time on task (sec)	Critical Errors (amount)	Non-critical errors (amount)
Login	Task 1				
Review and monitoring of behaviour and outcomes	Task 2				
	Task 3				
Social Support	Task 4				
	Task 5				
Information about health and emotional consequences	Task 6				
Associative learning and generalisation of behaviour	Task 7				
Rewards and incentives	Task 8				
	Task 9				
	Task 10				

Table 5: Data table template for usability metrics

Among the usability metrics the physical activity and the stage of change was measured. The documents to measure these attributes already exist. One is the short version of the International Physical Activity Questionnaire (abbr. IPAQ) [48] and the other one is an adapted version of a behaviour change questionnaire, aiming at the readiness to change physical activity behaviour [49], [50]. The third questionnaire, after the usability test, was generated in the context of this thesis. Data from this questionnaire was collected in another data table. It contains the overall data of every participant. The items of the questionnaire are categorized in demographic data, data about smartphone and app usage and data concerning the prototype from the usability test (see Table 6). As the questionnaire was designed in German language some of the items are verbalised in German too.

Nr.	Item	P001	P002	P003	P004	P005	P006	P007	P008	P009	P010
I	Geschlecht										
II	Alter										
III	Gewicht										
1	Besitz Smartphone										
2	tägliche Nutzung Smartphone										
3	Nutzung von Apps										
4	3 wichtigsten Apps										
5	Health Apps										
6	Nutzung Health Apps										
7	Intuitiv										
8	Darstellung Daten										
9	Übersichtlich										
10	Privat nutzen										
11	Review and monitoring of behaviour and outcomes										
12	Social Support										
13	Consequences: health and emotional										
14	Associative learning and generalisation of behaviour										
15	Rewards and incentives										
16	Identification as role model										

Demographische Daten
Smartphone-/App-Nutzung; allgemein
Urban Adventurer

Table 6: Data table for the questionnaire about smartphone and prototype usage (in German).

4.3.1 Analysis of questionnaires about physical activity and stages of change

The data of the questionnaires were analysed differently. Data from the IPAQ was entered in the automatic report tool from Di Blasio et al. [48] to measure the activity level of a participant. The IPAQ divides participants in three activity levels:

HIGH - This category describes higher levels of participation in physical activity. The IPAQ Research Committee proposes a measure of at least one hour per day or more, of at least moderate-intensity activity or an amount of activities which can be equated to this measure.

MODERATE - This category is proposed as a level of activity equivalent to half an hour of at least moderate-intensity physical activity on most days.

LOW – This category is simply defined as not meeting the criteria for either of the previous categories.

To analyse the data of the ‘Stages of Change’ questionnaire an excel file was created, using the algorithm from Baum et al. [50] to determine the stage of change by filling in the answers of the participant. Depending on which answers are given in question 1 and 2 the algorithm shows the stage of change the participant is in (see Fig. 5):

Precontemplation – It is considered as the stage where people have no intention to change their behaviour in the near future, e.g. in the next six months. Many of them have no awareness

regarding their problem and insufficient knowledge about long term consequences of their actual behaviour.

Contemplation – In this stage people experience awareness regarding their behaviour. They think about changing in the next six months. However, they are not entered into a commitment yet.

Preparation – People in this stage express their intention to change their behaviour within the next month and already tried to change in the past.

Action – Reaching this stage means that people were actively structuring their behaviour, experiences and their environment in the last six months to solve their problem. This stage requires a huge amount of energy and time.

Maintenance – The fifth stage describes people who maintain their achieved changes in behaviour for more than six months. The practice of learned skills and strategies finally gets routine.

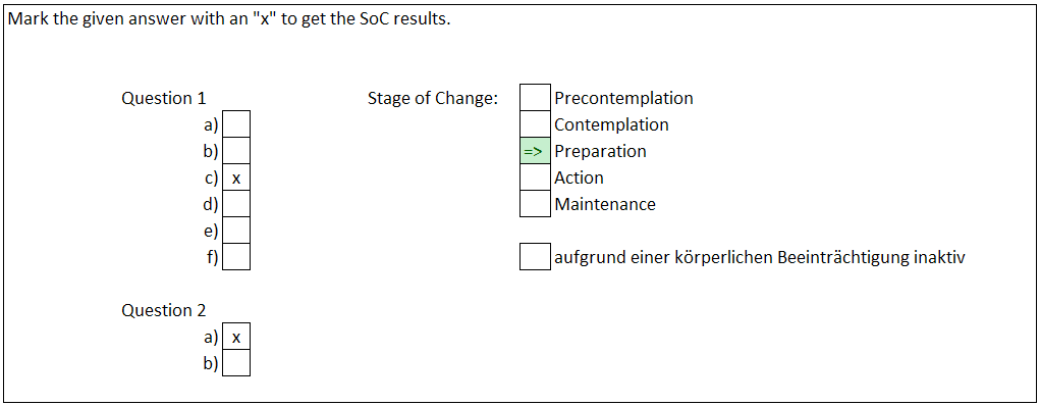


Fig. 5: Excel form to determine the 'Stage of Change', based on the algorithm of Baum et al. [50].

4.3.2 Analysis of usability metrics

The analysis of the usability datasets was conducted in Microsoft Excel. The rates and means of the usability metrics were calculated and visualized in diagrams if adequate. Analysing the usability metrics in the first instance means to calculate the completion rate, the error-free rate and the time on task. The completion rate can be figured out by counting the successfully finished tasks proportional to the unfinished tasks. The same procedure can calculate the error-free rate. The only difference is to oppose tasks without critical or non-critical errors and tasks where errors occur. First step to analyse the time on task variable, every task was handled separately to see if there are major differences between users. Second, for all time values from each task the geometric mean was computed. According to Sauro and Lewis [51] the best way to find the estimate of the middle task time, for sample sizes less than 25, is the geometric mean. It has less error and bias than the median or (arithmetic) mean.

5 Results

This chapter is split in three parts. The first part shows the baseline characteristics of the participants and their results from the questionnaires about physical activity and stages of change. This is followed by the presentation of the specific data from the usability test and the general usability metrics. The last part of this chapter will show data connected with the implemented behaviour change interventions in the prototype.

5.1 Baseline Characteristics

Baseline characteristics	
Variables	**N (%) Total = 10**
Gender	
Male	5 (50)
Female	5 (50)
Age	31,6 (±11,9)
Weight	74,7 (±11,9)
Smartphone possession	
yes	10 (100)
no	0 (0)
Daily Smartphone usage	
less than 1h	0 (0)
2-3 hours	7 (70)
more than 3 hours	3 (30)
App usage in general	
yes	10 (100)
no	0 (0)
3 most important Apps	
Whatsapp	8 (80)
Instagram	7 (70)
Facebook	4 (40)
Installed Health Apps	
yes	8 (80)
no	2 (20)
Health App usage	
daily	4 (50)
3-4x/week	0 (0)
1-2x/week	2 (25)
never	2 (25)

Table 7: Demographics and data about smartphone usage

The baseline characteristics of the participants who completed the questionnaires and attended at the usability test are shown in Table 7. The group of participants had a mean age of 32 (±11,9) years and had an equal distribution of both genders. The mean weight was found at 75 (±14,7) kg. This variable was relevant to determine the average weekly energy expenditure through the International Physical Activity Questionnaire (abbr. IPAQ). 100% of the participants were in possession of a smartphone, further they used mobile applications on their devices and therefore met the inclusion criteria for the usability test. Most of the participants used their smartphones 2 to 3 hours daily, while some of them use it for more than 3 hours a day. Participants were encouraged to name their three most important apps. 80% mentioned the mobile application ‘WhatsApp’ in their list of the 3 essential apps on their phone. Many participants also mentioned ‘Instagram’ (70%) and ‘Facebook’ (40%) as essential applications. Eight participants have installed health apps on their smartphones and 50% of them use this type of apps on a daily base.

