Understanding Users' Motivations for Wearable Activity Tracker Use

MASTER DISSERTATION

Marco António da Silva Pestana Leão

MASTER IN COMPUTER ENGINEERING

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Abstract

Personal monitoring devices such as activity and sports trackers are becoming increasingly popular. This could be explained by the increasing versatility of the sensors used in wrist wear trackers, smart wristwatch and smartphones (monitoring with increasing parameters and higher precision) and their associated software applications. However, while there is growing interest, recent research has indicated that the use of such devices and applications does not necessarily sustain in the long term.

This thesis presents a study of users' experiences of some users of these devices. Taking a qualitative inquiry, this thesis presents an understanding of the use of these devices, and the psychological needs they satisfy. Grounded on insights from this qualitative inquiry, we derive ideas for the design of physical and sports trackers with the intention of sustaining long-term engagement.

Resumo

Os dispositivos de monitorização pessoais, tipo activity trackers ou sports trackers estão se tornando cada vez mais populares. Isso pode ser explicado pela crescente versatilidade dos sensores usados em trackers de pulso, relógios de pulso inteligentes e smartphones (monitorização com parâmetros crescentes e maior precisão) e seus aplicativos de software associados. No entanto, embora haja um interesse crescente, pesquisas recentes indicaram que o uso de tais dispositivos e aplicativos não se mantém a longo prazo.

Esta tese apresenta um estudo das experiências de alguns utilizadores desses dispositivos. Fazendo uma consulta qualitativa, esta tese apresenta uma compreensão sobre o uso desses dispositivos e as necessidades psicológicas que eles satisfazem. Baseado em ideias desse inquérito qualitativo, derivamos ideias para o design de activity trackers e sports trackers com a intenção de manter o envolvimento a longo prazo.

Acknowledgments

I would like to thank my advisors, Professor Evangelos Karapanos and Rúben Gouveia, for their contribution, in the form of advice, help, availability and participation in the evolution of the whole project. Especially for the commitment, that they always present throughout the aid provided.

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1. Introduction

In recent decades, consumer-driven society has been facing a growing problem of obesity, caused by a stressful life, physical inactivity and bad lifestyle choices [37]. These factors are directly responsible for increasing incidents of chronic conditions such as diabetes, cardiovascular disease and obesity, which result in too many early mortalities and increasingly expensive public health care costs spreading around the world. Health leaders, concerned about these factors, started to consider methods for increasing awareness of poor health habits and the promotion of healthier behaviours, such as incorporating regular physical exercise in the person's daily lives. Some support in this endeavour has come from the use of advances in sensor technology, which have contributed to an increasing market for wearable activity trackers, i.e. electronic devices that monitor users' physical activity, provide goals to achieve different activity levels, and collect data measurements from that achievement.

Changes in good health habits are difficult to make, even more so to make permanent, and there are many complexities to convincing people to change their everyday behaviours. The field of psychology explains this through behavioral theories such as Goal-Setting Theory [11] or the Transtheoretical Model of Behavior Change [16]. Goal-Setting Theory [11] explains the reaction of individuals to different types of goals, motivation to achieve those goals, and the importance of the goal for the individual and measures of achievement. Transtheoretical Model of Behavior Change [16] describes the several steps undertaken for intentional behavioral changes. Both theories are detailed later in chapter 2. As main objectives, these theories give orientations for persuading people to change their way of life.

People with more means of information available such as television, newspapers, internet and social media, have become more aware of their sedentariness and the dangers that entails. Nowadays, people have included in their daily routines time for the practice of physical exercise, as they are increasingly aware of its benefits. This growing interest in looking for well-being through physical exercise began in the 1980s [38]. The decade of the 1980s, can be seen as a time of change in attitudes, because there arose a tendency to adopt a welfare approach through the practice of new physical activities such as fitness, aerobics, and jogging [37]. Physical exercise has become a way of life and activity trackers became desirable technologies, as they give users valuable information acquired from those physical activities. Activity trackers have been implemented in several ways, through the increasing pervasiveness of mobile technologies. Tools such as mobile phones, or more recently, wearable devices - such as smartwatches or wristbands, have increasingly focused on tracking people's physical activity, supporting individuals in the establishment of healthy habits. Conroy *et al*. [36] have emphasized the prevalence of trackers in people's everyday lives, mentioning that applications to support user's health-related goals are widely being used by one in five smartphone users, most of them downloaded from the internet.

However, despite the initial interest of users, research has found that after this novelty effect most users loose interest in these devices/applications over time, and this could be caused by the feedback these systems return to their users, [10] for example, improper information or penalties given when the user does not perform as expected. The devices should maintain their user motivations to keep them interested. In addition, the giving of wrong information caused by the technology unable to analyze a certain physical activity is undesirable. Due to these and other reasons, recent research suggests that one in three users discard the tracker during the first six months of use.

1.1Aims of this thesis

This thesis analyses what uses users give to both wearable activity trackers and sports trackers, and what gratifications they receive from them. With this acquired knowledge, one can offer possible reasons for users of these devices losing their interest over time. It also contributes with information and suggestions for improvement of these devices, and applications to make them more appealing, motivating their use over a longer period, thus sustaining longer termed engagement.

1.1.1. Chapter 2

In this chapter, we review relevant literature in the areas of Personal Informatics and Behaviour Change Technology. We introduce the notion of Personal Informatics Systems as defined by recent research and elaborate on their contribution to helping humans obtain self-knowledge. We also present commercial wearable and commercial sport activity trackers and their usages, and some examples are given of the two genres of devices. Some Behaviour Change Theories also are explained, which are important for designers of persuasive technologies, such as Goal-Setting Theory [11] and the Transtheoretical Model of Behaviour Change [16], In addition to the above theories, this thesis is complemented with the following theories: Presentation of Self in Everyday Life Theory [17], Cognitive Dissonance Theory [18], and Fogg's Behavior Model [19]. Finally, the Uses and Gratifications Theory is presented that later guides both theoretically and methodologically the conducted study.

1.1.2. Chapter 3

In chapter 3 we describe the method employed in our study, conducted with the goal of understanding how and why people use physical activity and sports trackers. To this end, we 1) review the devices that we focus on, 2) describe the surveys deployed in our study, 3) provide insights into our participants, namely the number of participants which participated in our study and their demographics (i.e. sex, age, duration of use, etc.). We also describe how the survey was deployed and where.

1.1.3. Chapter 4

In chapter 4, we present the main results of our study that emerged from the data analysis. These are monitoring physical activity; real information about one's capabilities; technology attraction; empowering /boosting motivation; getting credits for achievements; reliability of the tracked data; ease of use or simplicity; and, self-esteem improvement.

1.1.4. Chapter 5

This chapter explores design recommendations according to the views expressed by participants. The aim of these recommendations is to innovate and make the devices more attractive, improving motivation, thus prolonging its use by users of all age groups especially the elderly. We expect these recommendations to help to overcome early abandonment of these devices by their users.

1.1.5. Chapter 6

In this chapter, we shortly outline the challenges we faced during the execution of the study along with the study's limitations, as well as the conclusions from the study and the recommendations for future research.

2. Literature Review

2.1 Personal Informatics Systems

Since ancient times human beings have always been curious about the world around them, and have always been interested in obtaining self-knowledge. One possible route to self- knowledge is, for example, observing and recording everything that happens in one´s life, studying behaviors and habits. With technological advances, sensors probe comprehensively and accurately track those data and computers can facilitate access to such information in a ubiquitous manner, for example, through the internet.

These systems, which automate this tracking process, are known as *Personal Informatics Systems* [1], and are used in many different areas and with different purposes. They help users to collect relevant data about themselves. They allow for self-reflection and achieve a higher degree of self-knowledge than previously available (e.g. Mint, http://mint.com, for finance and Nike +, http://nikeplus.com, for physical activity); without the aid of such devices, this level of observation, record-keeping and analysis would be unavailable to humans using natural means of memory and recollection.

These interactive technologies help people to better understand their behavior. With this support, users not only obtain a set of behavioral data, but also can manage exploration and understanding of that information. These systems must be both efficient and simple to use. Therefore, it is crucial to identify problems that users may encounter through acquisition of personal data, whilst in use, with the intention of further improvements and implementation of maximum efficiency.

Li *et al*. [1] present a model of five stages (Figure 1) in the use of personal information.

- **Preparation:** that which happens before the collection of information, deciding what information will be recorded and how it will be recorded.
  Obstacle: Determining the information to be collected and which tools to use in this collection.
- **Collection:** Collection of data through observation of the actual context.
  Obstacle: An incorrect choice of tool cannot meet the needs of the user. Flaws in the data collection, a lack of information or reliance on estimation of subjective data is also seen as an obstacle at this stage.
- **Integration:** This step consists of processing the data collected into their final format.
  Obstacle: Synchronization of information coming from differing sources and their subsequent organization. If the integration of this information is slow due to its multisource nature, for example, this leads to further complications meaning more work on the part of the user.
- **Reflection**: Refers to the reflection on the personal information that user collected in the form of lists or displays. Reflections are short-term or long-term. Short-term reflections allow the user be aware of their current state. Long-term reflections allow the user to make comparisons between the information acquired over time.
  Obstacle: Lack of time or retrieval difficulties, exploration or comprehending the information.
- **Action:** In this step, after reflection and already with the results of the information collected, people decide what to do with this new self-knowledge.
  Obstacle: Although some systems are designed to encourage users to take action, other systems may not, which creates a barrier for users who have a little more difficulty in making use of their personal information.

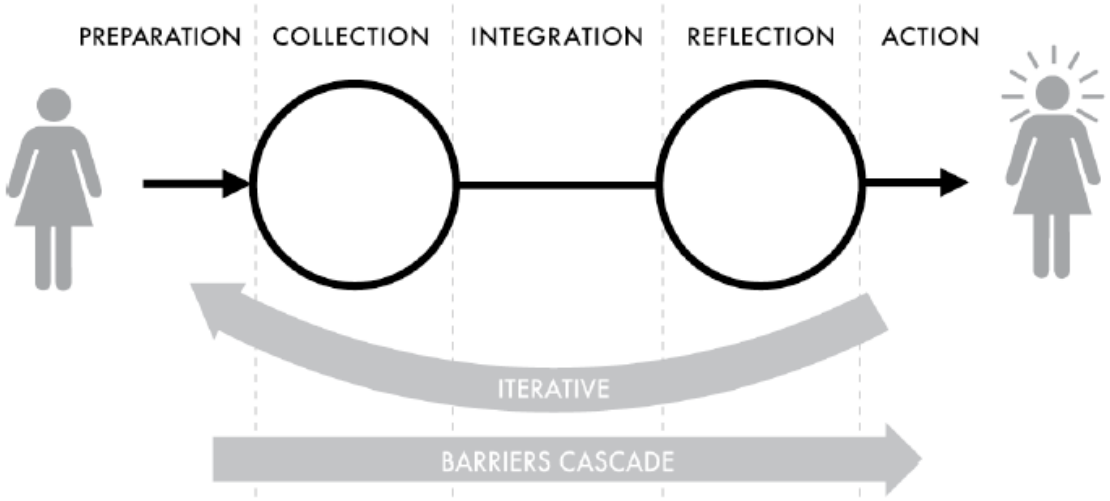


Figure 1 - - Li et al. [1] Stage-based model of personal informatics.

In their model, they also mention four important properties to be followed.

- **Cascading Barriers**: Systems should be devised in the light of all the steps because possible problems that appear in earlier stages, pose difficulties in the progress towards the following steps.
- **Iteration**: The personal informatics systems must be flexible enough to support different types of data from other systems throughout the various stages.
- **User-driven and system-driven**: Each step can be user-oriented or oriented to the system or even a combination of both states. User oriented step indicate that it is the user who performs the tasks. A System oriented step indicates that the system executes the tasks in this step.
- **Uni-faceted vs multi-faceted information**: Uni-faceted systems are simpler and have only one aspect of the life of the user such as a physical activity. It just concerns one parameter. Multi-faceted systems are more complex and manage multiple aspects of life.

According to Li et al. [1], although this model is applied to "manual" personal informatics systems, its paradigm fits very well automatic personal systems, since the above steps are representative of both. These personal informatics systems are part of both activity trackers and sports trackers, which will be described in the next sub-chapter.

2.2. Commercial wearable activity trackers

Advances made in the development of sensors and micro controllers with very low consumption technologies, have promoted the emergence of a market for wearable activity trackers such as *Fitbit* [2], *Jawbone Up* [3] and *Nike + Fuelband* [4].

Such systems are presented as an alternative to simpler tracking systems such as pedometers, devices that count user steps or applications for mobile phones that perform the same function using the sensors of the devices. According to advances in increasingly ubiquitous technology, the ability to capture much more detail than simple user steps is today widespread. These devices or applications are capable of capturing and presenting a variety of events in our lives.

Here are described some examples of these devices:

Fitbit HR [2] - The Fitbit HR (Figure 2) uses a three-dimensional accelerometer to sense user movement. The tracker measures steps taken, and combines it with user data to calculate distance walked, calories burned, floors climbed, activity duration and intensity. It uses an OLED display to display this and other information such as the battery level. It also measures sleep quality by tracking periods of restlessness, how long it takes the wearer to fall asleep and how long they are actually asleep. When connected to a computer, the base station will upload data to the Fitbit website, where a number of features are available: one can see an overview of physical activity, set and track goals, keep food and activity logs, and interact with friends.

Figure 2 - The Fitbit Tracker [2].

Jawbone Up [3] – *Jawbone* consists of a wristwear tracker, (Figure 3) that monitors user's physical activity. The Jawbone works similarly to Fitbit (through accelerometers that measure physical activity), differing regarding the level of feedback given to the user. The Jawbone does not present any feedback to the user through the bracelet. A mobile application is needed to see the tracked data. Besides showing feedback on one's current step count, the app also provides details into one's goal completion, provides suggestions on how to include physical activity into one's life. It also has a social component where one can search for friends who also use UP

accounts and invites them to be part of the same team and /or compete against them. The application lists the performance of the team in a social feed on its main page.

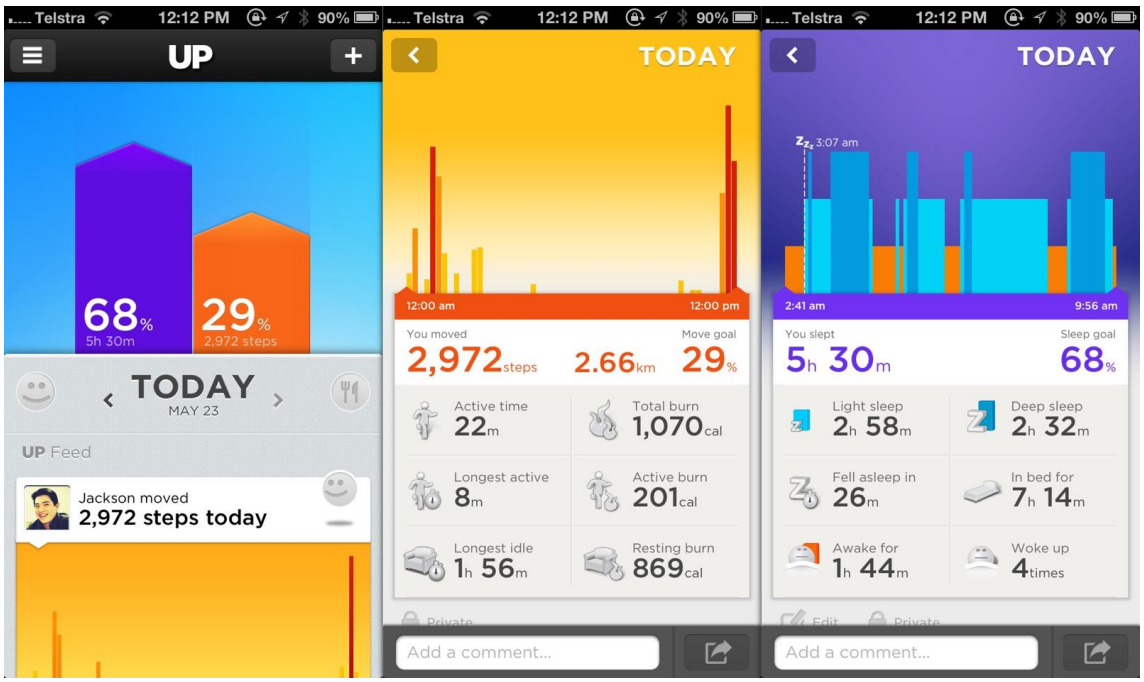


Figure 3 - The *Jawbone Up* [3].