Beside the demographic data, two questionnaires collected information about the current physical activity level and the stage of change the participants are in (see Table 8).

Activity Level and Stage of Change	
Variables	**N (%) Total = 10**
Current Activity Level	
High	5 (50)
Moderate	4 (40)
Low	1 (10)
Current Stage of Change	
Precontemplation	0 (0)
Contemplation	2 (20)
Preparation	3 (30)
Action	1 (10)
Maintenance	4 (40)

Table 8: Distribution in Activity Level and Stage of Change

Half of the participants were stated ‘high’ in terms of their activity level. The second largest part of the group is on activity level ‘moderate’ and only one participant was on activity level ‘low’. The participants were distributed on following stages: While no one meets the criteria of the first stage ‘Precontemplation’, two participants are categorized in the stage ‘Contemplation’. This means they think about changing. Three participants of the questionnaire are in ‘Preparation’ stage and already tried to change in the past. One person is in the ‘Action’ stage and four others reached the ‘Maintenance’ stage. The last two groups differ from the other ones as they show that people in these stages are already active.

5.2 Usability Metrics

There are three main metrics that were recorded and analysed: task completion, time on task and occurring errors while testing the prototype. The task completion analysis has shown that 95% of all attempts were successful. Only 5% of the predetermined tasks were not completed. The majority of incomplete tasks is found in Task 3 of the prototype task list and belongs to the behaviour change technique category of ‘Review and monitoring of behaviour and outcomes’. The time on task variable was measured for each single task. Every task got one time-value from each participant, resulting in a total of 10 values. The geometric mean of the collected task time was computed for each task (see Fig. 6). The overall mean task time was 27.4 seconds with a standard deviation of 12.3 seconds. To classify the weight of each task, a pareto diagram with the mean time on task values was created (see Fig. 7). The errors that occurred during the usability test were separated in critical and non-critical errors. The summarized data of each participant showed that 5 critical errors appeared. Two of these critical errors appeared at Task 10 of the task list. Non-critical errors appeared 29 times, most frequently in the categories ‘Review and monitoring of behaviour and outcomes’ and ‘Associative learning and generalisation of behaviour’. Based on these numbers the error-free rate was computed. Regarding all tasks and critical errors, the overall error-free rate is 60%. Including also non-critical tasks the error-free rate scales down to 20%. The error-free rates for each task reach from 40% to 100% (see Fig. 8).

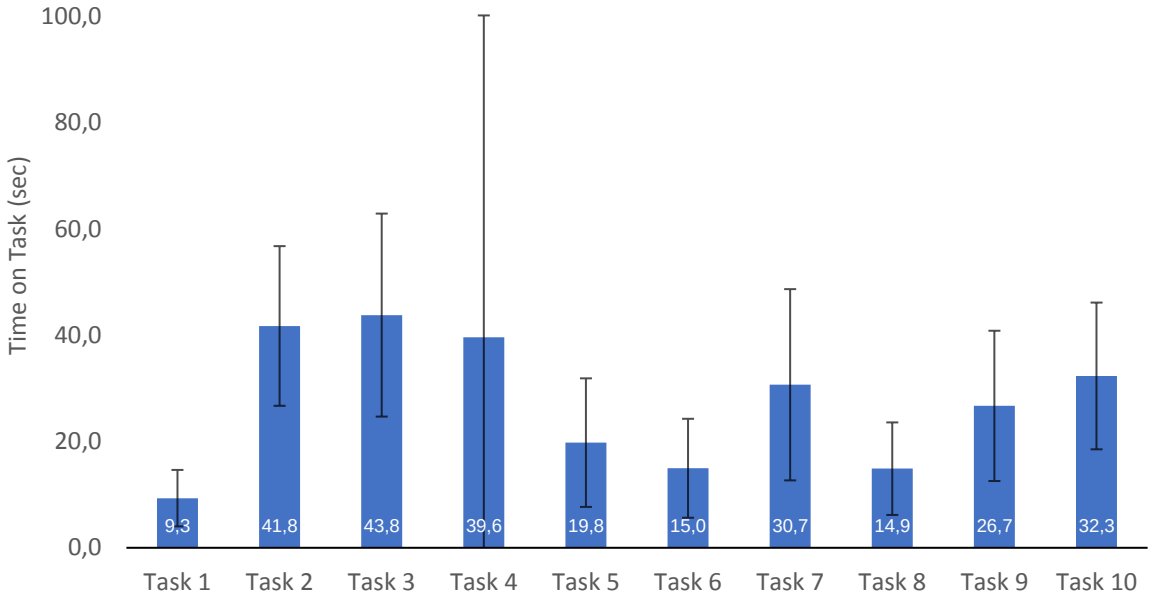


Fig. 6: Geometric mean of the collected times for each task. Including standard deviation.

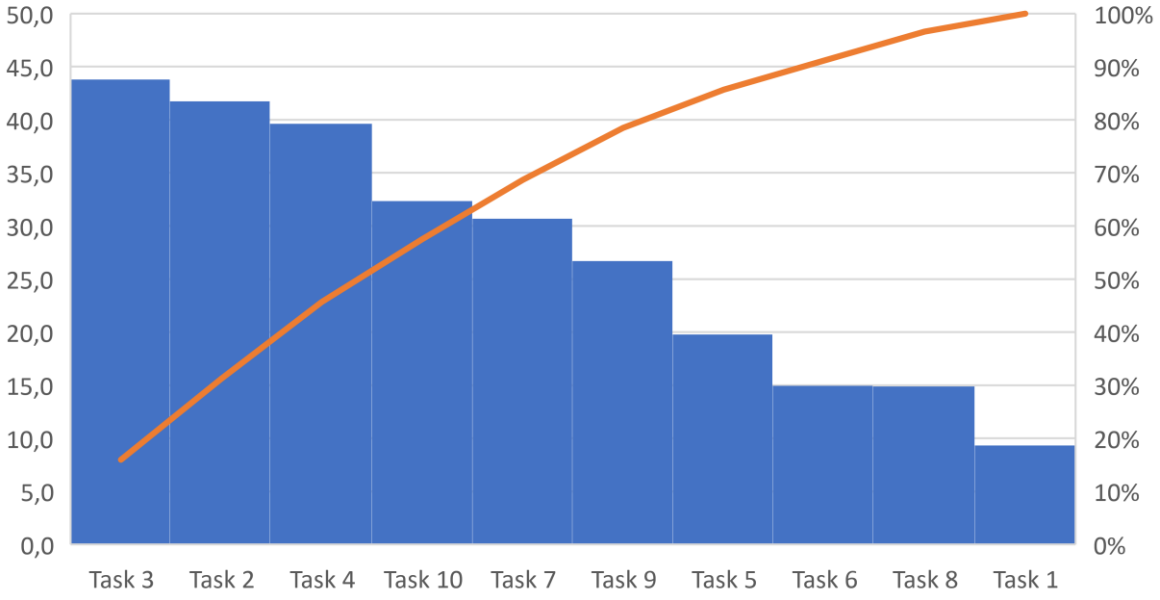


Fig. 7: Ranking based on cumulated times for each task and their share of overall task time

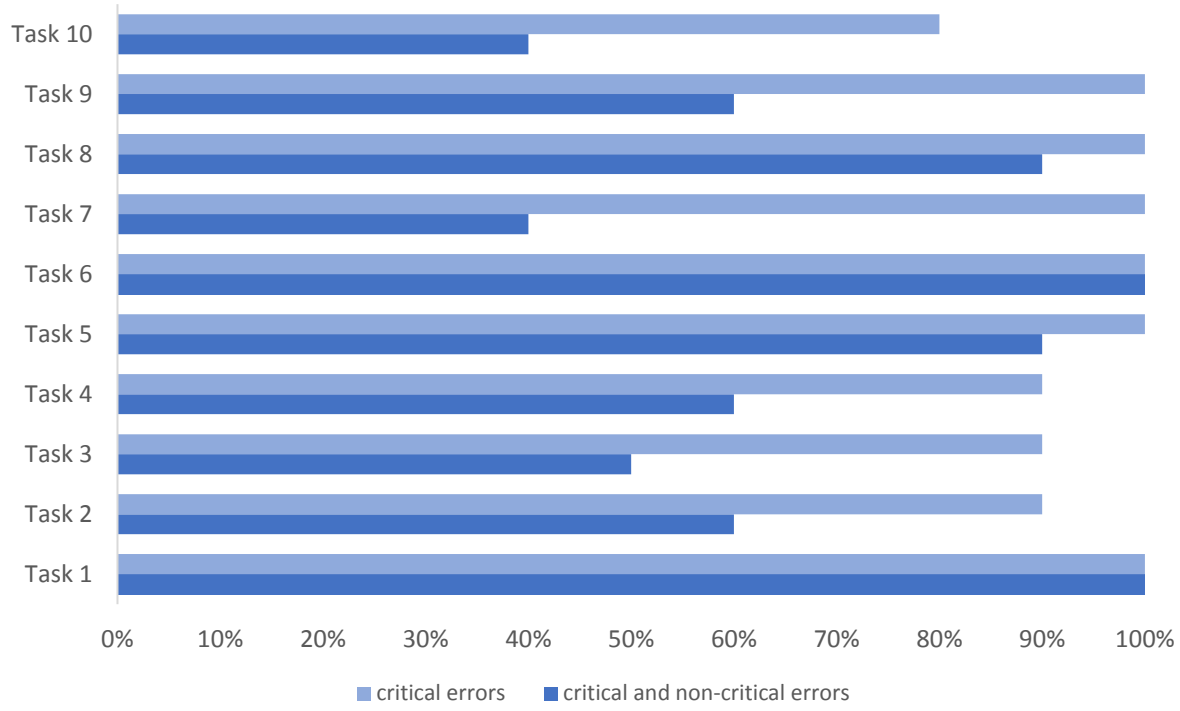


Fig. 8: Error-free rates for every task. Including critical and non-critical errors

5.3 User Experience with behaviour change techniques

Effect on motivation (clustered)

Cluster	BCT Likert Score
Activity Level	
High	2,0
Moderate	2,0
Low	1,2
Stage of Change	
Contemplation	1,6
Preparation	1,9
Action	2,2
Maintenance	2,0

Fig. 9: Effect on motivation in different participants groups

Beside the demographic data in Table 7 the last questionnaire enquires also specific information about the tested prototype. The first four questions were about the handling of the prototype. Participants were asked if the app is intuitive, informative and clearly structured. One question was about the potential further use of the prototype. 6 out of 10 participants found the prototype very intuitive. Seven participants say that the prototype is very informative and clearly structured. Six participants would fall back on the prototype for private use and only one participant would not use it for private purposes (see Fig. 10). The final part of the questionnaire covered the effect on

motivation through behaviour change techniques (see Fig. 9). A value of 1 means a strong effect on motivation and a value of 5 means no effect at all. Six categories of behaviour change techniques were implemented in the prototype and these categories were tested in the questionnaire. The categories ‘Rewards/Incentives’ and ‘Associative Learning/Generalisation’ meet with the approval when it comes to a positive influence on behaviour (see Fig. 12). Interventions informing about ‘Health and emotional consequences’ found neutral to negative consent according to participants. ‘Review and monitoring’, ‘Social Support’ and being a ‘Role model’ found moderate agreement within participants. Strong disagreement from at least one participant was found in ‘Review and monitoring’, ‘Rewards/Incentives’ and ‘Health/Emotional consequences’ (see Fig. 11).