Nike + Fuelband [4] – *Fuleband* is a wristwear activity tracker (Figure 4). This device allows users to monitor their physical activity, and amount of calories burned. Different from most trackers, the Fuelband does not provide feedback on one's step count. Instead, steps are converted into *NikeFuel* points. The information generated by the bracelet can be linked to *Nike +* online community, and to an application on users' mobile phones. It allows users to track their progress, compare it with community members and define fitness goals.

Figure 4 - The *Nike + Fuelband* [AC].

Moves [5] –Moves is an application for smartphone (Figure 5) which records the daily activities of the user. This application supports walking, biking and jogging. The application is always on and users can view the distance, duration, steps, and calories burned for each activity, and just need to keep the Smartphone with them. With small changes, this application helps one think about life in a new way that can lead to long lasting healthy habits. Moves is a pedometer that helps one to walk more. The application shows how many steps taken and aim for a goal of 10,000 steps a day. It logs the venues that users have visited (and the respective time spent within each), as well as the modes of transportation within venues.

Figure 5 - The *Moves* [5].

2.3. Commercial sport activity trackers

Sports Trackers are used to track particular sport activities such as running, cycling, athletics, and surfing. As opposed to activity trackers – which are commonly labeled as tools that help users achieve a more active lifestyle, sports trackers are performance-oriented, helping users log and improve performances in specific sports. These tools allow joggers, for instance, to follow a route, monitor speed, time spent and energy expended during a jog. These tools typically provide personal workout plans – one can view more information related to health such as training volume control vs body weight and BMI (Body Mass Index). Information can be analyzed on a smartphone or personal computer. Alternatively, as user option, can be shared on social networks. These are devices for monitoring and storing data aimed at performers of sports but can also be utilized to initiate any program of physical activity.

The following are examples for this type of trackers: *Garmin Forerunner 610, 620,220* [6]; *Polar FT80* [7]; *Suunto Ambit2* [8].

Any of these devices and applications described below, are capable of monitoring a variety of parameters with detail, which can be used to analyze and advise for the purpose of achieving improved performance and motivation.

Garmin Forerunner [6] consists of several models of watches with several sensors like: *GPS*, pedometer, barometer, altimeter, accelerometer to measure such things as calories burned, distance traveled, and heart rhythm. These watches uses plans to support several sports including swimming, cycling, running and many more. They use a computer interface e.g. *Garmin Connect*, to show the paths or routes travelled, historical routes completed, new routes, and added points of interest that can be viewed with *Google Maps*. The communication between devices and computer is achieved by *Bluetooth, USB* or *Wi-Fi*.

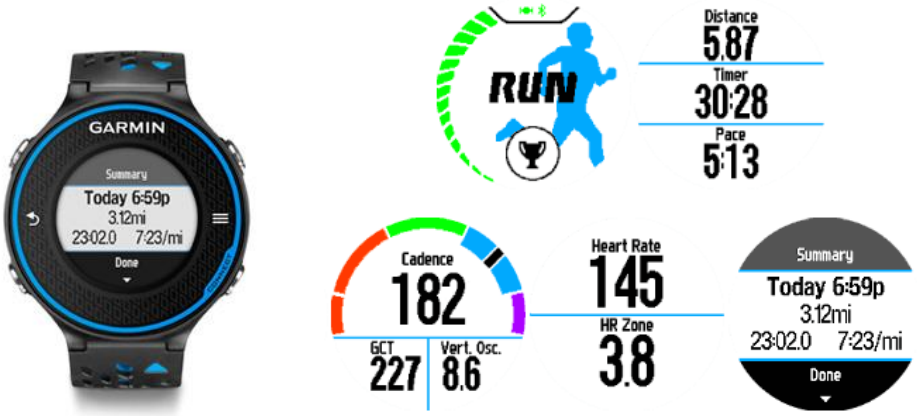
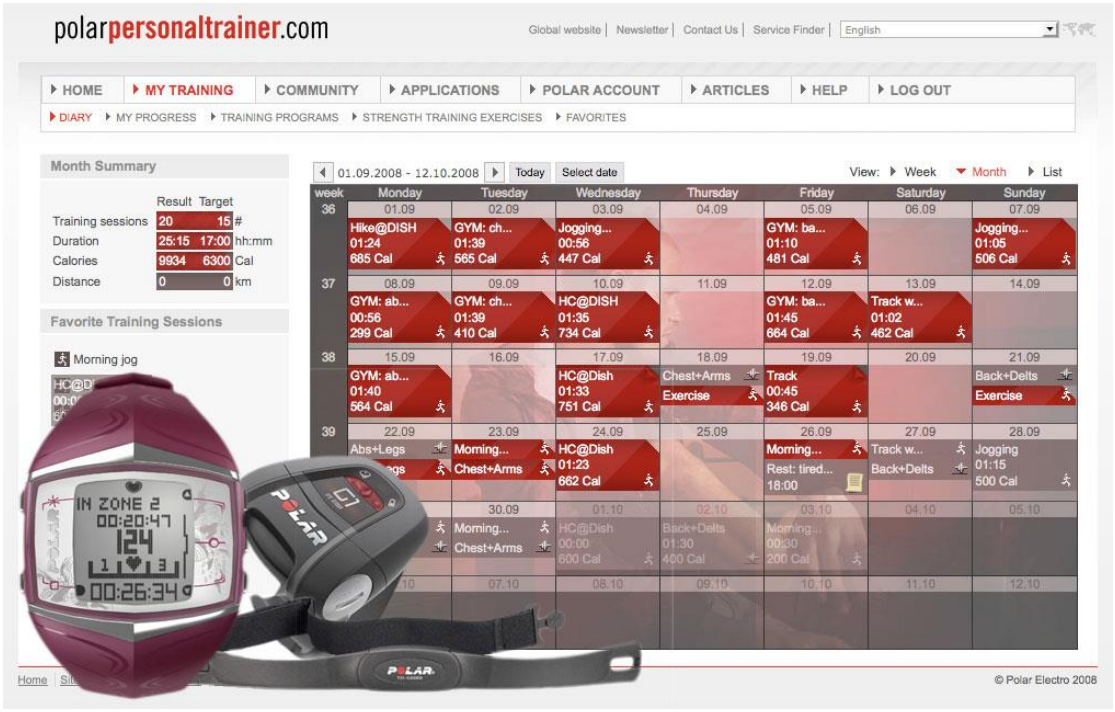


Figure 6 - The *Garmin Forerunner* [6] 620 watch and a view of Garmin Connect. Software

Polar FT80 [7] this is another model of watch for athletes, which uses specialized programs of support for various types of sport. It gives advice for improvements in athletic performance and gives assistance in situations of rehabilitation, weight management, and achievement of a healthier lifestyle. Coupled with several sensors it uses programs to support training like Smart Coaching Feature, Strength Training Guidance, Star Training Program, Fitness Test, Training Load, OwnZone, Relaxation Test, and Smart Calories. It connects to personal computers or Apple Macs via Polar FlowLink software, to transfer data for further analyze and evaluate trough the online link polarpersonaltrainer.com.



(a)

(b)

Figure 7 - The *Polar FT80* [7] watch and a view of Polarpersonaltrainer.com

Suunto Ambit2 [8] is a multi-sport *GPS* clock that combines training programs with several sports applications in an evolutionary way. It has navigation routes and waypoints. It comes equipped with various sensors such as *GPS*, accelerometer, monitoring of heart rate and it allows connection to the PC by *USB*. It is suitable for cycling and triathlon athletes. Besides having specific training for these sports, it also fits more general applications. The information recorded by the device can be shared on the Movescount.com site (http://www.movescount.com/pt/) as well as experiences acquired by its users. Here, the user has a diary of their detailed records and can create a personal training program or choose from several pre-defined programs.

Figure 8 - The *Suunto Ambit2* [8] watch and a view of Movescount.com

Commercial sports trackers, compared to commercial wearable activity trackers, are most popular with highly motivated users or professional sportsmen; however, they are flexible enough for average general use. These devices are not the best for motivation and initiation of people who have a sedentary lifestyle, because although they are very flexible, do not provide interactive features of motivation or encouragement for this change.

It is anticipated by their current inherent design that customers for the above devices are already well motivated and knowledgeable in their habits. In order for these devices to be utilized to encourage the general public to face and abandon their unhealthy lifestyle, additional features will have to be added to initiate, maintain and modulate the motivational requirements of this more general usage to overcome this identifiable lack of sustainment of longer termed engagement.

Improvements in long term engagement for professional sportsmen may be achieved by more dynamic evolution in the programs of support for various types of sport. These should be flexible to automatically evolve the same time as its users improve their performance.

2.4 Behavior Change

Behavioral changes depend largely on the motivation an individual has. Therefore, the challenge is how to motivate that individual to achieve that end. Despite individuals wanting to be healthy, there is a discrepancy between their wishes and their lifestyle. This sometimes can be attributed to bad decisions that prevents individuals reaching their desired lifestyles. Therefore, there is the need for an external support mechanism that will help and guide in making the right choices. The application of existing persuasive technology design is salient in this instance and can be adapted for this purpose (see chapter 5 page 40 for examples) Cosolvo et al. [10]. The field of psychology has extensively examined the way that behavior is influenced. In this field, one finds many studies on the basic social functioning of people, and how human behavior can be shaped and influenced. There are some theories and design strategies that are widely used in research persuasive technologies in health intervention. One of the most prominent strategies is self-monitoring. There is also considerable cross-pollination between these areas of health intervention with developing movements within relatively new field of sport psychology.

2.4.1 Behavior Theories

Cosolvo et al. [10] argues that designers of persuasive technologies often design systems based on behavioral theories, such as Goal-Setting Theory [11] or the Transtheoretical Model of Behavior Change [16].

2.4.1.1 Goal-Setting Theory

Locke et al. [11] explains the reaction of individuals to different types of goals, their motivation to achieve them, the importance of the goal for the individual, and the individual's progress measurement for achievement. For example, the individual has to decide that a given goal is important to him. He should set this goal instead of it being awarded to him without justification. His progress should be easy to measure and understandable that goal has been achieved. The goal should be challenging, but should be something that the individual believes achievable. As the individual improves, he should be encouraged and receive feedback concerning his progress.

According to Locke et al. [11], goals affect performance through four mechanisms:

Firstly, goals have a policy function; they direct attention and effort to activities relevant to the purpose and divert attention and effort from the objective to irrelevant activities. This effect occurs both cognitive and behavioral.

Secondly, goals have an energizing effect. Strong goals lead to greater effort than weak goals.

Thirdly, goals affect persistence. When participants are allowed to control the time it takes to perform a task, difficult goals prolong effort. There is often, however, a compromise between the time and the intensity of effort. Faced with a difficult goal, you can work faster and more intensely for a short period or work slower and less intense for a longer period.

Fourth, the goals affect action indirectly leading to arousal, or discovery and use of knowledge and strategies relevant to the task. It is a virtual axiom that every action is the result of cognition and motivation, but these elements can interact in complex ways. The objective performance relationship is stronger when individuals have a strong commitment to their goals.

Many applications use goal setting as a strategy to encourage physical activity Munson et al. [12]. For example:

Houston [13] a mobile application that encourages users to walk. With this implementation, the user has to reach a daily goal based on historical activities. *Houston* provides a congratulatory message and a simple symbol ('*') when users meet their goals. This application was developed for the Nokia 6600 phone, and the steps count of the user was detected by a pedometer. The user enters the pedometer count steps into the *Houston* application on the phone. He can confirm his score whenever he wants, and the application indicates when its final tally is reached for the day. The step count of the day and the previous day can only be seen. If the goal has not been reached, a pop-up message indicating how many steps that are left comes into sight.

This application gratifies the user when his daily goal is reached. Inside the *Houston* application, the user can also choose to share his current stage with members of his group, add notes to his step count, and send messages to his group members. The user can see an assessment of his daily step count and the members of his group.

(a) (b)

Figure 9 - The *Houston* [13] (a) step count totals for the user's last seven days, including a "*" to indicate days when the daily goal was met, and (b) *Houston* running on a Nokia 6600 mobile phone.

UbiFit [13] [14] is a mobile application that motivates physical activity. It allows definition of weekly fitness goals - a primary and an alternate. The user chooses to work towards his main goal or alternate objective, each week. This application generates an image of a garden (a flower for each activity performed and a butterfly upon goal attainment) as the phone's wallpaper to reflect the week's activities and goal progress. *Ubifit* users receive a virtual flower that grows to indicate their recent activity level, and badges for achieving goals and step count milestones.

The *UbiFit* works by setting objectives, providing progress achievements, and rewarding when these goals are achieved. This application promotes self-reflection by giving personal conscious awareness of weekly physical activities performed by the user. It consists of three main components: a glanceable display, an interactive application, and the fitness device the MSP *Mobile Sensing Platform* (Figure 10) which is a pager sized computer operated by batteries. This computer is equipped with 3D accelerometers sensors, barometer, humidity, visible light and infrared, temperature, microphone and compass.

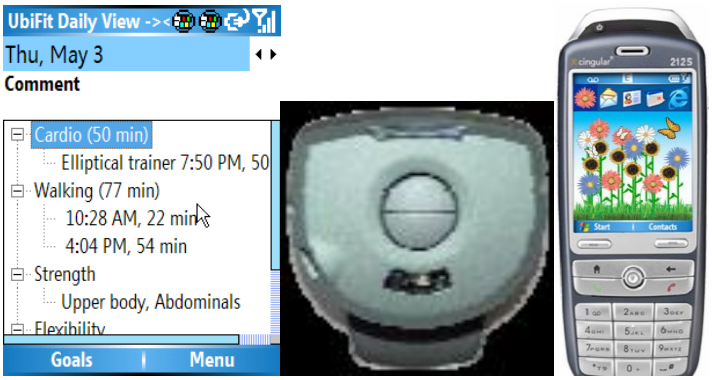


Figure 10 - An overview of *UbiFit* [13][14] **(**a), interactive application where activities are broken down by category. (b), the fitness device — i.e., the MSP — is shown, and (c), shows the garden as seen on the background screen of a singular 2125 Windows Mobile Smartphone. c) Show the glanceable display's garden.

The *UbiFit* uses this device to evaluate physical activities in real time. Then the evaluations are transmitted by *Bluetooth* to a *Smartphone* 's lists of activities. It transmits their probabilities to an interactive application and then to the glanceable display. The application adds this data, then refines it and turns it into less technical and more "humanized" information like "22 minutes of walking or 35 minutes of racing." This application provides information about the performed physical activities and a journal to add, edit or delete information about these activities. In this application, the user sees his performed daily physical activities. He can add physical activity not provided, and show his progress towards the weekly goal.

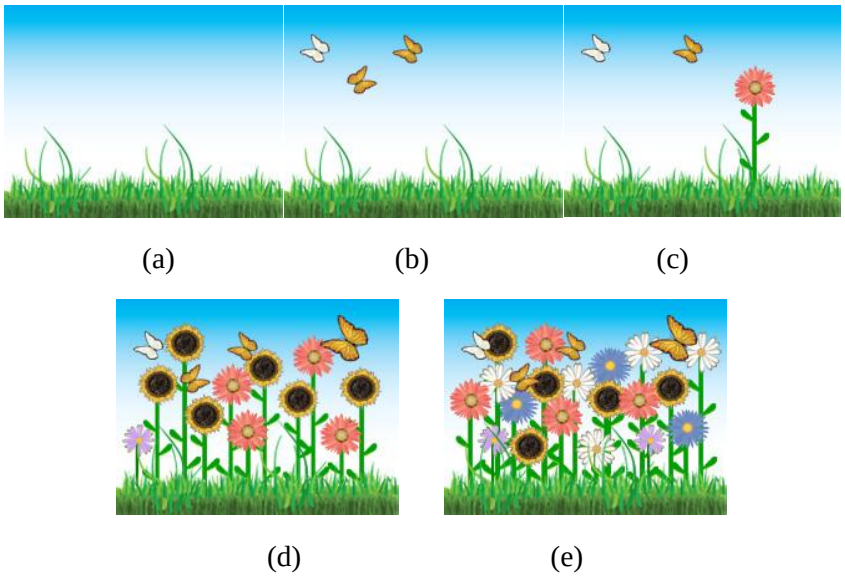


Figure 11 - (a) the user has not performed any activities yet this week, and does not meet any goal in any of the prior three weeks; (b) the user has not performed any activities yet this week, but the three small butterflies indicates that the goal in each of the three prior weeks (yellow = primary goal, white = backup goal) has been met; (c) the user has performed one cardio activity so far this week and has met the goal last week and three weeks ago; (d) the user has had an active week, but only performed cardio and walking activities; (e) the user has had an active week full of variety.