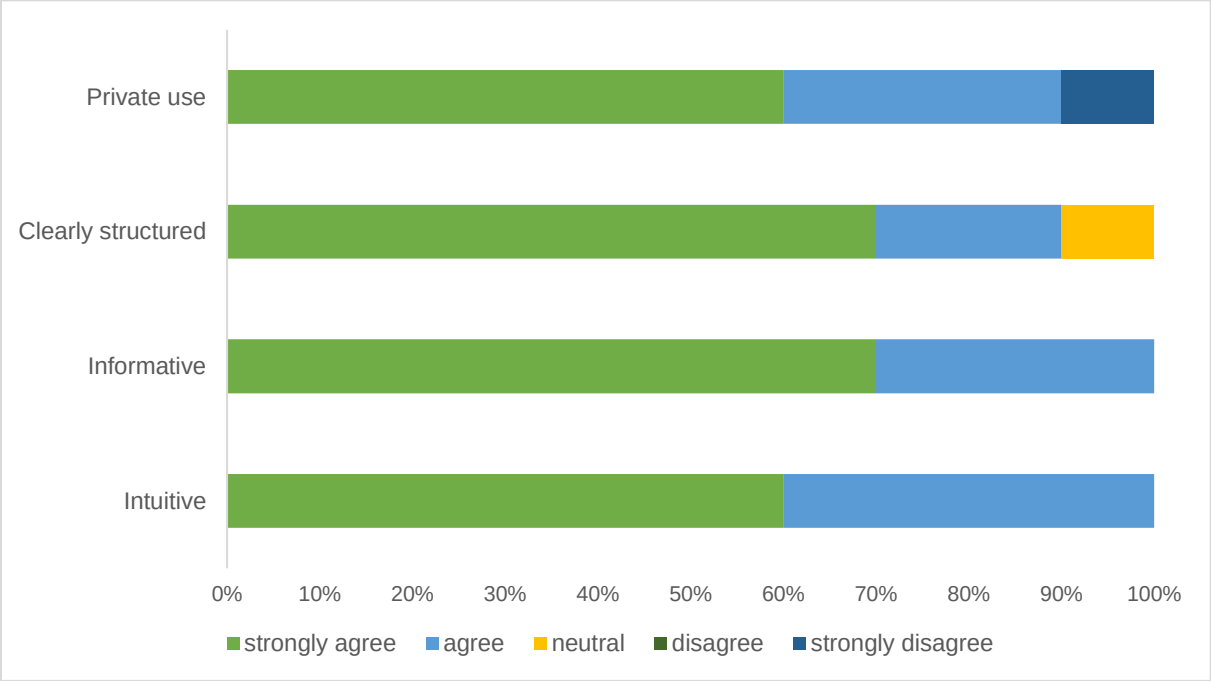


Fig. 10: General feedback about the prototype

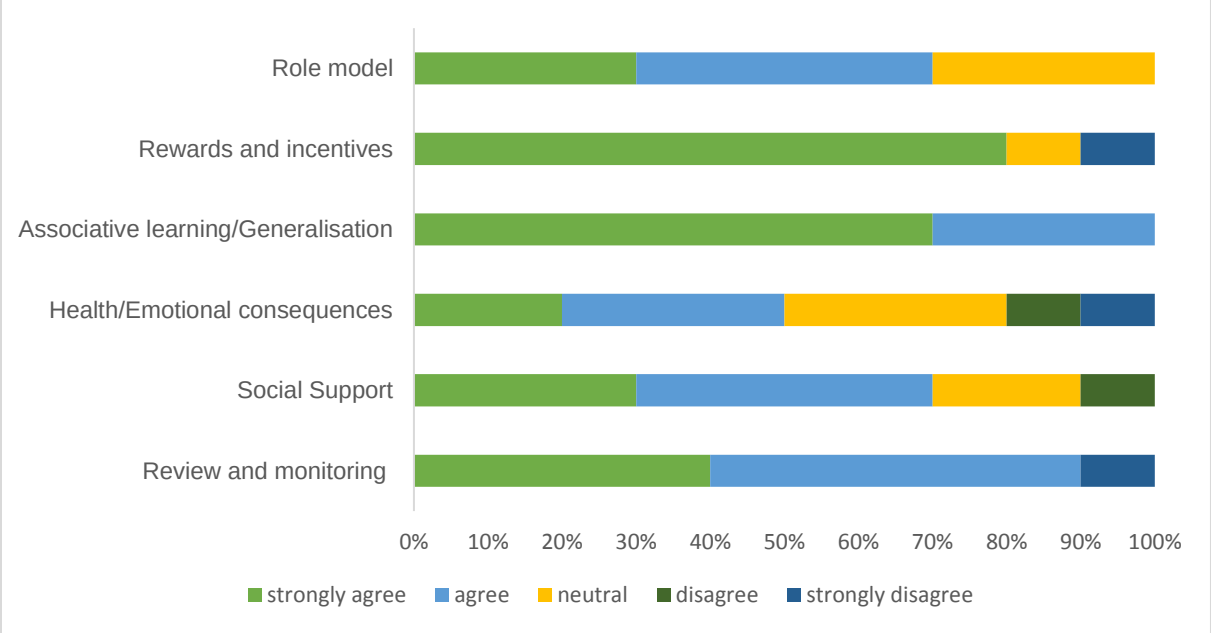


Fig. 11: Consent on implemented behaviour change techniques affecting motivation

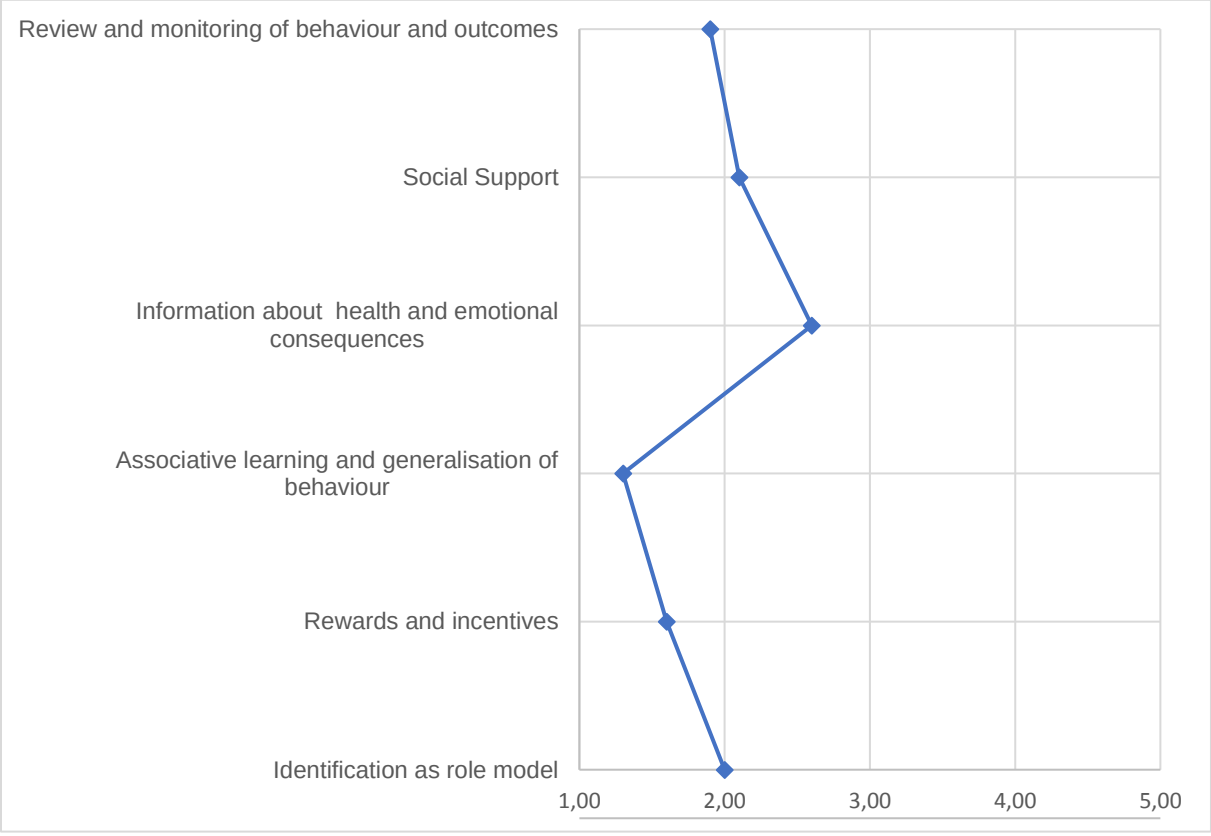


Fig. 12: BCT Likert-Score regarding all participants (1 = highly motivational, 5 = not motivational)

6 Discussion

This paper focused on testing usability and user experience of specific behaviour change techniques implemented in a health application prototype. The methods used to gather results were a usability test and questionnaires. The main aspect which should be highlighted is the effect on motivation for health behaviour change. Therefore, the number of participants to test was set to 10. A standard usability test, aimed at finding most of the usability problems, would set the participant count to 5 or above [52]. In case of this paper the usability test was extended with specific user experience requirements for motivation-focused behaviour change analysis. The measurement of behaviour is based on subjective evaluations and therefore the test focus was on qualitative findings. Although quantitative usability metrics were measured to support qualitative findings, but they were not the main goal of this test.