The Glanceable Display (Figure 11 (a)-(e)) is available as a smartphone background image, that features key information about the user's physical activity and achieved goals as a subtle reminder. The glanceable view provides weekly status, goal attainment, physical activity behavior, and a subtle but persistent reminder of a commitment to physical activity.

As mentioned above, the background image of the screen uses the metaphor of a garden that blooms throughout the week, as the user performs physical activities. When it reaches the weekly goal, a large yellow butterfly appears near the top right corner of the image. Types of physical activities are presented by smaller white butterflies representing recent goals accomplished, and serve to reward and as a reminder of past successes. With the display of *UbiFit Garden*, a healthy garden is healthy behavior.
According to Cosolvo et al [14] this system motivates positively the user. The user is never penalized for failure to execute some activity, but simply there appears less stuff in the "garden" image. Overall, this system was well accepted, participants even said they were motivated to achieve the goals by the glanceable display.

Fish'n'Steps [15] is an application that was implemented with the intention to promote physical activity and another way of combating obesity and chronic diseases.

Fish'n'Steps associates steps taken daily by a user with the growth and activity of a virtual character in the computer, in this case a fish in a virtual aquarium with other fish that represent other users, thereby creating an environment of cooperation and competition. In the course of their study, it was found that users had established new routines and reached healthier patterns of physical activity in their daily lives. Users of this application used a pedometer to count their daily steps. This count was then related to growth and emotional state of the virtual fish of each user. Additional incentives were designed to incorporate the social dynamics such as competition.

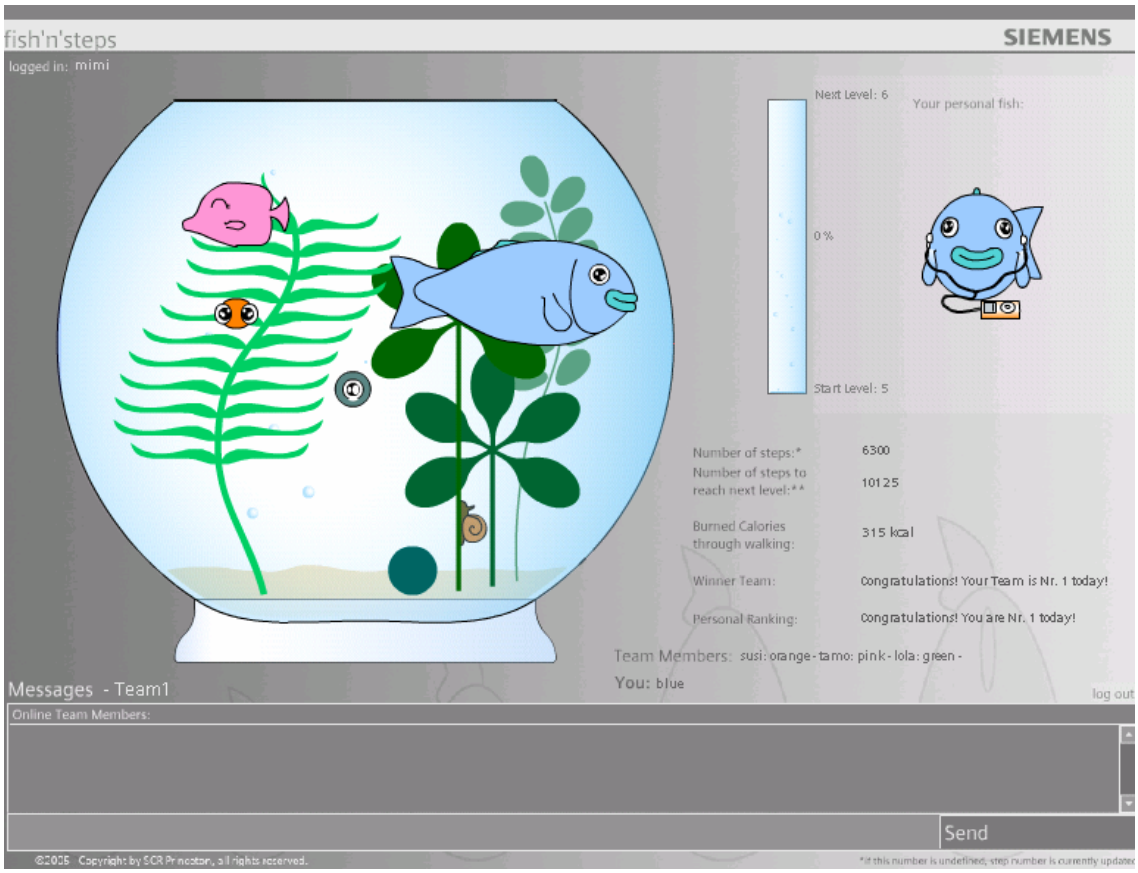
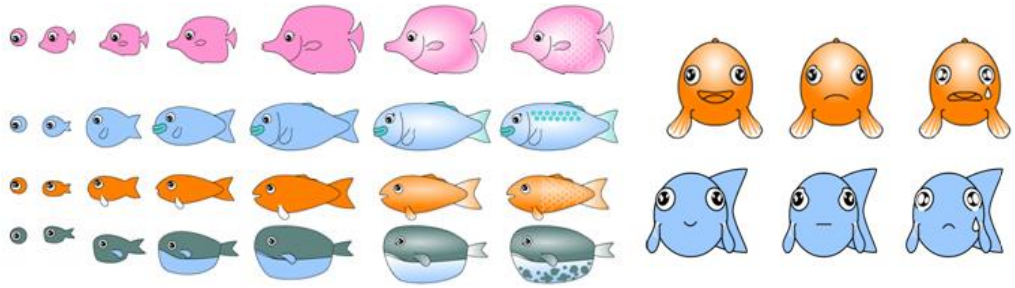


Figure 12 - *Fish'n'Steps* [15] one participant's display after approximately two weeks into the trial in the *Fish'n'Steps* team-condition, also the public kiosk and pedometer platform, which rotated through each of the team fish-tanks. The components of the personal display include: a fish tank which contains the virtual pets belong to the participant and his/her team members; a virtual pet, the participant's own fish in a frontal view on the right side next to the fish tank; calculations and feedback regarding improvements, burned calories, progress bar, personal and team ranking, etc; and a chat window for communicating with team members

This application is based on the establishment of daily goals. When the daily number of steps taken by a user is downloaded from the application database, it is compared with the predetermined goal.

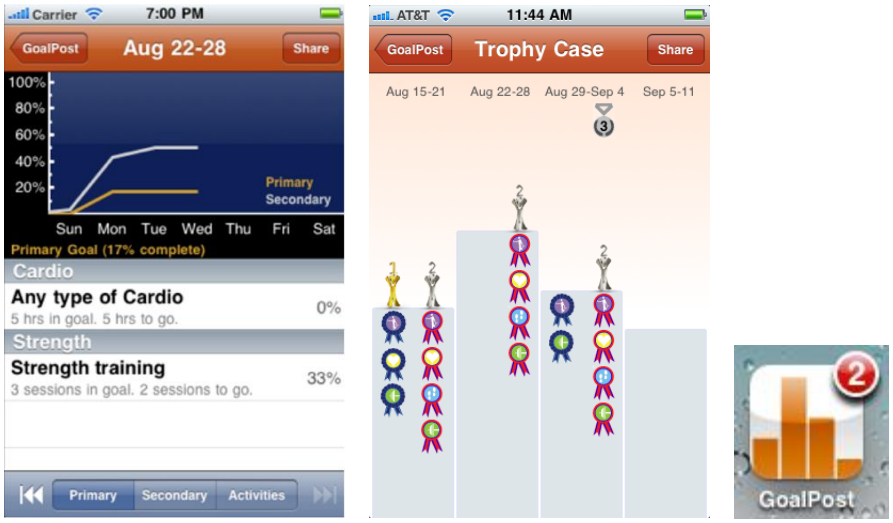
Based on previous studies, designers in this application have implemented three heuristics for the personal goals of each participant including intervention over a period of at least six weeks, by when each participant must have achieved a reasonable goal. The authors report that in previous studies, the average increase reached was about 3000 steps. Therefore, this application has an upper limit of 12000 steps per day as was established in previous studies. They also found that participants were able to achieve a level of 10-12000 steps easily. Subjects, whose improvement exceeded their weekly goal, were given a new goal based on an adjustment of their baseline. With the intention of creating incentives, the progress of the participants was reflected on the virtual character ("fish") in two ways: the daily increment in steps influenced the growth of the respective fish whenever the user exceeded their goal pre-defined. But also when the fish reached its maximum size a new "baby" fish was added. The facial expression of the virtual fish also changed with the progress achieved: "happy" when the daily goal is reached, "angry" if progress was almost achieved, "sorry" if progress was inadequate. This application had a strong performance at the desired result, because it stimulated the motivation for physical activity through the achievement of pre-determined goals for participants.



(a) (b)

Figure 13 - *Fish'n'Steps* [15] - the various stages of growth (a) and (b) three types of facial expressions of the virtual fish.

GoalPost and GoalLine [13] are two versions of an application for iOS developed to promote physical activity. The two versions of this application allow setting weekly goals for physical activity, virtual rewards for achieved goals, and history of these activities. The *GoalPost* version still allows sharing of the user's Facebook NewsFeed. In these applications are users who set weekly goals and uses categories such as cardio, strength, flexibility, walking, and others. They can choose their activities from a predefined list or create their own list. They can also see their progress by category or by specific activity. They can define primary and secondary objectives. As they progress, the application encourages the user to go further. These goals can be changed at any time. The objectives achieved are awarded with trophies and ribbons; trophies are the prize for the completed weekly activity, and ribbons the prize for the completion of an activity within each category.



(a) (b) (c)

Figure 14 - *GoalPost* application [13]: (a) viewing progress for the week*;* (b) the trophy case provided a view of the last four weeks of goal achievement; (c) reminder "badge" on the application icon, indicating two days since the user's last recorded physical activity.

Like other applications, *GoalPost* also implements the metaphor of rewards as a way of congratulating achievements. For such, symbols of ribbons and trophies are used. The "Trophy Case" Figure 14 (b) shows the trophies and ribbons representing goals completed and categories of activities for a period of four weeks. The ribbons represent the categories completed within one goal (blue for categories on the main goal, red for the secondary). The trophies represent the achieved objectives (gold for the primary objective, the secondary silver) needed to complete all parts of their goal.

GoalPost and *GoalLine* provide persistent pop-up reminders about activities. For example, after two days with no diary entries, one "badge" Figure 14 (c) appears in the application icon that reflects the number of days since the last recorded activity.

Both versions allow self-monitoring, Figure 14 (a) in the form of bars show the progress for each category within the primary and secondary goal. The user can view data for the current week and the previous ones. The user may share this information.

This application has proven to be an application that motivates users to gradually increase their physical activity, and encourages them to add variety to their exercise routine. The objective of this application is to investigate techniques for encouraging physical activity.

2.4.1.2 Transtheoretical Model of Behavior Change [16]

The transtheoretical Model of Behavior Change describes five stages individuals typically go through when engaging in behavior change:

- **Precontemplation** – with no intention to change in the near future. At this stage, individuals are not aware of their problems. Although people (family and friends) around them are aware, they cannot convince them to change their behavior. Practically, only in the form of some kind of threat is that change provoked. In these circumstances, there

may appear some change but only as the threat persists. To a researcher who is developing some sort of technology to assist in behavior change to healthier attitudes, this must be taken into account, as this phase is the most critical in convincing the user to change. The system should "educate" the user to that change.

- **Contemplation** – the individual seriously thinking about changing but not taking action. At this stage, people already are aware of their problems but have trouble committing to change. Without the right help, they stay in this state. They can defeat positive developments that they have made, since they are not sufficiently motivated to continue engagement in the evolution. Systems should be able to help people overcome these difficulties through motivation and encouragement. For example, rewarding them always for the correct behaviour.
- **Preparation** - Not acted in the past year but intends to act next month. We are facing a transitional stage because here the individual already shows intended behavior change next month, despite not having changed in the previous year. The individual has not yet acted but shows that intention. It is at this stage that the individual makes the decision to change. Systems at this stage should further encourage users because the goal has yet to be secured.
- **Action** - performed the desired action less than six months. At this stage, the individual has changed the form of behavior to overcome problems. To do this, the individual makes a commitment and uses time and energy to accomplish it, and as such, receives external recognition. This behavioral change is only valid if it is retained for at least a duration of six months. The systems at this stage are of crucial importance in supporting behavior change and as such must follow and guide the user's progress.
- **Maintenance** - Performed consistently desired behavior for six months or more. This stage is where the user will actually "work" towards not only avoiding a relapse but also to strengthen the newly acquired behavior. Being at this stage means that the individual no longer remains in the addictive behavior but becomes involved in a new pattern of behavior for more than six months. At this phase, the system must be able to maintain the motivation of the user because there is always the risk of a relapse. Even at this stage.
- **Termination –** the user is highly motivated and confident without risk of relapse to harmful behaviors.

Despite these traditional behavioral theories being acknowledged as important for developing persuasive technologies, a critical component of the project is often ignored. That is, the impact that technical support for behavior change has on the social world of the individual. After all, the technologies often impact on the daily lives of individuals who use them.

2.4.1.3 Presentation of Self in Everyday Life Theory

Goffman [17] explains the ways that people use to create certain impressions they want others to have of them. This theory uses the metaphor of the theatre to explain. The individual acts towards a certain audience and his performance is any activity that takes place during his presence before a group of observers. This individual and the public are the participants of the activity. The individual before this audience shows his best performance.

This operation is carried out in two stages: front and backstage. The first is where the individual actually performs but does not show his true self. The second is where the individual relaxes, the "masks" cease to operate because he is confident that no one will see.

An effective way to promote a technology changing behavior in the life of an individual, is allowing this individual to have control of his information in the form of data collection, to monitor how this data is used. It should be the individual who decides access to their backstage.

An application that addresses this factor is UbiFit [13] [14] because it is an application where the information is not displayed in a common area but on the mobile phone, unlike Fish'n'Steps [15] where information is shared with other users.

2.4.1.4 Cognitive Dissonance Theory

It is a theory of social psychology that has enjoyed wide acceptance in the field of Communication. Cognitive Dissonance is explained as a conflict of beliefs, attitudes and behaviors [18]. This conflict leads to a feeling of discomfort, which in turn instills an attitude change to reduce this discomfort and restore the balance. This theory sees individuals as decision makers that use dissonance reduction strategies to regain balance, especially if the dissonance affects self-esteem. This dissonance is uncomfortable enough that the individual search for the balance. The State of dissonance in the individual, avoids situations that contribute to its increase. Inconsistency can be reduced in three ways:

- **Changing the beliefs** - the individual may alter one or more beliefs in order to make the relationship between actions and beliefs stable. This could reduce the dissonance. In spite of being simplest way to reduce dissonance it is not the most common as people use to keep their basic attitudes and beliefs pretty stable and do not like change their thoughts and beliefs. Simplest way to resolve dissonance between actions and beliefs is simply to change beliefs. One's could, of course, just decide that cheating is o.k.

- **Chaging actions** - the individual filters information that interests him in order to overcome the dissonant beliefs. The guilt or anxiety feelings can demote the individual to do the action again but if he controls these feelings, he might repeat it.

- **Changing action perception** - a third way to reduce dissonance is to reduce the importance of the action. If the action is viewed in another context, which convince the user that it is consistent with his beliefs, thus it will seem an accepted action. You might decide that the test you cheated on was for a dumb class that you did not need anyway. Or you may say to yourself that everyone cheats so why not you?

This theory predicts that if a goal is to be achieved it is necessary to go through many obstacles and difficulties, then that goal becomes more valuable than for an individual that has achieved without any difficulty.

The UbiFit [13] [14] is guided by this theory in its warnings, as it alerts the user to the fact that the garden is becoming less cared for. It implements ideas to exercise more.

2.4.1.5 Fogg's Behaviour Model

Fogg B. [19] explains that human behavior is a result of three factors: Motivation, ability and triggers. To adopt a certain behavior a person must be motivated to do so, have the ability to perform that behavior, and be alerted to this behavior.

The three causes listed above must happen simultaneously to obtain the expected result (behavior). Figure 15 shows a representative diagram of this model. On the vertical axis, we have the representation of motivation. On the horizontal axis, we have the representation of skill. The star in the upper right corner represents the target behavior with it is associated triggers. The star position means that high motivation and high skill are both needed for its attainment. The diagonal arrow represents the increase in motivation and likewise ability required to achieve the ideal target behavior. The star representing the target behavior can be placed anywhere in the plan. E.g. More motivation needs less ability or less motivation more ability. Behavior triggers behave as a kind

of reminder to achieve the target behavior and can take many forms: one beep, a text message, etc. To achieve high motivation some components /factors are required such as pleasure, hope, and acceptance. The ability has subcomponents as time, money, physical effort. These subcomponents respectively contribute towards the growth of motivation and ability.

The *Fish'n'Steps* applications [15] *UbiFit* [13][14] GoalPost and GoalLine - [13] exhibit features of this model because it instills the ability and motivation to their users so as to achieve high capacity, leading to behavior change.

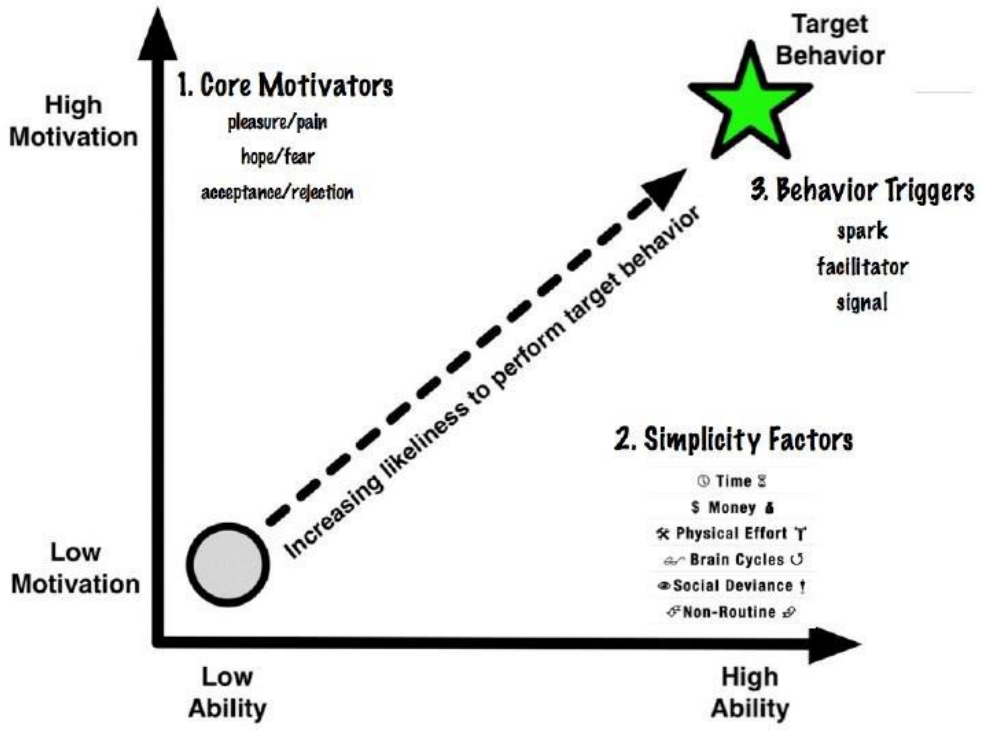


Figure 15 - Fogg's Behavior Model (FBM) – retrieved from [19]

2.5 Strategies for the design of physical activity trackers

Consolvo et al. [10] proposed strategies for the design of technologies that have the intention to help people to change their everyday behavior. Their strategies were an extension of prior studies. These strategies contributed to tactics and social characteristics, which encourage people to adopt a physically active lifestyle. To support their strategies, they based on some behavioral theories such as *Goal-Setting Theory* [11] and *Transtheoretical Model of Behavior Change* [16] and based in some Social psychological theories such as *Presentation of Self in Everyday Life* [17] and *Cognitive Dissonance Theory* [18]. Their intention was to understand how to design technology, which supported people behavior change into healthy habits. Consolvo and colleagues based their investigation in some previous investigations such as *Breakaway* [20], *Fish'n'Steps* [15], *UbiFit* [13] [14] and *Houston* [13]. Consolvo et al. [10] proposed eight design strategies which were based on design goals established by *Breakaway: 1) Abstract &Reflective, 2) Unobtrusive, 3) Public, 4) Aesthetic, 5) Positive, 6) Controllable, 7) Trending / Historical*, and *8) Comprehensive*.

Breakaway [20], is an application that prevents people to be sitting for long periods of time. The application suggests people to take breaks more frequently. The user's chair has some sensors on it which detects the person is sitting on the chair or not. These sensors are connected to a computer with Breakaway application installed and communicate in a non-obtrusive manner how long the user has been sitting.

This application controls a robotic sculpture placed on the desk which slumps over, if the user sits on more than an hour. If user takes regular breaks, the sculpture sits upright and appears "healthy." It provides peripheral awareness to the user when he is at his desk. The use of the sculpture of an aesthetic and realistic way simultaneously, promotes change in human behavior.

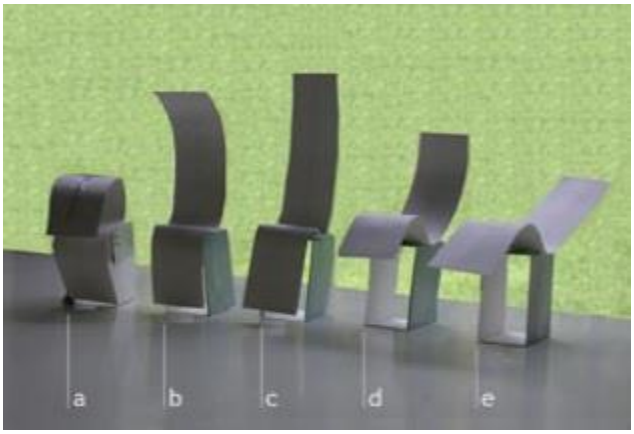


Figure 16 - Breakaway's [20] sculpture positions.

Consolvo transformed these goals into general design strategies, plus, adding four other:

- **Abstract & Reflective**: It uses data abstraction, instead of raw or explicit data from the user that motivate reflection about their behavior, showing him the relationship of these behaviors with his goal. The abstract allows the individual to perform his representation of the data by giving them, alternative meanings and allowing the creation of an ambiguity to create a story. Presents the individual with an opportunity for reflection. The *Breakaway* [20] presents this abstraction for his sculpture because it is the position of the user as it is too long sitting. The *Fish'n'Steps* [15] represents user behavior in the abstract because it has a fish in an aquarium representing the steps taken by the user.

- **Unobtrusive**: Being present for its user, capture, record his data and make it available to him whenever the user needs but in a discreet manner, without interference in his daily life. The technology must have a discrete aspect. Should be available to its user without creating unwanted attention on him. For example, applications that choose to present information on mobile phones like *UbiFit* type [13] [14], *Goalpost*, *Goalline* [13] and *Houston* [13]. These applications can be classified as an unobtrusive as they use a common technology already adopted by the user - The mobile phone.

- **Public:** The captured data which for some reason has to be accessed/ displayed in a more public medium, must not compromise in any negative way its owner before others who also may share the same medium. The lifestyle behavior change technologies should be devised and implemented taking care with how the data may be exposed to people outside the application. These data cannot somehow expose the user to an unpleasant way for people around him. Must respect the *Presentation of Self in Everyday Life Theory* [17].

The *UbiFit* [13] [14] or *Goalpost* and *Goalline* [13] and *Houston* [13] applications make use of mobile phone so, do not present great dangers of exposing data to third parties without the user's control on the other hand, *Fish'n'Steps* [15] requires some caution because the data are exposed to multiple people in a common medium.

- **Aesthetic**: the technology must sustain interest and curiosity as it may be used over time as a personal object. It must remain comfortable and attractive to support the user's personal style; the aesthetic aspect of technology should follow the concepts proposed in the *Presentation of Self in Everyday Life Theory* [17] when Aesthetics act as the part of the front stage, which is where the characteristics that user wants to present to their audiences. Therefore, it should be an accurate picture of his personal style. Aesthetics also contributes to the credibility of the technology as people often access and evaluate them based on an inspection of their characteristics and a comparision with market alternatives. An application that can be used as an example is *the Fish'n'Steps* [15] for its appearance when seen at the kiosk created interest and excitement even in people who were not participating in the event. The *Breakaway* [20] application also presents an elegant and attractive way to his user information.

- **Positive**: the user's behavior change(s) must be encouraged with positive reinforcement. This reinforcement can be in the form of rewards. Rewards motivate desire for behavior changes and thus achieve goals and objectives. If for some reason, this behavior change was not made, it should not be rewarded but also should not be penalized. Lifestyle behavior change technologies should be able to continue to captivate the interest of its user over time, thus providing incentives and rewarding effort. If for some reason the user is not able to achieve the desired behavior, the technology should not penalize the user but continue persuasively to motivate him so that interest remains. Sometimes penalties can result in a lack of motivation to change practice behavior and the subsequent abandonment of the application. One such example is the application *Fish'n'Steps* [15] When the user failed commitments this was reflected in the presentation of virtual aquarium cloudy water, sad or angry faced fish, and absence of decoration in the aquarium. These results stemmed application use. On the other hand, the study of the *Houston* [13] *UbiFit* [13] or *Goalpost* and *Goalline* [13] concluded they were motivators for their users.

- **Controllable**: depending on the circumstances, the technology should allow the user to edit the data to be presented in the way that he finds most appropriate. The user should be given control over access and what is seen. These technologies should enable priority for the user to fully control his data and allow free choice about who should or should not view, thus respecting the concept of front stage and back stage of the *Presentation of Self in Everyday Life Theory* [17]. The individual handles the data presented, thus distinguishing what is permitted front stage and what is hidden back stage. However, these technologies should be perspicuous enough to accommodate these concepts, while helping the individual to reflect on their actual behaviors.
  Technologies when interacting with user behavior should be as accurate as possible, as it is frustrating for the user receiving incorrect information about their performance. This leads to a loss of credibility by the user. This credibility is very important when we are dealing with monitoring technologies that display data in the form of measurements.

- **Trending/Historical**: the technology must provide accurate information and easy access about the past behaviour of the user regarding their goals and objectives. This information should be portable between devices. Technologies to encourage behavioral change must be able to store information from past results related to certain goals. This data should be available to the individual when manipulating. He should be able to be conscient of his evolution and so make good decisions that guide the achievement of the desired lifestyle.

The *Houston* [13] application provided short-term history information about user goals and objectives.

- **Comprehensive**: account for the range of behaviors that contribute to the user's desired lifestyle; do not artificially limit data collection and representation of the specific behaviors that the technology can sense or monitor. Technologies must use the correct means and be adaptive to the context of the task being performed otherwise risks being a discouragement to the user. Technology, which makes false counting, monitoring or even simply, being unable to achieve monitoring of the event will equally is discourage, and not benefit the credibility of this technology. An example of this was both Fish'n'Steps [15] and Houston [13] who used pedometers to measure steps taken by the user, but if he decided to bike instead of walking they were no longer able to properly monitor such performance, the user then did not receive credit for work performed.

The above theories form a solid base, as one can see by the examples of given applications, which used them, from which one can discern guidelines to foster ideas and suggestions for improvement of existing applications or the creation of new designs more efficient and appealing. For example, as the sports trackers and activity trackers interact with their users and influence their behaviour they should respect the directives of the Theory of Cognitive Dissonance. These devices/applications should respect user privacy as oriented by the Goal-Setting theory. The significant influence on the development of human improvement provided by these devices should be done by stages, as stated within the Transtheoretical Model of Behavior Change, as users are not necessarily at the same level. The ideas and suggestions mentioned before should be rich enough to stimulate owners´ gratitude and pride when using such devices which as attested by Fogg's Behavior Model are necessary adjuncts for goal attainment, prospering significant improvement with the drive to long-term sustained engagement.

2.6 Understanding the psychological impact of trackers - Uses and Gratifications Theory

The Uses and Gratifications theory is a theory that seeks to explain the reasons that lead people to use specific media to meet certain needs. It seeks the understanding of the use of the media, the motivations of those uses and the gratifications people gain from such use. It seeks the answers to the "How and Why" of media use. This theory, gathers information or research regarding to people and information about the uses they make of the media. This theory has been applied over the years and research the use and the understanding of the results of such use, in various types of media.

2.6.1 Beginning

This theory was born in the late 1940s. It began as an investigation into the gratifications and effects of various forms of media, and how they captured the interest of audiences. The first studies were essentially descriptive and sought to classify the responses of audiences into categories. For example, their study of the Radio Cantril et al. [28] concluded that the radio introduced profound changes in the social aspects and behavior of individuals.

Bereson et al. [29], conducted intensive interviews to find out what people felt about the lack of newspapers. To do this they led small group interviews. They found that the newspaper holds several meanings for their readers: - as interpretation of the world of public affairs, as an aid in everyday life, as a pause in the daily life of the people, and for social contact. They concluded that the newspaper was a valuable source of reading in society because it had become a ceremonial or ritualistic act for many people.

Three functions of mass media were described by Lasswell [24] surveillance of the environment, correlation of events and transmission of social heritage, becoming the basis of the needs and expectations in the model of uses and gratifications. This study indicated that the media fulfill some needs of everyday life of individuals. These initial investigations were inconsistent and individualistic in their methodologies; they were not very sophisticated studies in the detection of the origins of the needs that motivated the choice of the media.

In the 1950's and '60s social variables and psychological precursor of gratification patterns are identified also several functions are identified such as companionship, mood changes, to counter loneliness or boredom Mendelsohn [25]. It was also introduced the variable race with the intention to predict the form as teenagers used the television as informal form of apprenticeship Greenberg et al. [26].

In the 1970s researchers examined the motivations of audiences and developed new types of uses applied by persons to the media and social rewards obtained. They suggest that certain basic needs interact with personal characteristics and with the social environment of the individual. Eastman et al. [30] indicated that the television could be used as the means to socialize, as company and as behaviour models. Three social origins were identified within media gratifications: normative influences, life changes socially distributed, and the reaction-subjectivizing individual to the social situation Blumler [27].

In the 1980s and '90s, one began to see valid responses, for example, the appearance of systematic attempts to conduct studies, modified repetitions, implementation of refining methodologies, analysis of the comparative results of separate investigations, and treatment of the mass media as a social phenomenon, and communication. Dutton et al.[31] concluded in their studies that education was an important factor in the adoption of computers in people's homes, and that the use of computers as a tool had a larger growth than as entertainment. They also suggested further research to study negative impact on computing caused by gender disparities and socio-economic inequalities.

The theory of the uses and gratifications was born due to the appearance of several of these studies that sought to investigate and find patterns in the users of the various media. This theory is being successfully applied to several recent studies as a tool, to explain what makes people use various means and receive satisfaction from them. Table 1 describes some examples of these studies.

Study	**Researcher**	**Year**
Internet	Stafford & Stafford [21]	2004
Facebook	Joinson [22]	2008
Online Communities	Lampe et all [34]	2010
Twitter	Chen [32]	2011
Foursquare	Lindqvist et all [33]	2011

Table 1 –Some Studies that used the theory of uses & gratifications.

Joinson et al. [22] for example, used U&G theory to understand the uses of *Facebook*. They applied the two studies where in the first study users were asked to describe their *Facebook* uses, and gratifications obtained in an exploratory way. Then as result of sentence and word group analysis, achieved from answers given, they considered the themes Keeping in touch - contacting

friends who are away from home; Passive Contact, Social Surveillance - passive observation in a non-contact environment; Re-acquiring Lost Contacts - reconnecting with or finding lost contacts; Communication - being “poked” or private messaging or writing on walls; Photographs - picture tagging, posting or sharing pictures; Design related - design simplicity allowing for ease of use; Perpetual contact - regular status updates of user and contacts; Making new contacts - acquiring new friends, joining groups.