Smartphone and mobile app usage

The inclusion criteria for participation at the test were the possession of a smartphone and the usage of mobile applications on the smartphone. All participants possessed a smartphone and used installed applications on their phone, so no participant was excluded. The subjective estimated screen-time of 7 participants results in 2-3 hours per day. 3 Participants use their smartphone more than 3 hours daily. A 2016 study of Christensen et al. with 653 participants shows an average screen-time of 1,48 hours. Their paper indicates association between younger age and longer average screen-time [53]. The mean age of their participants above the median average screen-time is 44,2(±11,9) whereas the participants of this paper have a mean age of 31,6(±11,9). The younger age of these participants could be a reason for the higher stated screen-time. The results of the questionnaires have shown that the most installed apps belong to the categories of messaging and social media services. These findings correspond with the previously cited Yahoo! Report [6]. 8 participants have installed health apps on their smartphone. 50 % of these participants use the health apps on a daily base, 25% use them once or twice a week and 25% never use them. According to the W3B-Report “Trends im Internet” uses every third smartphone user in Germany a health app [54]. Their data shows a more frequent use in younger people. The ‘HealthMine’ report shows that 50% of all health app users use fitness apps [43]. The higher amount of health app users in the available sample may arise from a higher activity level in the sample than in the average person. The results of the IPAQ show a percentage of 50% highly active and 40% moderate active participants. Only 1 participant in the available sample is categorized with low activity. Also, the low mean age of the tested participants plays a role and may indicate the higher use of health apps.

Usability Metrics

The analysis of the usability metrics has shown that the wording of the task description was comprehensible and the tasks itself feasible. 95% of all tasks were completed. With 2 out of 10 attempts marked as incomplete, task 3 listed the most incomplete attempts of participants. In task 3 the participants were asked to measure their resting heart rate. As a matter of design this task is more complex than others. Four steps were needed to complete this task whereas other ones can be done in one step. The analysis shows also an accumulation of errors at task 3. One critical and four non-critical errors occurred, which means that several participants had problems in fulfilling this task. A possible explanation would be an insufficient task description. The description of task 3 was held short and simple, maybe too short in case of this rather complex task. The visualization of the cumulated task times for each task, support the assumption that task 3 was too difficult to perform for participants (see Fig. 7). It shows that this task holds the highest percentage of the overall task time. Fig. 6 shows the absolute numbers of the calculated geometric mean task times. Each value was computed from all participant times who completed the specific task. The standard deviation of task 4 is very high. The reason is a long-lasting attempt of one participant. The participant hung on and completed the task in 207 seconds. This outlier caused the high standard deviation.

Although no specific goal was set for the overall error-free rate, 6 out of 10 error-free tasks regarding all participants is considered as a good benchmark for a first prototype. This rate excludes documented non-critical errors. If the non-critical errors would be included the error-free rate would scale down to 20%. Nonetheless, this is still an acceptable rate referring to benchmarks from Sauro and Lewis [51]. Test designs with an iterative structure have the advantage of prototype optimization after the first test. The error-free rates in re-tests will be lower than the rates from the original test. The presented usability test was designed to collect the current state of motivational and behavioural conditions and the influence of behaviour change techniques on motivation. To measure the impact on motivation a questionnaire was handed over, but no re-test was planned.

From technical perspective every previously chosen behaviour change technique was implemented in the prototype. Some of them were implemented as part of the gamified content and others not. The feature ‘Information about health/emotional consequences’, which was implemented without gamified elements, has shown a lower effect on motivation for behaviour change (see Fig. 12). Before using behaviour change techniques in real-life applications, the design guidelines from Google or Apple should be considered. Thus, the chance is higher to avoid common mistakes and delivers a reasonable app experience from start. Subsequently, user engagement and user retention can be increased through selected behaviour change techniques.

Behaviour change techniques

The main findings show that each of the implemented behaviour change techniques (abbr. BCT) had a positive impact on participants motivation. The scores of the single BCT categories on the Likert scale were all below the value 3. The used Likert scale had a range from 1 to 5. A value of 1 equals to strong effect on motivation while a value of 5 means no effect at all. Regarding the mean values for each category of behaviour change techniques, computed through all participant data, the highest impact on motivation was reached in the categories of 'Associative learning/Generalisation' and 'Rewards/Incentives'. The latter in particular, is very common when it comes to gamification, i.e. to the implementation of game design elements in non-game contexts. Rewards often appear in the shape of badges which are defined as visual representations of success [55]. In this paper, badges were used as one behaviour change technique out of the category 'Rewards/Incentives'. The results show that the badges had a high impact on participants motivation as 8 out of 10 participants perceived it as strongly motivating. Still, it is not the category with the highest positive effect on motivation according to data. 1 participant claimed that there is no effect on his motivation through rewards and/or incentives. Another technique used to determine the effect of this category was 'Self-reward'. According to Edwards et al. [34] this technique is rarely used in smartphone apps. Ryan and Deci say that self-determination, in terms of goal-directed behaviour, is a major aspect for intrinsic motivation and regulation [56]. Therefore, this technique was used as part of the 'Rewards/Incentives' category and regarding the results it seems that self-determination had at least a positive influence on the perceived motivation boost in participants. The generalisation technique was simulated through a feature called 'Friendly Walk'. The participants were able to invite their friends to a meeting in the city. The prototype displayed the walking distance to the meeting point for every invited user. Aim of this feature was helping the user to associate the positive stimulus of 'meeting friends' with the activity 'walking'. Using this feature on frequent base will lead ultimately to a generalisation of 'walking' to meet friends, which would be a behaviour change. Although, the implementation of this behaviour change technique could be misunderstood due to a highly social component within it. It not only addresses associative learning and generalisation but also the BCT category of 'social support'.

According to available data, the prototype feature which addressed the BCT category of 'Information about health and emotional consequences' had the lowest impact on participants motivation. The implementation of this behaviour change technique was rather simple. The information about health and emotional consequences was placed in a designated area of the prototype. The related task was simply to call up this area. For this specific feature, no gamified elements were used. This could be the reason for the lower motivation-enhancing effect. Developing gamified elements to inform users about the consequences of behaviour change towards more activity and a healthier lifestyle may lead to open-minded users who are easier engaged in digital health measures.

Looking at the activity level and the current state of change in single participants, there seems to be a link between a higher activity and an advanced stage of change. 80% of all participants categorized with an activity level ‘high’ are in the state of ‘maintenance’ which means they maintain their current physical activity behaviour for more than 6 months. It seems that sportive people have an easier approach to stay in the maintenance stage once it is reached, without falling back to older behaviour. The main reason for this, is the fact that in case of physical activity the achievement of a high activity level is very desirable. Participants want to maintain this behaviour as long as possible. Once a generalisation of this physical activity behaviour is reached, it becomes even easier to maintain it, because it integrates in their daily life. For these participants the physical activity is no challenge but a routine. The stages of change in participants categorized with ‘moderate’ or ‘low’ activity range between ‘Contemplation’ and ‘Action’. This means that every one of them at least thinks about changing physical activity behaviour. Some of them think about a change in the next 6 months while others are already planning for change within the next month. One of the moderately active participants already adopts the new habit for at least 6 months.

The features of the prototype were designed to meet the requirements as behaviour change techniques. Through the last questionnaire the participants indicated the effect on motivation for behaviour change regarding the tested features in the prototype. Looking at the data from all three questionnaires leads to following findings: The prototype features had lower impact on motivation in participants with a higher activity level (see Fig. 9). One possible explanation could be the smaller need of motivators to engage in physical activity in already sportive people. They often have generalized the physical activity behaviour and show intrinsic motivation for exercising and therefore need less extrinsic motivation. Data also points out that some of the participants in different stages of change react differently to behaviour change techniques. For participants located in the stages ‘contemplation’ and ‘preparation’ the prototype features showed higher impact on motivation. Participants in the stages ‘action’ and ‘maintenance’ found the features less motivational (see Fig. 9). Data indicates that people who are already performing their new behaviour need less motivation enhancing features in their health app. However, due to the fact that just 6 out of 16 categories of behaviour change techniques [16] were tested, there is no certainty if people in higher stages of change need less motivators. The combination of other behaviour change techniques may lead to different results.