On the second study they used answers proposed by the participants in first stage of the study, but applied to questions 2 to 4 which were taken and a new list was created. A total of 46 items was obtained. Then this new list was submitted again to an analyze and evaluation by the participants, based on the 7-point Likert scale where 1 scale very unimportant and 7 very important and based on the metric " How important are the following uses of *Facebook* to you personally?” and found that the greater use that users give to Facebook was essentially to social searching and surveillance or to find old friends. To investigate in more detail exploratory factor analysis was conducted.

From this analysis, they identified seven factors. Social connection - articles related to keeping in touch; Shared identities - were identified three groups: groups, organizing events, meeting of like-minded people; Photographs - includes the making and photographs of survey; Content - applications, quizzes, games that are part of *Facebook*; Social investigation - contains social searching and browsing social; Social network - which allows surfing the social networks of other people and friends; Status update - covers newsfeeds and updating the status on Facebook. They concluded that the use of Facebook was mainly for the social investigation, sharing photos, and verification of status updates. The sites of social network were used to create social bonds, for communication, surveillance, and surfing. The designers will have to continue to provide feeds between users and allow one’s desire to control their representation in these social sites.

Chen [32] presents us with a study of the uses and gratifications, regarding *Twitter*. *Twitter* is a blogging platform and also a social internet network sharing short messages, (up to 140 characters) between users or followers called *Tweets*. With this study Chen wanted to understand whether *Twitter* satisfies one of the basic needs of the human being - to interrelate - because with so many additional members (about 21 million in 2009), understanding the gratification of this interrelationship between people, was an asset for understanding how people interact online.

As tool for this study, Chen used the Theory of Uses and Gratifications because it is based on the principles, which underline the social and psychological needs of people and it studies how the media meet these needs. As this theory had already been used successfully in other studies related to the web, Chen justifies it being the most appropriate tool for their study. Chen applied the principles of U&G theory to consider how people used *Twitter* and what satisfaction they obtained by connecting with others through it. She examined how the use of *Twitter* was related to the satisfaction of people's needs. She assumed that the more time people pass on Twitter, greater the potential reward of being connected to other persons on the social network. As the U&G theory explains that the computer can be used as a way of satisfying a psychological need, and also that people have the possibility of choosing their media, so the choice of *Twitter* as the chosen media should be to meet these needs in some way.

The study examined how often people used Twitter over a period of months and on a daily basis. The study examined how people felt satisfied by being linked to others who use this medium. An important result was found that the use of Twitter over the months was more responsible for the gratification of needs of people being connected to each other than the daily hours spent sending repeated messages from other people. However, these results also confirmed the results of previous studies that people who use Facebook feel more connected to others than by use of Twitter.

Lindquist et al. [33] present results of three studies on the *foursquare* check-in system. Researchers categorized such location-sharing applications as *purpose-driven* where people request for the current location of another person or as *social-driven* where people share their location with friends. *Foursquare* among others is part of this second category. As *foursquar*e is presented as an application with 5 million users, the researchers saw here a study opportunity to consider how people use this system and how it satisfies their needs. They wanted to know "what value drives people's use of these systems?"; "How have users appropriated these systems inventing new purposes for them to serve? ". *Foursquare* presents itself as a mobile game, one way to learn about cities, a form of information sharing between friends (e.g. location) and a presentation of sites where users were and whom they were with.

Results of three studies examining location sharing were presented. The first study utilized interviews with early adopters to understand how they used it and what values they obtained from such use. The second was based on a study to examine in qualitative terms *foursquare* usage patterns and privacy concerns. The third study was based on a survey of questions about *foursquare* usage patterns. With these studies, researchers presented how *foursquare* is used both qualitatively and quantitatively identifying the most common sites of check-in, and distinctions between recent and older users of the application. Their research is based on studying the uses and gratifications procedure. With these studies, the researchers concluded that people use *foursquare* to locate friends, and fun. They found that there are very active people in the gaming aspect and checking-in at others people homes or others who use *foursquare* for safety purposes. They found that users had few concerns about privacy.

Lampe et al. [34] investigated the reasons that lead people to participate in online communities. Their study compares two theories of user motivation. Uses and Gratifications theory, and Organizational Commitment Theory, which states that the contribution of an individual to an organization is proportional to its affinity for this organization. The researchers conducted a survey addressed by both anonymous users and registered users, based on the theories described above, raising four questions:

"How do U&G and Organizational Commitment relate to different perceptions of site use?"

"How do U&G and Organizational Commitment relate to the probability that a user is anonymous or registered?"

"For anonymous users, how do U&G and Organizational Commitment relate to the probability the user is a first time visitor to the site?"

"For registered users, how do U&G and Organizational Commitment relate to their levels of participation in the site?"

As a result, the researchers found that users turned to these sites looking essentially for information, but to their satisfaction get additional benefits, which motivates them to return. Some groups seek entertainment and others provide information. Investigators found that for the administrators of the site the iteration that this provides is more important to some than for other users. Motivations and commitments varied depending on the type of users. They, motivated by the importance and a sense of value within the organization become affiliated and identify in the site. The emergence of a sense of belonging to the site is common to all types of users.

Gouveia et al. [41]

In their study, they explored the real use of an activity tracker to better understand the subtleties of how users interact with these devices, how it affects their physical activity, contrary to most studies that focus on trackers effectiveness. According to the researchers, while such studies are effective in evaluating personalized efficacy, they are limited in predicting the adoption and use

in real life. Their study showed how tracking activities in everyday life can be complex. For example, lack motivation to set goals by the users, where they only interact very briefly with the tracker, and revealing a deep lack of interest in their own historical data.

In addition, it has shown that trackers can have a dual nature: - as an ineffective technology that encourages change only during specific moments in time and - as a "transformational" technology that encourages but maintains new practices to the point that the device ceases to be required. Researchers see activity trackers as an example for a new genre of interactive "transformation technologies."

Understanding how these technologies are actually used can be gained by research of detailed and naturalistic surveys on the adoption, use, and disengagement of this technology. Through this deeper understanding, researchers find it possible to evolve the activity activity from a "deficit" technology to a full-fledged tech support.

Coorevits et al. [42] in their study they present us facts that the activity trackers are more and more popular and with more and more applications in different industries. The researchers say that this market could reach 30 billion dollars in 2020 and will contain several products from several companies. However a current concern is the large rate of users who are giving up to use their device. It is mentioned by the researchers that because the business models are of the push type can not follow and understand the real needs of the users, also previous studies have focused more on the technological characteristics and potential of adoption of wearables. Thus, there is no understanding of the reason for this abandonment by users.

The researchers propose the identification of the main reasons, from the perspective of the user, that lead to dissatisfaction and abandonment of the devices. They suggest that marketers should focus on iterating among consumers in communities where they can gain valuable information about consumption.

The researchers found that data consistency and accuracy are a challenge for activity trackers because they are often very limited and inaccurate. They must capture greater diversity of data and with greater accuracy and that can be integrated into a wider ecosystem. The limitations and inaccuracies that these devices sometimes present are the result of a disarticulation between the expectations of their capacities and their actual use. In their work it is also emphasized that users need more signals and reminders to use the devices. These should be activated at the right times. Software should trigger encouraging prompts through push notifications or integrate more gamification elements into applications.

2.6.2 Uses and Gratifications Theory and wearable trackers

The Uses and Gratifications Theory can be an appropriate methodology for studying the uses and gratifications people derive when using wearable activity trackers, especially as the focus of this study is determining how people incorporate wearable activity trackers into their daily lives. This theory has proved to be an effective way of understanding how people use technology. It could also explain the reasons that most trackers have failed to derive long-term sustained engagement for the majority of their users. So, The U&G theory will be applied to support the learning and to understand, as these persuasive technologies are becoming increasingly common, what constitutes their success, and if these technologies continue to offer value by supporting the human change behavior over time, Fritz et al. [35].

U&G has given proves, since its beginning to current days, to be a basis from which to construct profiles of uses a user gives to a such media and gratifications user gets from it. Specifically, U & G presents us with a more individualistic and personalized view, it provides the "customer-level" view of the use of a certain mass media [21]. Stafford et al. [21] in their internet study also

report that their choice of use of U & G Theory was due to the fact that the Internet is an interactive technology and user-directed nature, this user-level approach seemed to them suitable for examining consumer Internet use.

The U & G theory provides the theoretical framework for understanding the specific reasons for such use. In the case of activity trackers, we have a mass media that can also be classified as an interactive technology and user-directed nature and in many of its iterations with the users, makes use of the internet as a means of communication. It seems then legitimate to use this theory applied to the study of activity trackers and, it is expected to get proves, when using this theory applied to the activity trackers, about how this system is used after months or years, how its use changes and what can be done to provide long term use and support systems. This understanding is provided through the analyses of qualitative data, where explanations are given as to what user needs, these systems fulfil and which behavioral practices, both initial and prolonged, are adopted by the user.

3. Study

The study employed in this thesis focuses on understanding how people incorporate wearable activity trackers and sport trackers into their daily lives. Our goals were to: 1) deepen the knowledge of the potential of these tools (e.g. what makes these tools pleasurable and engaging?), and 2) provide design recommendations for prolonging users' period of engagement when interacting with these tools. To do this, reliance was placed on the first part of U&G theory, where Individuals were asked to describe their experiences with these tools through the first step of the U&G theory. A list of four open questions, which attempt to identify the use and gratification of a certain media, were provided to participants. These questions were suggested by Stafford [21] and further adopted by Joinson [22] and Spiliotopoulos [23]. This study is qualitative in nature.

The questions were as follows:

"What is the first thing that comes to mind when you think about what you enjoy most when using this media?"

"What other words describe what you enjoy about using this media? "

"Using single, easy-to-understand terms, what do you use this media for?"

"What uses of this media are most important to you?"

We focused on the answers given only to the first question following the methodology contained in the first part of the Uses and Gratifications Theory. By analyzing the answers, a list of words or phrases was obtained which characterize typical uses and gratifications in an exploratory manner. With this procedure, a theoretical construct was obtained from the sample domain. The obtained results were grouped and categorized by topic / degree of similarity subsequently constructed the section of results. Based on these results, design recommendations were drawn up. For this study, it was necessary to implement two surveys. One directed at sport trackers users and the other at activity trackers users. Both surveys were developed on *Qualtrics* (www.qualtrics.com), a free online survey software which allows for creation and then deployment online. This software provides links, which can be used for posting on the internet (i. e. social sites like Facebook, Twitter).

3.1 Survey

The survey itself consisted of three parts: Introduction, Demographic questions and usage information and Experience report questions (see Appendix A). The Introduction explains to whom it is directed (in this case people who uses sports or activity trackers), what is it for, conditions for participation, and the procedure (in this case people will be asked to complete a short survey about the use of activity trackers, and the same was given for sports trackers). The survey consisted of 8 questions and the duration was recommended for approximately 12 minutes or less. Demographic questions and usage information – age, gender, type of devices used, and duration of its use. Experience report questions - after choosing one of the devices, users were allowed to answer the last four questions following the method proposed by Stafford [21] and further adopted by Joinson [22] and Spiliotopoulos [23]). The questions were as followed:

"What is the first thing that comes to mind when you think about what you enjoy most when using the device, you use?"

"What other words describe what you enjoy about using this device? "

“Using single, easy-to-understand terms, what do you use this device for?”

“What uses of this device are most important to you?”

Participants were asked to answer the questions detailing as much as possible their experience and describing their feelings about it.

3.2 Method

The proposed study was conducted through the following steps: First, the questionnaires were created using the tool Qualtrics.com and then both deployed through the Mechanical Turk site. On these questionnaires participants generated phrases to describe the way they use these devices and what pleasure they got from that use. Both questionnaires also included demographic questions (age, gender, occupation, tools owned and period of purchase). Sport and wearable activity tracker users were recruited from either community pages[1] social media (e.g. Facebook) or Mechanical Turk. 214 participants responded to the activity trackers survey and to the sports trackers survey, 209 participants. Both surveys were available for a month. Following the method proposed by Joinson [22], the first U&G question was used to create a list of clustered themes that described the uses of activity trackers (See Appendix A page. 64). These were grouped by related answers (i.e. answers that express similar ideas).

For example, the followings answers may lead to the theme **competition** e.g.

I really like Fitbit because it helps me compete with my sister to see who is more active.

I share my information of the Fitbit community page to show others how active I am.

The Fitbit webpage has a wall of honour, so I really try to keep up in the ranks.

Other probable themes may be socializing, healthy, way of life, personal knowledge.

A first version of the surveys was deployed through *Amazon Mechanical Turk* (www.mturk.com) to an initial group of twenty participants just to test the process, to understand if the questionnaire was well written, and to allow for some filtering and refinement. The decision to use this site was determined by the necessity to reach a maximum number of people quickly. The intention was to obtain the most diverse opinions possible. These first reports gave ideas for necessary refinements, after which it was deployed again in its improved mode. The final version of the online survey was deployed again using *Amazon Mechanical Turk* and $0.70USD per hit was offered as incentive for the participant’s effort. Only after the participants choose which device they personally used were then permitted to answer the remaining questions. This was added as a simple passive control-group mechanism with the intention of filtering responses from only participants who used these devices.

3.2.1 Participants

214 responses were obtained to the activity trackers survey. From those, 105 were discarded for being vague or out of context – leading to a total of 109 surveys. Regarding sports trackers, about the same results were obtained - from 209 initial responses, 103 were rejected for being vague or out of context - leading to a final number of 106 surveys. Both surveys have been active for a month.

Regarding the activity trackers survey, 67 respondents were male and 42 female. Most of the answers were given by people between the ages of 25 to 34, and most of them were using the

[1] https://www.fitbit.com/login?redirect=http://community.fitbit.com/t5/Force/Fitbitburnedarm/td-p/3661

device for about six months. The devices most used were Fitbit owned by 32% of respondents and Nike+ Fuelband owned by 20% of them. In respect of the sport trackers, survey 75 male users, 28 female users participated with the predominant age of 25 to 34 too, and most of them had been using the device for about two years. In this case, the devices most used were Sports Tracker owned by 35% of respondents and Nike+ Running owned by 20% of them.

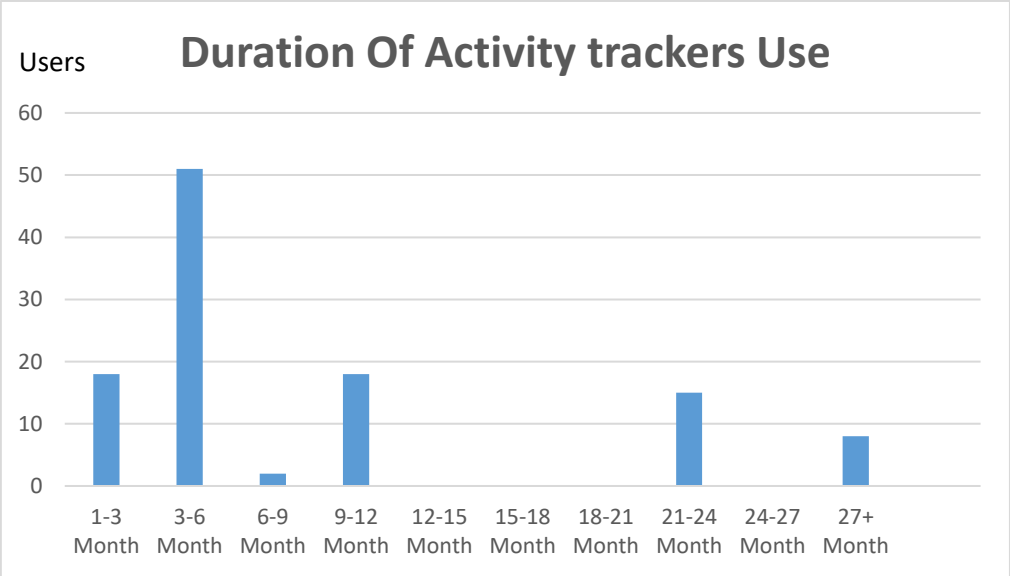


Figure 17 – Activity Trackers use.

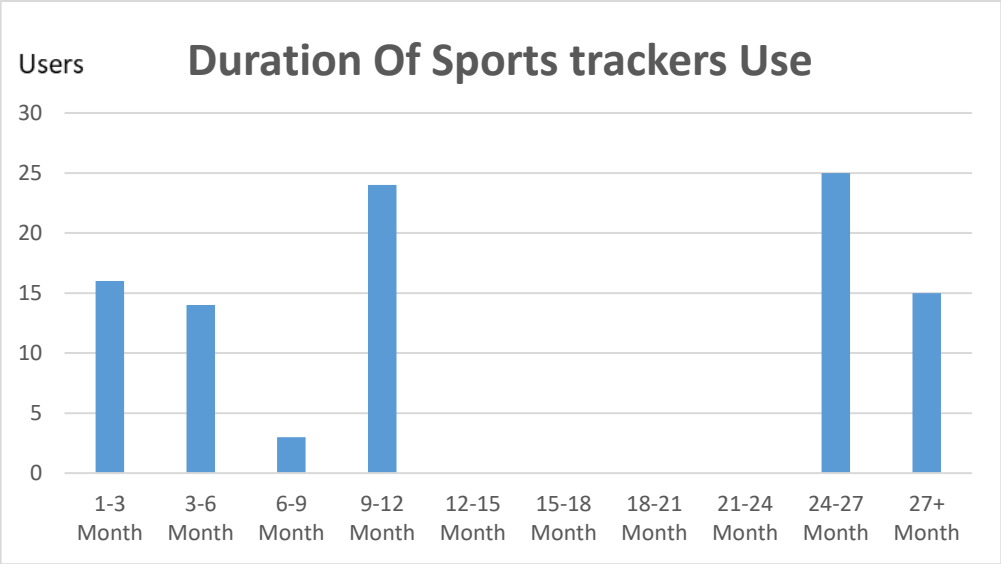


Figure 18 – Sports Trackers Use.

4. Findings

4.1 Analysis

Following the method proposed by Joinson [22], the answers given in both surveys to the first U&G question ("What is the first thing that comes to mind when you think about what you enjoy most when using the device, you use?"), were used to create a list of clustered themes describing the uses of these devices. The participant's responses were analyzed one by one and, grouped by similar ideas or concepts. Subsequent to these common ideas or concepts, a theme or title was attributed. This resulted in 41 themes related to activity trackers and 35 themes related to sports trackers. We further conducted a comparison between both devices - comparing the themes encountered in each to assess the different ways of use. Then these answers were grouped again and based on the ideas expressed in that answers it was created a common theme to both devices and a description to each. A total of 8 themes were found. These themes are described below.

4.1.1 Monitoring physical activity

Self-monitoring can be seen as a technique of observing and qualifying the one's own health behaviour over a period of time. The self-monitoring of one's behaviours has been found to lead to increase in one's step count and overall health improvements – such as a loss of weight. The general effect of self-monitoring was highlighted through participant's reports [13]. Activity trackers allow users to gain immediate awareness of their daily activity levels, as described by participants: e.g.

I enjoy that I can measure how many steps I walk and how active I have been during the day. [P41]

Sports trackers, although providing similar awareness, differ, as they were mostly used within a specific set of activities (e.g. jogging, swimming, etc.):

I like seeing my run once I'm done (...) whenever I need to. [P55];

Participants praised the immediate feedback provided by each device, helpful to check one's progress towards ongoing goals:

It helps me track my fitness activities and gives me a good view of my progress. [P54]

Others found that checking progress over the longer term helped them gain richer understandings about their capabilities:

I like to look at my progress. So I already think about my last run and app use before I start the next one. [P59].

4.1.1.1 Accurate information about one's capabilities.

Both tools are praised for their ability to automatically track activity levels and provide "honest feedback" as opposed to human estimations that may be biased-prone:

I can understand how I am performing with no underestimates or overestimates. [P69] "

I can see how I am progressing from one jog to another. It accurately helps me to adjust my workouts for upcoming Triathlon training. [P50]

Receiving "honest" feedback is important as it allows participants to better understand their limits and trust in the reliability of such tools:

I love my JawBone so much because I use it to record my LIFE basically, it's amazing. I love how I can wear it all day everyday like a trend. I also like how it records my every movement, sleeping patterns, calories burned. There is so much more I love about it though! Best Invention EVER. [P62]

All in all, self-monitoring tools allow users to observe their progress as well as ongoing results and statistics. This is important as it allows users to gain awareness of their limits and identify where they can improve. Such tools can be seen as "personal trainers", which could potentially personalize the goals and targets provided to users based on their performance.

4.1.2 Technology attraction

Technology has become increasingly an integral part of our lives and has been defining the way we live and work. We depend on this to perform our most basic daily activities: to communicate, to share information, to travel, among other examples. It has also been widely integrated in the practice of physical activity in the form of monitoring and promoting the execution of this activity [14]. This persuasive technology and the improving mobile devices with their ubiquitous sensors have contributed to good health and fitness practices. The expansion of wearable devices have made a profound contribution to the development of these technological innovations by promoting awareness about ourselves and by changing our health behaviours. By integrating new technological possibilities, as well as by the development of new sensors, users are offered the most relevant data to support their decisions. Participants are drawn to innovative aspects of these devices such as their simplicity of use, efficiency and ubiquity. These tools are becoming more efficient and smaller with increasing processor power and miniaturization of sensors. A very attractive fact that these devices provide is the capturing of large amounts of data that will allow then to draw user's profiles about their habits and behaviours. [35].
Advances in trackers are praised, by both activity and sport tracking users. As one activity tracker user stated:

These devices are the future of fitness [P96].

With respect to Sport trackers, participants enjoy the advanced aspect of these devices meaning its ubiquity, its high capacity of tracking several metrics and with it, providing support to the user exercises also the flexibility they have to connect to other devices.

Using GPS, apps on your phone can determine your speed and the distance you have travelled. [P78]

All in all, the evolution of these devices seems to attract users – This is reflected, for instance in the number of devices that are sold as soon as a new version is launched in the market. Ubiquity of devices is also important, as user's value devices that integrate into their daily lifestyles.

4.1.3 Empowering /boosting motivation.

Motivating can mean convincing someone to do something. A person without dynamism or stimulus to act could be defined as unmotivated, while someone who shows a will or enthusiasm for reaching an end is considered motivated. The guideline for motivation comes from implicit attitudes that, in the presence of the proposed goals, trigger the action. For example: "A student may be motivated to learn a new skill set because he or she understands their potential utility or value" Ryan et al. [39].

One way to motivate tracker's users is by the goals achievements. The tougher goal the higher performance. This is described by Goal-Setting Theory, which explains the reaction of individuals to different types of goals, their motivation to achieve them, the importance of the goal for the individual, and the individual's progress measurement for achievement.
The goal must be set by the user instead of being awarded to him without justification. The goal should be challenging, yet should be also something that the individual believes being reachable.

As the individual improves, he should be encouraged and receive feedback concerning his progress [11]. This feedback, for example, could be in a form of rewards. Participants were often surprised about how good those simple rewards made them feel. Participants cited those rewards as motivators to get them to do more activity when implemented well, simple rewards can help motivate users to be physically active and remind them to be proud of their healthy accomplishments [13]. Activity trackers use rewards to empower and motivate users towards walking goals:

Quantifying my nature experiences and fitness goals. [P10]

I enjoy that I can measure how many steps I walk and how active I have been during the day. It gives me a set goal to achieve 10,000 steps. I always feel incredibly accomplished when I reach this goal. [P41]

Users also feel motivated by being able to self-monitor their physical activity levels:

It is a motivator for me because I know that my activity is being tracked and it pushes me to continue with my exercise. Even when I am not working out, it still pushes me to be active because I am being tracked all the time, even when at work, school, etc. [P 67]

Sports trackers empower/boost users in a similar way, but also push them to go further than their limits:

I use it to remind myself that I must workout harder. I look at it as I am about to lift heavy weight and I guess it helps psychologically. [P 47]

I love the reminders to increase activity. [P 13]

It can record my distance with speed as well as it can challenge to other people throughout my activities. [P 11]

Here the users tell us the satisfaction they feel when they push themselves and achieve their goals even with friends help.

Ease of use, almost accurate measurement of distance and time, and user-friendly tidy console. Though it is a personal device, make and I and my friend share it, I feel very confident to wear it as it makes it easy for me to track the distance I cover and try to improve on the time which I do my best. [P 52]

Both sports and activity trackers motivate users by tracking their physical activity levels and providing rewards. Sports trackers seem to take this motivation further, with users pushing their limits towards improving previous workouts – in a certain way, sports trackers promote self-competition (i.e. *Trying to improve myself every time I work out*) as activity trackers are used towards achieving a more linear/non-changeable goal (e.g. 1000meters every day).

4.1.3.1 Getting credits for achievements

Both activity and sports tracker users praise the fact that trackers reward them when achieving goals, through trophies or other motivational feedback:

I can set and achieve different health goals using it. / I can manage record and analyze this data for more improvement. [P 83]

As a suggestion, designers could break up goals into micro-goals, motivating users towards a longer, more enduring end-goal.

4.1.4 Reliability of the tracked data

Here, stories are centered around the reliability invested in these devices, namely the accuracy of results such as distance tracked, heart rate measurements or calories burnt during activities – i.e. users trust the data provided by these devices**.** Sport tracker users tell us:

I enjoy the ability to have an accurate calorie burn count for tracking purposes. [P 23]

Almost accurate measurement of distance and time. [P 52]

Users also refer to the reliability of these devices in terms of their physical robustness/non-problematic software.

How long the sports tracker operates? I have had it for about 3 years now, and I have not had any problems with it so far. [P 12]

Similarly, activity tracker users praise the reliability of the tracked data:

Very effective and performing well. [P 24]

Accurately measuring fitness. [P 71]

People receive useful knowledge of their capabilities.

It is very handy and shows the accurate results of my workout. [P 63]

Users of these devices see them as advisory or a tutorial instead of "simple tools", therefore it is essential they must be very accurate and should not fail. These devices should have a simple and intuitive software yet should give detailed information about user performance providing salient support to the exercise execution. As an idea for future development, trackers could utilize such artificial intelligence as is currently already available within mobile phones, such as the personal assistant of Google Pixel XL to provide richer feedback, better tailored towards personal needs and goals.

The popularity of crowdsourcing through social media networks is already proving successful in garnering relevant data of customer needs, and a useful method for market testing pre-production ideas. Encouraging tracker users to engage in this form of customer feedback would be appropriate and help strengthen customer adherence to the product.

4.1.5 Ease of use or simplicity

Users remarked on the ease of use and the simplicity of these devices. They appreciate also the iteration the devices provide allowing them to program almost everything related with the exercises. Users also remark on the autonomy felt when using these devices. In the case of the Sport trackers, users appreciate the ease of use of the device as well as its ergonomic design**.**

The ease of use of this device is what makes me enjoy it the most. It has a lot of simple easy to access functions (…) it pairs easily with the sports tracker software. [P 65].

Users further appreciate easy-to-understand information provided by these devices:

Information is simple to understand yet very complete. [P 3]

It is easy to understand. I do not like information that is difficult to understand, but my sports tracker gives simple information. [P 57]

These factors allow users interaction with these devices without wasting too much time with the operations.

It is quick to access. [P 42]

Activity tracker users, mention the facility in use and the learnability that these devices/applications can provide and the satisfaction they get from that knowledge.

I enjoy the flexibility of the design, as it is a clip that I can place anywhere on my body. I have tried many other types of trackers, such as wrist based ones and even the applications on my phone, but the Fitbit is better as it just seems more accurate and convenient. [P 43]

It's very useful and easy to use. I can easily understand about distance walked or run, calorie consumption etc. [P 86]

Indications are that the simpler, the better. Users here remarked that the simpler the software use looks, the better it is for them to interact with the device and the easier it is to understand the information, the device returns to them. Therefore, it is important to develop an even more "intelligent" software that supports users, regarding their exercises (for example instead of trying to achieve a fixed goal, adapt a goal considering the user's personal agenda for that day). Yet this software must be kept as simple as possible.

4.1.6 Self-esteem improvement

Self-esteem can be described as a person's emotional and subjective self-assessment of self-worth. It is an act of judgment of the person himself. Self-esteem is maintained or augmented through acts and behaviours that promote feelings of worth. These feelings of worth feed the person's ego making him feel dignified and as good as any other person instead of feeling like a weak and dislocated person in society. Activity trackers as well as sport trackers are more than just tools to change behaviour. By being incorporated into people's daily lives, they foster new forms of relationship between them and new ways of increasing self-esteem [37].

Users report trackers to have a real impact and influence on their behavior with changes attained towards healthier habits. Users feel heightened self-esteem and appreciation when seeing themselves reach their goals via their activity tracker. Activity trackers users, report self-esteem improvements by seeing their results in the long-term. Their stories highlight the psychological effect of these devices on the user's daily lives.

I enjoy that I can measure how many steps I walk and how active I've been during the day. It gives me a set goal to achieve 10,000 steps. I always feel incredibly accomplished when I reach this goal. [P 41]

To be fit to my health and to my happiness that makes me to start my day with extreme joy. [P 99]

Sport trackers support exercises that are more specific. Athletes get their self-esteem improved by sensations like immediate enjoyment and sense of accomplishment provided by physical activity when achieving or overcoming goals.

Seeing how much I have improved from past runs. [P 55]

I really enjoy seeing how far I reached when I'm running. [P 75]

Overall, these devices contribute to the improvement of their self-esteem. They really feel the motivation to change to healthy habits and a better life. It is interesting to see how a small object has such power in people's lives, influencing them by the production of useful information from which much more informed decisions can be made by the individual potentially changing their habits and lifestyle. Designers should try to highlight and emphasize the possible effects on self-esteem provided by these trackers. One idea could be to suggest exercises based on user's historical information – instead of having a stable goal, this could fluctuate according to their context (e.g. lower goals on busier days). Another idea could be to promote social features. For example, if a user friend's is nearby also training, the software could inform the user and suggest

performing a similar exercise together. By exercising with a friend, with a mutual goal, we speculate that user's self-esteem could be heightened.

5. Discussion and design recommendations

Activity trackers can do more than simply report a user's activity. These devices give to their users the opportunity to experience personal progress in a way never before tried. These devices can be used as tools to make personal progress more efficient and by providing feedback, enable individuals to make decisions for a healthier lifestyle. Promoting personal progress will lead to improved health, user satisfaction, and sustained long-term commitment. However, to get people to make these decisions and to have a positive impact on their health, one needs to use the activity trackers in more innovative ways.

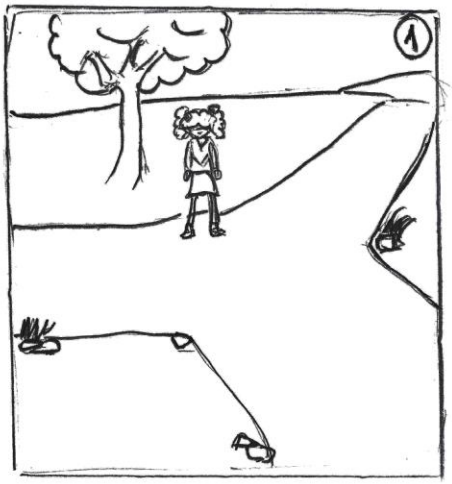
In this study, eight distinct uses and gratifications were identified for users of activity trackers (see section 4). In this chapter, we present, based on these eight uses and gratuities, some design suggestions in order to increase the efficiency of the activity trackers, to make them more appealing and innovative, contributing to avoid being discarded and instead becoming catalysts of good practices that increase substantially individual well-being and thus stimulate behavior change.