7 Conclusion

This paper provides an experimental test design to measure the impact on motivation through behaviour change techniques in health apps. The test was conducted in the setting of a prototypical step counter app. Making the setting as realistic as possible helped the participants to concentrate on their task, without being distracted by an obviously experimental setup. In combination with gamification approaches it showed a positive influence on motivation of test participants. To capture qualitative as well as quantitative data the participants filled in questionnaires and attended a modified usability test. Results have indicated there might be interrelations between the activity level and the current stage of change of participants and the effect of behaviour change techniques on their motivation. However, due to the special usability setup and a lot of variables this paper only took 6 out of 16 categories of behaviour change techniques into account. From the total of 93 defined techniques only 12 were examined in this paper. Considering all behaviour change techniques may reveal different combinations of them to serve the purpose of enhancing motivation for physical activity behaviour change. In this thesis some of the rarely used techniques were tested to determine if they could be implemented in smartphone apps, more precisely in health apps for physical activity. Results have shown that the technical implementation of the chosen behaviour change techniques is feasible, but with diverse effects. Overall the use of gamification elements was well accepted by test participants. According to their verbal statements after the test, it enhanced the fun factor of the prototype use. It is not effective to implement as much behaviour change techniques as possible in one application. Instead, future research should focus on evaluating different combinations of behaviour change techniques and the use of gamification as motivation enhancer.

8 Literature

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Appendix

Data tables

Table 1: Completion overview of all tasks and all test participants followed by completion rate

	P001	*P002*	*P003*	*P004*	*P005*	*P006*	*P007*	*P008*	*P009*	*P010*
Task 1	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Task 2	yes	yes	no	yes	yes	yes	yes	yes	yes	yes
Task 3	yes	no	yes	yes	yes	yes	yes	yes	yes	no
Task 4	no	yes	yes	yes	yes	yes	yes	yes	yes	yes
Task 5	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Task 6	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Task 7	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Task 8	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Task 9	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Task 10	yes	yes	yes	yes	yes	yes	no	yes	yes	yes
							yes		**95 %**	
							no		**5 %**	

Table 2: Results of the IPAQ and Stages of Change questionnaires

Participant	***Activity Level***	***Stage of Change***
P001	HIGH	Maintenance
P002	HIGH	Preparation
P003	LOW	Contemplation
P004	HIGH	Maintenance
P005	HIGH	Maintenance
P006	MODERATE	Action
P007	MODERATE	Preparation
P008	MODERATE	Contemplation
P009	HIGH	Maintenance
P010	MODERATE	Preparation

Table 3: Time on Task metrics for each task and the geometric mean of all participant times for the specific task

Task 1	
5	10
12	11
6	19
6	7
20	8
geom. mean	**9,3**

Task 2	
29	48
/	48
32	67
34	24
55	60
geom. mean	**41,8**

Task 3	
26	/
82	65
37	51
40	27
48	/
geom. mean	**43,8**

Task 4	
/	24
34	43
82	207
11	28
66	20
geom. mean	**39,6**

Task 5	
26	23
16	17
11	42
10	26
43	11
geom. mean	**19,8**

Task 6	
32	8
24	18
9	15
7	13
32	13
geom. mean	**15,0**

Task 7	
49	9
44	15
39	33
23	24
64	56
geom. mean	**30,7**

Task 8	
14	18
22	10
8	29
8	8
31	21
geom. mean	**14,9**

Task 9	
18	21
37	23
41	49
15	20
53	18
geom. mean	**26,7**

Task 10	
22	36
40	23
28	55
/	15
48	48
geom. mean	**32,3**

	ToT geoMean	**STD**
Task 1	9,3	5,32
Task 2	41,8	15,03
Task 3	43,8	19,11
Task 4	39,6	60,57
Task 5	19,8	12,10
Task 6	15,0	9,31
Task 7	30,7	18,00
Task 8	14,9	8,71
Task 9	26,7	14,14
Task 10	32,3	13,81

Total mean	**27,40**
Total STD	12,27

Table 4: Critical errors registered per task and participant

Critical Errors

		P001	P002	P003	P004	P005	P006	P007	P008	P009	P010	**Total**
Login	Task 1	0	0	0	0	0	0	0	0	0	0	**0**
Review and monitoring of behaviour and outcomes	Task 2	0	0	1	0	0	0	0	0	0	0	**1**
	Task 3	0	1	0	0	0	0	0	0	0	0	**1**
Social Support	Task 4	1	0	0	0	0	0	0	0	0	0	**1**
	Task 5	0	0	0	0	0	0	0	0	0	0	**0**
Information about health and emotional consequences	Task 6	0	0	0	0	0	0	0	0	0	0	**0**
Associative learning and generalisation of behaviour	Task 7	0	0	0	0	0	0	0	0	0	0	**0**
Rewards and incentives	Task 8	0	0	0	0	0	0	0	0	0	0	**0**
	Task 9	0	0	0	0	0	0	0	0	0	0	**0**
	Task 10	0	1	0	0	0	0	1	0	0	0	**2**
												5

=

Table 5: Results of the questionnaires – demographics, app use, prototype evaluation, BCT evaluation

Nr.	Item	P001	P002	P003	P004	P005	P006	P007	P008	P009	P010	
I	Geschlecht	m	m	w	m	m	w	w	w	m	w	
II	Alter	56	21	54	28	25	28	26	28	25	25	
III	Gewicht	87	99	89	76	72	63	67	51	86	57	
1	Besitz Smartphone	ja	ja	ja	ja	ja	ja	ja	ja	ja	ja	
2	tägliche Nutzung Smartphone	2-3	2-3	2-3	3+	2-3	3+	3+	2-3	2-3	2-3	
3	Nutzung von Apps	ja	ja	ja	ja	ja	ja	ja	ja	ja	ja	
4	3 wichtigsten Apps	Whatsapp Instagram Wetter	Willhaben Instagram Shazam	Whatsapp Google Maps Galerie	Whatsapp Telegram Safari	Whatsapp Instagram Email	Facebook Whatsapp Runtastic	Instagram Facebook ÖBB Scotty	Whatsapp Instagram Facebook	Whatsapp Instagram	Whatsapp Instagram Facebook	
5	Health Apps	ja	ja	nein	ja	ja	ja	ja	ja	nein	ja	
6	Nutzung Health Apps	täglich	nie	/	täglich	nie	1-2	täglich	1-2	/	täglich	**mean**
7	Intuitiv	2	2	2	1	2	1	1	1	1	1	1,40
8	Informativ	1	1	2	1	2	1	1	1	2	1	1,30
9	Übersichtlich	3	1	1	1	2	1	1	2	1	1	1,40
10	Privat nutzen	1	2	1	1	5	1	2	2	1	1	1,70
11	Review and monitoring of behaviour and outcomes	1	2	1	2	5	1	2	1	2	2	1,90
12	Social Support	1	3	1	2	2	4	2	3	1	2	2,10
13	Consequences: health and emotional	1	1	2	2	5	3	3	2	4	3	2,60
14	Associative learning and generalisation of behaviour	2	1	1	1	1	2	1	2	1	1	1,30
15	Rewards and incentives	1	3	1	1	5	1	1	1	1	1	1,60
16	Identification as role model	1	2	1	1	3	2	2	3	3	2	2,00
	BCT Likert Score (mean)	1,2	2,0	1,2	1,5	3,5	2,2	1,8	2,0	2,0	1,8	
	Stage of Change	Maintenance	Preparation	Contemplation	Maintenance	Maintenance	Action	Preparation	Contemplation	Maintenance	Preparation	
	Activity Level	HIGH	HIGH	LOW	HIGH	HIGH	MODERATE	MODERATE	MODERATE	HIGH	MODERATE	