5.1 Boosting motivation

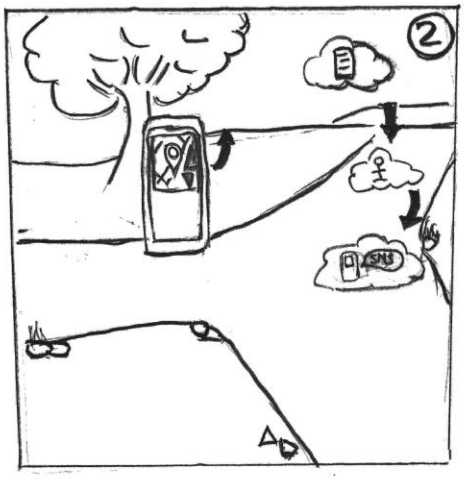
Trackers adopt different strategies towards motivating users to perform physical activity - such as using rewards, or trophies to highlight achieved goals or using messages of encouragement. Based on participant's insights, trackers could also use social support to boost their motivation. For instance, certain goals could be collaborative (i.e. accomplished with the help of friends) because when users have companionship in the exercise execution, they feel more motivated, as one of our participants noted:

Ease of use, almost accurate measurement of distance and time, and user-friendly tidy console. Though it is a personal device, make and I and my friend share it, I feel very confident to wear it as it makes it easy for me to track the distance I cover and try to improve on the time which I do my best. [P 52]

So in this case, the application or device, through the use of GPS sensors could detect where the user is and seek for nearby friends – or other people. These friends could be obtained from social networks in which the user is registered (e.g. Facebook). The idea is to alert the user of their presence (friends) suggesting to do the exercises be accomplished together, with the effect of motivating all participants to achieve the objectives of the exercises. Following the acceptance of the notification, the application after consulting the respective statistics and targets achieved, could adapt a balanced exercise for both participants, even taking into consideration differing levels of difficulty needed by users. This whole iteration should work only after the user's permission.



Ann is practicing physical exercises in the park



Her smartphone detects her location and connects to a data centre to locate a friend of hers who is in the neighbourhood and send him a message to practice physical exercise with Ann

Ann is practicing physical exercises with her friend

Figure 19 – Motivation with friends help.

As another idea, trackers could accept the creation of various user profiles (see Figure 20). This way, trackers could be shared (for example) by several members of a family or friends instead of being individualistic. Each user, could be identified for example by a biometric sensor built into the device which immediately not only validate his access to the device but also access to all data of this profile such as statistics, exercises made before or to be done, goals etc., customizing at that moment the device for that profile.

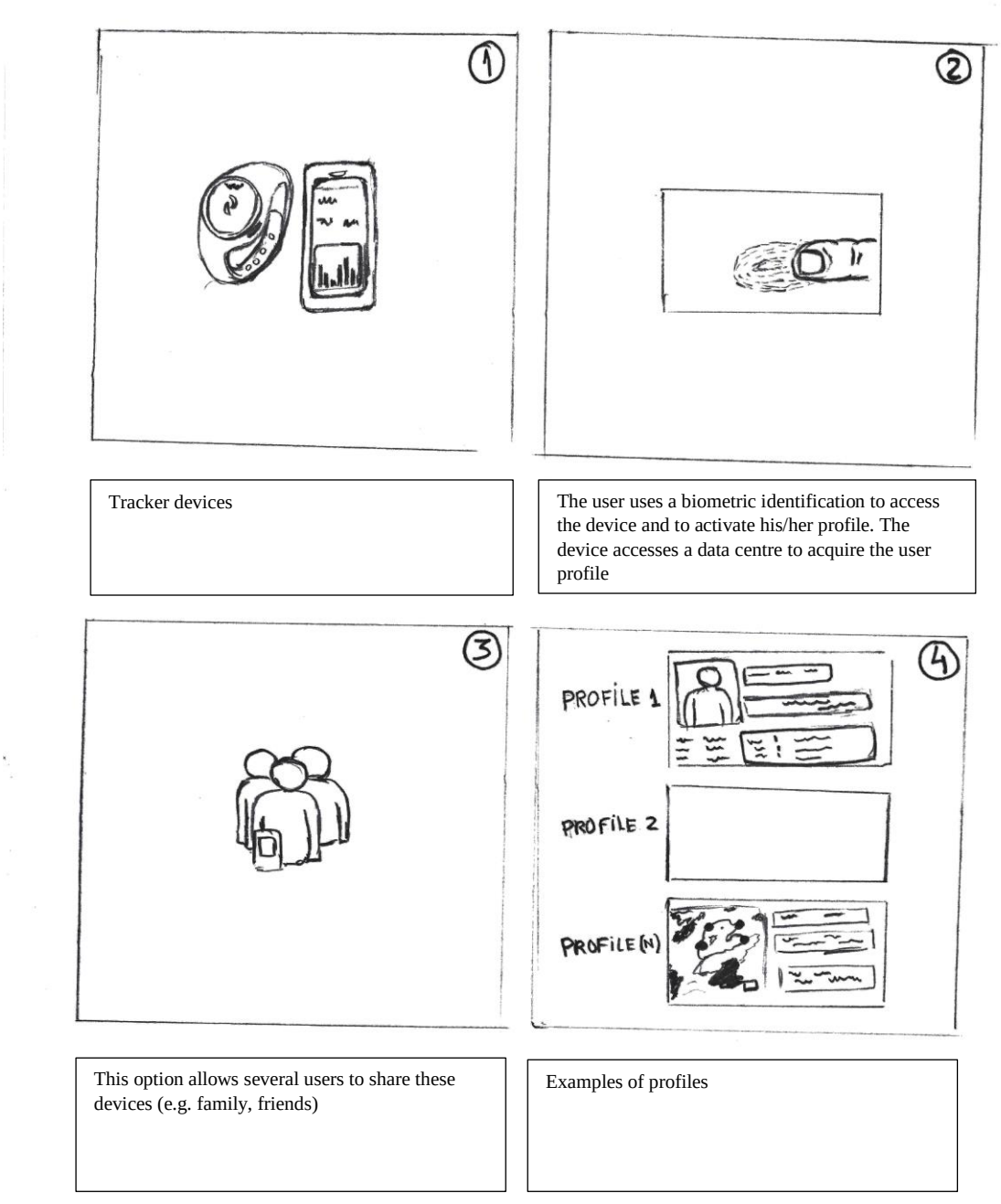


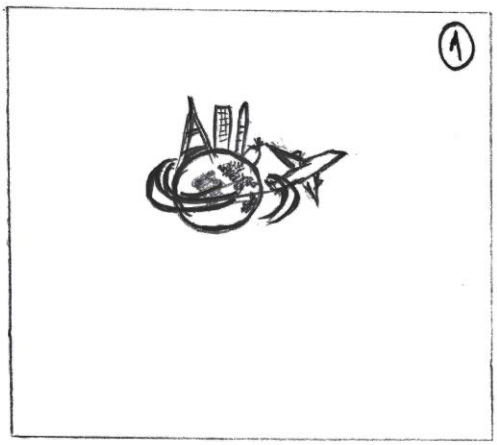
Figure 20 - Multi user profiles.

5.2 Supporting physical activity out of the daily routine

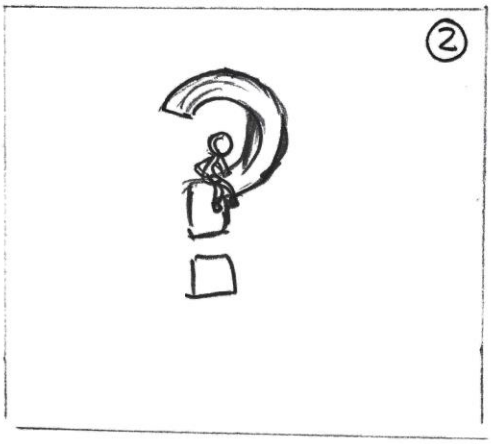
Trackers were used to support physical activity in users' daily life, as described by our participants:

I like how it tracks my activity as well as my sleeping pattern. Knowing how many steps I take per day is important to ensure that I maintain my fitness. Checking my status throughout the day gives me the motivation to meet my daily goals. The sleep tracker ensure that I know my body is getting the required rest so I can maintain the level of fitness I desire. It is so useful that even I take it to my trips. [P 104]

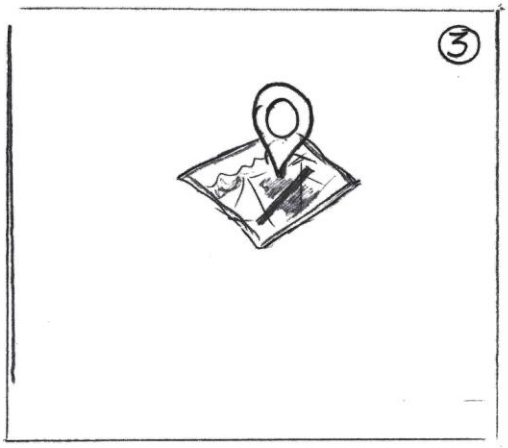
In order to support physical activity, even during non-routine behaviours (e.g. travelling on vacations or business), trackers could suggest activities in users' surroundings. The fact of being in a different place can often be an obstacle to the performing of exercises, as places where the exercises could be performed may not be known. The application (in the case of wearable trackers) after user location identification (GPS) could access a database listing suitable locations nearby and make suggestions such as parks, bike rental, canoe rental, courses (etc.) where the user could perform any type of exercise shown for example in augmented reality. Sport trackers applications could suggest more specifically the exercise type available such as gymnasiums, swimming pools, parks, places for rowing or cycling.
This support could even extend the devices further, by integrating these suggestions into other devices – such as a car's dashboard by accessing via *Bluetooth* the navigation, and could present the different suggestions verbally and through visual cues on the maps. After acceptance of these suggestions by the user, guidance would be activated on the map and traced the route to goal. All this iteration would always be performed with the permission granted via the customer's option.



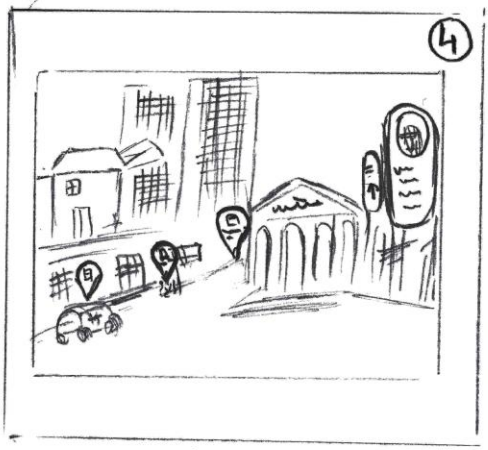
How to support physical activity, even during non-routine behaviours (e.g. travelling on vacations or business)?



In a foreign place sometimes, it is hard to know where to practice some physical exercise



By the user's location identification (GPS) the device could access a data centre about suitable locations around that place and make suggestions such as parks bicycle rental, canoe rental, fitness gymnasiums, etc.



The locations could be shown in augmented reality

Figure 21 – Keeping active in foreign places.

5.3 Improving user's physical outcomes

Activity trackers allow users to gain immediate awareness of their daily activity levels, as described by participants:

I enjoy that I can measure how many steps I walk and how active I've been during the day. [P 41]

Sports trackers, although providing similar awareness, differ since they are mostly used within a defined set of activities (e.g. jogging, swimming, cycling etc.):

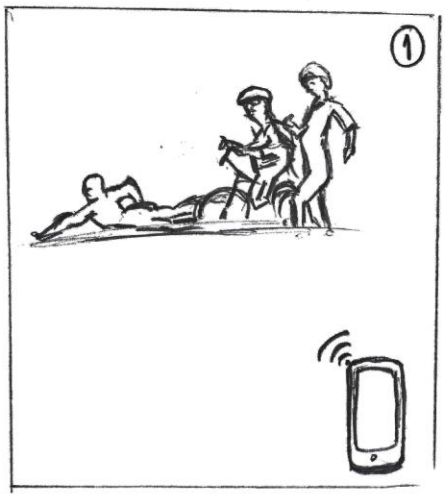
I like seeing my run once I'm done (…) whenever I need to. [P 55];

Sports Tracker will revolutionize how you program your Track & Field, Swimming, Running and others jogs. [P 45]

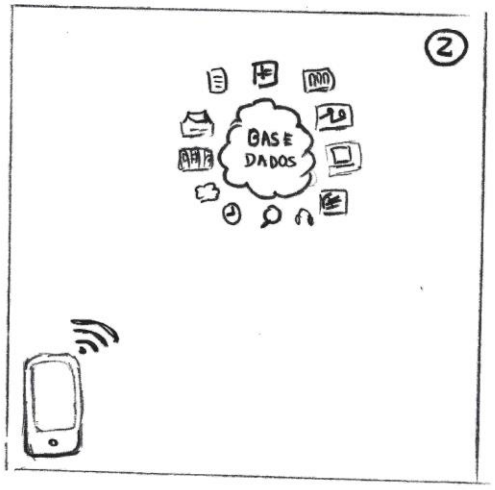
Participants from both tools found that providing immediate statistics on ongoing and on recently performed exercises was important by checking goal progress towards their daily goal. Others found that checking progress over the longer term helped them gain richer understandings about themselves:

I like to look at my progress. So I already think about my last run and app use before I start the next one. [P 59]

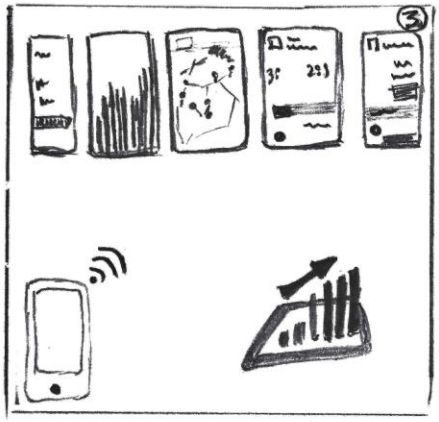
These devices, based on user statistics and progress, could **automatically** suggest goals to be met, without waiting for users to update their goals (either by making them harder to achieve or easier, or even suggesting a different exercise). The statistical information could be obtained from a data center provided by the manufacturer of the device / application.



Sport and activity trackers record all data related with the exercises performed



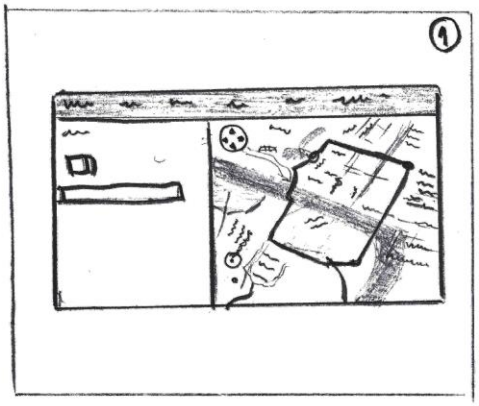
The statistical information could be obtained from a data centre where the user statistics data is recorded



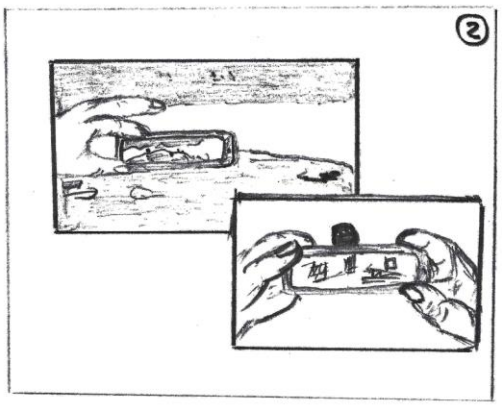
By the data analysis and based on the statistics the devices /applications could suggest new goals to achieved, thus increasing the user's performance.

Figure 22 – Exercises adaptive evolution

Another facility that could improve the attractiveness of these devices would be to propose going through certain routes in the form of games, in addition to simply tracing paths made by the user, the user goes through certain routes in the form of games similar to Pokémon Go (https://www.pokemongo.com/) or Zombies, RUN! (https://zombiesrungame.com/). Along the way the game would track, inform (for example in the form of augmented reality) on how to overcome the obstacles proposed for the different levels, and thus to achieve the proposed goal.At the end of the game, for example the user could receive some kind of prize such as a voucher type or another genre. Another alternative there could be a guided tour to a place of public interest enriched with information (again possibly in the form of augmented reality) about points of interest along the route.



(1) …Instead of the usual route tracking.



(2) It could be suggested to perform the route in the form of a game using augmented reality in it.

(3) A visit to interesting places also using augmented reality about all themes of interest related with that place, instead of the games, could be considered.