Demographische Fragen
Smartphone-/App-Nutzung allgemein
Urban Adventurer
BCT Evaluation

Forms and questionnaires

Declaration of consent for the Usability Test

Einverständniserklärung Usability Test – Testperson

Vielen Dank für Ihre Teilnahme an diesem Usability-Test. Durch Ihren Beitrag kann die App, die ich Ihnen gleich zeigen werde, verbessert und weiterentwickelt werden.

Um die Ergebnisse des Tests besser analysieren zu können wird die Bildschirmaktivität des Smartphones aufgezeichnet. Zusätzlich wird durch das aktive Mikrofon das Gespräch zwischen dem Testleiter und der Testperson aufgezeichnet. Die erhobenen Daten aus den Aufzeichnungen werden für die Auswertung und Demonstration der Testergebnisse im Rahmen meiner Masterthesis verwendet.

Ich erkläre mich bereit am Usability-Test im Rahmen der Masterthesis “Behaviour change interventions in mobile health applications - Testing the potential of a gamified step counter app to change physical activity behaviour” (-> Titeländerungen vorbehalten) von Stefan Roiss teilzunehmen.

Ich bin ausführlich und in einer für mich verständlichen Art und Weise über den Test informiert und aufgeklärt worden.

Ich bin damit einverstanden, dass ich in Ton und Bild aufgezeichnet werde während ich an dem Test teilnehme. Ich gestatte es ausdrücklich, diese Aufzeichnungen und die Auswertungen aus den Fragebögen zu Zwecken der Untersuchung und Demonstration der Testergebnisse im Rahmen der Masterthesis von Stefan Roiss zu verwenden.

Die erhobenen Daten werden vertraulich behandelt und nur in anonymisierter Form im Rahmen der Masterthesis veröffentlicht.

Name, Vorname (in BLOCKSCHRIFT): _____

Ort, Datum: _____

Unterschrift Testperson: _____

Unterschrift Testleiter: _____

Task list for the usability test

Aufgabenliste für „Urban Adventurer“

Führen Sie die folgenden Aufgaben in der App aus. Lesen Sie die Aufgaben laut vor, führen Sie sie aus und signalisieren Sie mit dem Wort „Fertig!“ wann die Aufgabe erledigt ist. Nehmen Sie sich so viel Zeit wie Sie brauchen. Da es um die Nutzungsfreundlichkeit der App geht, wird der Testleiter nicht eingreifen falls Sie die Aufgabe nicht sofort lösen können. Nachdem Sie eine Aufgabe abgeschlossen haben fahren Sie mit der nächsten Aufgabe fort.

1. Loggen Sie sich in der App als „you@example.com“ ein.
2. Bringen Sie in Erfahrung was Ihr vorgegebenes Tagesziel in Schritten ist. Danach öffnen Sie die Detailansicht für ihr persönliches Tagesziel. Dort erfahren Sie wie man einen Level aufsteigen kann.
3. Messen Sie ihren Ruhepuls.
4. Helfen Sie ihrem Teamkollegen Jim bei seiner Challenge gegen Tom Tailor und feuern Sie ihn an.
5. Fügen Sie Anita zu ihrem Team hinzu.
6. Erfahren Sie die Vorteile der Nutzung dieser App. Öffnen Sie dazu die FAQs.
7. Gemeinsam bewegen macht mehr Spaß. Rufen Sie ihr Team zu einem Friendly Walk zusammen.
8. Regelmäßige körperliche Aktivität zahlt sich aus. Gehen Sie in den Bereich Belohnungen und sehen Sie sich Ihre Abzeichen an.
9. Wollen Sie wissen was das maximal erreichbare Level ist? Finden Sie die Level Übersicht und öffnen Sie die Beschreibung des maximalen Levels.
10. Erstellen Sie ihre eigene Belohnung. Setzen Sie sich 50.000 Schritte als Ziel und belohnen Sie sich mit neuer Kleidung nachdem Sie ihr Ziel erreicht haben.

Das war’s! Vielen Dank für ihre Mithilfe. Überreichen Sie dem Testleiter das Smartphone und folgen Sie den weiteren Anweisungen.

Questionnaire 1 – IPAQ short form [48]

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

SHORT LAST 7 DAYS SELF-ADMINISTERED FORMAT- German Version

Wir sind daran interessiert herauszufinden, welche Arten von körperlichen Aktivitäten Menschen in ihrem alltäglichen Leben vollziehen. Die Befragung bezieht sich auf die Zeit die Sie während der **letzten 7 Tage** in körperlicher Aktivität verbracht haben. Bitte beantworten Sie alle Fragen (auch wenn Sie sich selbst nicht als aktive Person ansehen). Bitte berücksichtigen Sie die Aktivitäten im Rahmen Ihrer Arbeit, in Haus und Garten, um von einem Ort zum anderen zu kommen und in Ihrer Freizeit für Erholung, Leibesübungen und Sport.

Denken Sie an all Ihre **anstrengenden** und **moderaten** Aktivitäten in den **vergangenen 7 Tagen**. **Anstrengende** Aktivitäten bezeichnen Aktivitäten, die starke körperliche Anstrengungen erfordern und bei denen Sie deutlich stärker atmen als normal. **Moderate** Aktivitäten bezeichnen Aktivitäten mit moderater körperlicher Anstrengung bei denen Sie ein wenig stärker atmen als normal.

1. Denken sie nur an die körperlichen Aktivitäten die Sie für *mindestens 10 Minuten* ohne Unterbrechung verrichtet haben. An wie vielen der **vergangenen 7 Tage** haben Sie **anstrengende** körperliche Aktivitäten wie Aerobic, Laufen, schnelles Fahrradfahren oder schnelles Schwimmen verrichtet?

   _____ Tage pro Woche ❑ **Keine anstrengende Aktivität (➲ Frage 3)**

2. Wie viel Zeit haben Sie für gewöhnlich an *einem* dieser Tage mit **anstrengender** körperlicher Aktivität verbracht?

   _____ Stunden pro Tag **_____ Minuten pro Tag**

   ❑ **Ich weiß nicht/ bin nicht sicher**

3. Denken Sie erneut nur an die körperlichen Aktivitäten die Sie für *mindestens 10 Minuten* ohne Unterbrechung verrichtet haben. An wie vielen der **vergangenen 7 Tage** haben sie **moderate** körperliche Aktivitäten, wie das Tragen leichter Lasten, Fahrradfahren bei gewöhnlicher Geschwindigkeit oder Schwimmen bei gewöhnlicher Geschwindigkeit verrichtet? Hierzu zählt nicht zu Fuß gehen.

   _____ Tage pro Woche ❑ **Keine moderate Aktivität (➲ Frage 5)**

4. Wie viel Zeit haben Sie für gewöhnlich an *einem* dieser Tage mit **moderater** körperlicher Aktivität verbracht?

   _____ Stunden pro Tag **_____ Minuten pro Tag**

   ❑ **Ich weiß nicht/ bin nicht sicher**

5. An wie vielen der **vergangenen 7 Tage** sind Sie *mindestens 10 Minuten* ohne Unterbrechung **zu Fuß** gegangen? Dieses beinhaltet Gehstrecken daheim oder in der Arbeit, gehen um von einem Ort zu einem anderen zu gelangen, sowie alles andere Gehen zur Erholung, Bewegung oder Freizeit.

   _____ Tage pro Woche ❑ **Keine entsprechenden Wege zu Fuß (➲ Frage 7)**

6. Wie viel Zeit haben Sie für gewöhnlich an *einem* dieser Tage mit **Gehen** verbracht?

   _____ Stunden pro Tag **_____ Minuten pro Tag**

   ❑ **Ich weiß nicht/ bin nicht sicher**

7. Wie viel Zeit haben Sie in den **vergangenen 7 Tagen** an **einem Wochentag** mit **Sitzen** verbracht? Dies kann Zeit beinhalten wie Sitzen am Schreibtisch, Besuchen von Freunden, vor dem Fernseher sitzen oder liegen und auch sitzen in einem öffentlichen Verkehrsmittel.

   _____ Stunden pro Tag **_____ Minuten pro Tag**

   ❑ **Ich weiß nicht/ bin nicht sicher**

Das ist das Ende der Befragung, danke für Ihre Teilnahme.

Questionnaire 2 – Stages of Change [49], [50]

Erfassung sportlicher Aktivität - SoC

Als intensive sportliche Aktivität bezeichnet man Tätigkeiten wie Joggen, Aerobic, Schwimmen oder zügiges Radfahren, also eine Aktivität, bei der Sie normalerweise ins Schwitzen geraten und ihre Atemfrequenz steigt. Von regelmäßiger sportlicher Aktivität spricht man, wenn diese Aktivität jeweils mindestens 20 Minuten dauert und mindestens an drei Tagen pro Woche ausgeübt wird.

1. Üben Sie zurzeit eine intensive sportliche Aktivität regelmäßig aus, d.h. für jeweils mindestens 20 Minuten an mindestens 3 Tagen pro Woche?

a) Nein, und ich habe auch nicht vor, in den nächsten 6 Monaten damit zu beginnen.

b) Nein, aber ich habe vor, in den nächsten 6 Monaten damit zu beginnen.

c) Nein, aber ich habe vor, in den nächsten 30 Tagen damit zu beginnen.

d) Ja, aber erst seit weniger als 6 Monaten.

e) Ja, seit mehr als 6 Monaten.

f) Ist mir wegen einer Körperbehinderung nicht möglich.

2. Haben Sie innerhalb der letzten sechs Monate etwas unternommen, um körperlich aktiver zu werden? (z.B. ein Sportgerät gekauft, sich nach einem Verein erkundigt, mehr zu Fuß gegangen...)

a) Ja

b) Nein

Questionnaire 3 – Prototype/ Behaviour Change Interventions

Allgemeine Fragen

Geschlecht

○ männlich ○ weiblich

Alter

_____ Jahre

Fragen zur Smartphone- und App-Nutzung
(zutreffendes bitte ankreuzen)

1. Besitzen Sie persönlich ein Smartphone?
   ○ ja ○ nein (→ weiter zu Frage 7)

2. Wie lange pro Tag nutzen Sie durchschnittlich ihr Smartphone?
   ○ weniger als 1 Stunde
   ○ 2-3 Stunden
   ○ länger als 3 Stunden

3. Nutzen Sie mobile Applikationen (=Apps) am Smartphone?
   ○ ja ○ nein (→ weiter zu Frage 7)

4. Was sind die 3 wichtigsten Apps auf ihrem Smartphone?

   _____

   _____

   _____

5. Haben Sie Gesundheits- und/oder Fitness-Apps am Smartphone?
   ○ ja ○ nein (→ weiter zu Frage 7)

6. Wie oft haben Sie diese Gesundheits-/Fitness-Apps im letzten Monat genutzt?
   ○ täglich
   ○ 3 bis 4 Mal pro Woche
   ○ 1 bis 2 Mal pro Woche
   ○ nie

Fragen zur App „Urban Adventurer“
(zutreffendes bitte ankreuzen)

7. Die App ist intuitiv bedienbar und erlaubt das schnelle Erfassen von Werten wie Schrittanzahl, Ruhepuls, etc.

trifft voll zu — trifft überhaupt nicht zu

○ ---------- ○ ---------- ○ ---------- ○ ----------○
1 2 3 4 5

---

8. Die Inhalte der App sind gut aufbereitet und vermitteln Informationen über mein tägliches Schritte-Ziel und den Verlauf meiner Herzfrequenzmessungen.

trifft voll zu — trifft überhaupt nicht zu

○ ---------- ○ ---------- ○ ---------- ○ ----------○
1 2 3 4 5

---

9. Die App ist übersichtlich gestaltet und man findet sich als neuer User schnell zurecht.

trifft voll zu — trifft überhaupt nicht zu

○ ---------- ○ ---------- ○ ---------- ○ ----------○
1 2 3 4 5

---

10. Ich würde die App privat nutzen um mein Bewegungsverhalten zu verbessern.

trifft voll zu — trifft überhaupt nicht zu

○ ---------- ○ ---------- ○ ---------- ○ ----------○
1 2 3 4 5

---

11. Die Dokumentation meiner täglichen Schritte und des Ruhepuls würden mir helfen aktiver zu werden.

trifft voll zu — trifft überhaupt nicht zu

○ ---------- ○ ---------- ○ ---------- ○ ----------○
1 2 3 4 5

X

12. Durch den sozialen Support meines Teams würde meine Motivation für Bewegung steigen.

trifft voll zu — trifft überhaupt nicht zu

○---------- ○ ---------- ○ ---------- ○ ----------○

1 2 3 4 5

---

13. Die App hat mich über die positiven Konsequenzen eines gesunden Bewegungsverhaltens aufgeklärt.

trifft voll zu — trifft überhaupt nicht zu

○---------- ○ ---------- ○ ---------- ○ ----------○

1 2 3 4 5

---

14. Durch die gemeinsame Bewegung mit meinem Team kann ich alltägliches Verhalten mit mehr Bewegung verknüpfen.

trifft voll zu — trifft überhaupt nicht zu

○---------- ○ ---------- ○ ---------- ○ ----------○

1 2 3 4 5

---

15. Durch Belohnungen und durch das Erreichen selbstgesteckter Ziele steigt meine Motivation mich öfters zu bewegen.

trifft voll zu — trifft überhaupt nicht zu

○---------- ○ ---------- ○ ---------- ○ ----------○

1 2 3 4 5

---

16. Als erfahrener User würde ich eine Vorbildfunktion einnehmen und anderen Usern dabei helfen ihr Ziel zu erreichen.

trifft voll zu — trifft überhaupt nicht zu

○---------- ○ ---------- ○ ---------- ○ ----------○

1 2 3 4 5

--- Vielen Dank für Ihre Zeit! ---