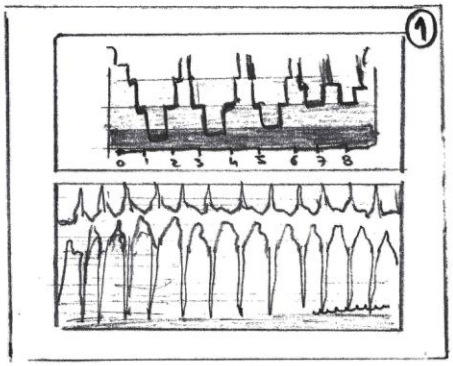
Figure 23 – (1) A usual route. (2) Two examples of augmented reality games. (3) One example of augmented reality information.

In a more specific example, one user (in this case an activity tracker user) showed some interest in monitoring the heart rhythm as well as the identification of abnormalities and mood changes. The activity tracker user refers this:

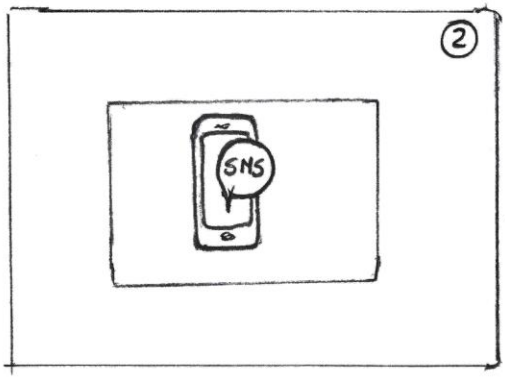
To monitor heartrates and identify abnormalities and mood changes. P [34]

Many of these devices are equipped with sensors to check sleep patterns and heartbeat. The information from these sensors is then recorded. Complementing this, the device after analyzing the information recorded, the device could send, in case of any abnormality detection (e.g. in heartbeat), a message to the user alerting him and suggesting a visit to the doctor.

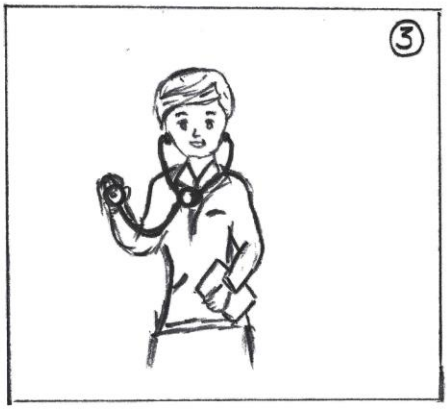
In a future situation depending on the evolution and reliability of these devices, the devices could also send an urgent message to the nearest healthcare services care including in this message the user's location and the reason(s) for the urgency.



Sleep patterns and heartbeat measures



The device analyses user patterns of sleep and heartbeat rhythm and if it detects an abnormality sends a message to him…



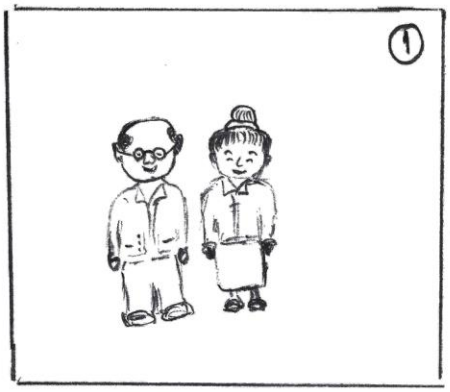
…suggesting a visit to the doctor

Figure 24 – An alert message

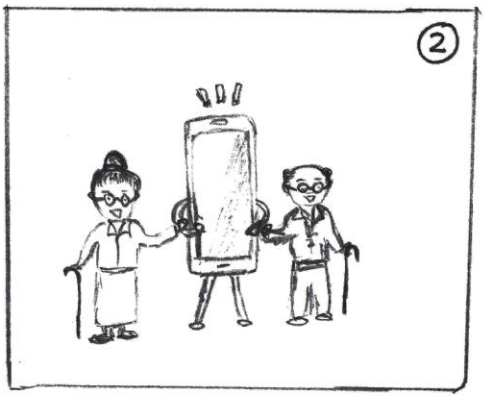
5.4 Help for the elderly

Analyzing both studies it was found that the predominant age group is between the ages 25 and 34, where we have 48 participants using Sport Trackers and 56 with Activity Trackers. Only two participants ranged between 55 and 64 years old. There were no participants in any of the questionnaires over the age of 64. Since both surveys were for participants aged 18 to 68 years old and ages above, there arises a few questions: why so few participants or none at all in the age group of 68 and above? Are these devices not seen to offer appropriate activity support for this age group? Is the software still too complex to be understood by people of these ages who may not have acquired the IT skills necessary? For future research, we believe it would be important to conduct an investigation focused on this age group. Such an investigation falls outside the scope of this thesis, and thus is here presented only by the suggestion of a few preliminary ideas:

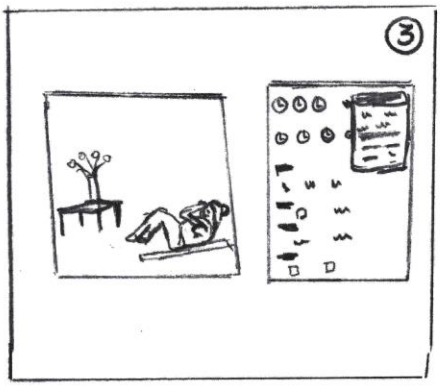
Given the results of the conducted research, it can be suggested that these devices / applications could also support people of more advanced ages than seemingly at present, as indicated by this study. To do this it would need to offer exercises more appropriate to these age groups along with various levels of implementation. Elderly people sometimes take a more sedentary attitude due to the necessities of the health issues governing advanced age. Furthermore, personal trainers specializing in this age group may not be locally available; or sometimes knowledge of such support may be difficult to obtain. These devices / applications provided with the appropriate software could assume these functions. The software would have to be as simple as possible to avoid difficulties in handling and in understanding.



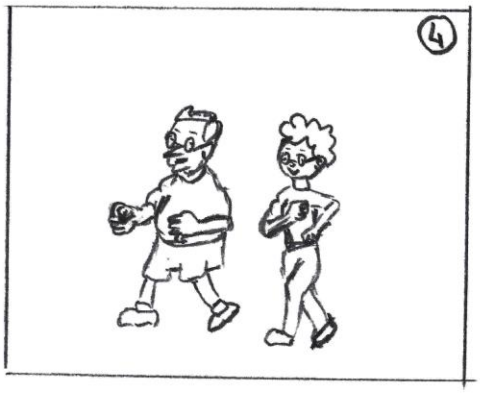
The elderly usually takes a more sedentary attitude because they often do not have support or ideas how they can be more active.



The devices/applications with the appropriate software could take on this “personal trainer” function.



The software should be very intuitive and simple to be understandable, yet should be evaluative to help improving the elderly performance.



Now we are active!

Figure 25 – Elderly people help.

6. Conclusion

This thesis investigated how people use trackers in their daily lives and how they perceive benefits from their use – with the purpose of leveraging on such insights towards designing more enriching tools, with prolonged use. The study presented within this thesis is an exploratory qualitative inquiry into users' experiences via social media. This study was conducted by deploying large-scale surveys targeting about 150 to 200 people. The surveys were left active for a month and during that time, a total of 214 responses to the activity trackers survey and a total of 209 to the sports trackers were obtained.

The study has been inspired by the U & G theory that theorizes how different media's meet user's social and psychological needs. This theory was used by Stafford [21] and further adopted by Joinson [22] and Spiliotopoulos [23]. The study consists of surveys, inquiring into participant's experiences with activity trackers using the first step of the U&G theory, which consists in a list of four open questions, to attempt to identify the use and gratification of a certain media. Focus was then centered on the answers given only to the first question following the methodology contained in the first part of the Uses and Gratifications Theory [22]. After analyzing the answers, a list of words or phrases was obtained characterizing typical uses and gratifications in an exploratory manner. The obtained results were grouped and categorized by topic / degree of similarity.

The analysis of these results revealed characteristics of both sport and activity trackers usage - the former could be seen as a device to support the practice of specific sports, and the latter a device to support people to improve their health. Both devices support for example, improvements in health and fitness by allowing users to set goals and suggesting additional exercise goals in. From the survey analyses, it was observed that most participants have been using these devices for an average of two years in the case of sport trackers, and in the case of the activity trackers, for an average of six month. This could be due to the fact sports trackers have been supporting athletes for longer, and so are more rooted in our environment.

This type of study always presents elements of unavoidable subjectivity because, when the object of analysis is related to human habits and behaviours, there is a lack of precision due to the inherent linguistic anomalies within, and almost control-free mechanisms without, unavoidably prevalent in the participants´ responses. As such, the results that arise from it share some of this subjectivity, which poses the question to what extent can they be considered accurate and coherent, especially when they are based on a qualitative analysis only.

6.1 Conclusions

From the study, however it was possible to assess in a qualitative way, what makes these tools pleasurable and engaging. It was found that users appreciate the fact that they can monitor physical activity because they can receive immediate information about their daily activity levels. The fact that these devices provide accurate information about one's capabilities by accurately tracking activity levels and provide "honest feedback", as opposed to human estimates that may be biased-prone, make them highly appreciated by their users. Other findings confirmed the attractions of the technology - the simplicity of use, its efficiency, its ubiquity, its high capacity of tracking several metrics and flexibility are demonstrable attributes that make these devices attractive. Empowering / boosting motivation characterizes the fact that these devices promote motivation in the form of rewards or pushing users to go further. Users clearly feel satisfied when they push themselves and achieve their goals even with the help of friends. Users praise the fact

that trackers reward them when achieving goals, through trophies or other motivational feedback in other words getting credits for achievements. The reliability of the tracked data is well praised by users. They also praise the devices physical robustness/non-problematic software. The devices are almost seen as an advisory or a tutorial instead of "simple tools". The ease of use and the simplicity of these devices was remarked on by users. The fact of the devices allowing users to program almost everything it was well praised by them. The real impact and influences these devices promoted on users' behavior, with changes attained towards healthier habits, was clearly demonstrable from the responses garnered in this study.

Based on these findings, design recommendations were drawn up including two recommendations specifically to *boost motivation*. Firstly, the application has the ability to find user's friends to join him in practice of exercise; secondly sharing the device among friends or family instead of being individualistic and for sole usage. Shared usage could be achieved through each participant accessing their own profile by identifying themselves in the device and synchronizing for a group/joint activity. More details can be seen above in sub chapter 5.1.1. Both of these design recommendations should follow Consolvo's design strategies [10]: such as Aesthetic - it must keep user interested and curious, and it may be used over time. It should be comfortable and attractive; Abstract & Reflective – it must use data abstraction to motivate user reflection about his behavior; Positive – the user behavior change must be encouraged for example with rewards and Controllable – depending on the circumstances user should be able to have control over de data. Another design recommendation is to help the user to locate places to practice the routines when travelling away from home (see section 5.1.2). Sometimes in a different country, it is difficult to locate places to practice some exercise. This recommendation gives some help in finding these by *supporting physical activity out of the daily routine*, such as parks, bike rental, canoe rental, courses (etc.). It does this by locating the user and searching those places nearby. This technology by following Consolvo's design strategies [10] should be unobtrusive – should be present for its user, capture, record his data and make it available yet in a discreet manner; and aesthetic (as already explained).

It was found that providing immediate statistics on ongoing and on recently performed exercises was important to participants from both tools to check goal progress towards their daily goal. It was also found that by checking progress over the longer term helped them to gain richer understandings about themselves. Considering this and based on user statistics and progress, arises the idea of the device to propose automatically new goals to be met, without waiting for users to update it. This was classified as *Improving user's physical outcomes* (see sub chapter 5.1.3.). Again following Consolvo's guide lines [10] this design should be abstract & reflective thus it must use data abstraction and not raw or explicit data with the intention of showing the relationship between these behaviours and the goals. It should be unobtrusive, controllable, trending/historical - technology must provide accurate information and easy access about the past behaviour of the user regarding their goals and objectives. Based on this data analysis, the device will automatically provide new goals and should be comprehensive –the data must use the correct means and be adaptive to the context of the task being performed, otherwise risks being a discouragement to the user.

Another suggestion would be to propose going through certain routes in the form of games, instead of simply tracing paths made by the user. These games could use the augmented reality to interact with the user and inform him about how to overcome the obstacles (see sub chapter 5.1.3. for details). This design should respect the abstract & reflective rule, and should be unobtrusive. Here the technology must sustain interest and curiosity as it may be used over time as a personal object so it must be aesthetic and also must be comprehensive.

Activity trackers in some cases are used to monitoring the heart rhythm as well as the identification of abnormalities, mood changes, and sleep patterns. Most of these devices are equipped with sensors to check sleep patterns and heartbeat rhythm. Usually the information tracked by the device is only recorded. One idea to complement this could be, after this data is analyzed by the device, in case of detection of any abnormality (e.g. in heartbeat), return an alert message to its user suggesting him see the doctor.

6.2 Limitations

From this study, a knowledge and understanding of these devices and how they are seen by their users was obtained. Based on this knowledge, some design recommendations have been presented that may add technological value to them. However, this contribution could have been deeper and more accurate if a different approach – such as the use of an experimental setup and a controlled group - had been followed to find out which was the more adequate method to obtain the answers. The answers to the questionnaires were essentially obtained through Mechanical Turk but the results obtained were not as expected. Although this method presented good results for other investigations previously performed, this study did not verify the medium´s suitability to meet with its aims. Since Mechanical Turk is a place where participants are paid to respond to questionnaires, the sincerity of the answers is questioned, or it is asked if there is any possibility of manipulation of the answers. Although some filters were placed on the questionnaires, the answers, rarely erudite enough, presented little detail, which sometimes provoked some difficulty in deducing the benefits and uses the users give the devices under analysis. One solution would be to go beyond the dissemination of the questionnaires in Mechanical Turk and augmented with face-to-face questionnaires for example addressing a control group such as practitioners of sport and/or portions of the general population with demonstrable experience of the devices. Thus, richer and more accurate information for analysis would be garnered. This was not attempted due to subsequent time constraints and emerging difficulties. However, in hindsight the questionnaires could have been improved at the filter level in order to compel responses in more detail, and could for example have been asked a supplemental question regarding the frequency of use of the devices (e.g. How many hours a day was the device used; ; How many times per month). Although one had the indication acquired from the questionnaires concerning the length of time of ownership of devices, it is not well understood from the limited replies how often respondents used them. This information it is relevant if one is to have a notion of how much the devices are already integrated in the daily lives of the participants. Thus, although not applied in this study, it is herein presented as suggestions for future work.

6.3 Future work

Focusing on the participant's age, in both studies´ analysis (activity trackers and sports trackers), it was observed that the predominant age group is between the ages 25 and 34, and no participants in any of the questionnaires over the age of 64 and above. Therefore, it aroused some curiosity as for example: are these devices not seen to offer appropriate activities support for this age group? Is the software still too complex to be understood by people of these ages?

From these questions, some other ideas fermented. These devices could offer special exercises more appropriate to these age groups along with various levels of implementation. The devices could assume the role of a "personal trainer" and give support to these people motivating them to be more active. The implemented software would have to be as simple as possible to avoid

difficulties in handling and understanding, and could also provide information regarding locally available sites of relevance where such activities are available. This could be seen as a *help for the elderly*. It should be comprehensive, trending/historical, controllable, very positive and abstract & reflective.

Another situation was observed within the study. When verifying the participants by gender it is acknowledged that we have 60 percent male and 40 percent female participants using activity trackers. In the case of sport trackers, we have 73 percent male and 27 percent female participants. These findings raise some questions: are men more dependent on these devices to maintain their routines? Do they prefer to have greater precision with their evolution? Are the devices wrongly designed only for male use as well as the associated software programmed only for male resistance limits? Is the software itself unattractive to women (perhaps too much information or too much statistics)? Is there an inherent male bias in the software design that needs assessing and addressing? Do women prefer to use music players (iPad, mp3) during the execution of their physical routines, instead of trackers, and thus perform them in a more relaxed way?

These and other issues deserve some attention and should not be overlooked; however, they are outside the scope of this study. They should probably be the subject of a new careful study within this area.

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Appendix A

Activity Trackers Survey

UNDERSTANDING THE USES OF ACTIVITY TRACKERS

NOTE: ALL ANSWERS WILL BE ASSESSED BEFORE ACCEPTANCE. VAGUE AND NON-RELATED ANSWERS WILL BE REJECTED!

INTRODUCTION

This survey attempts to collect information about the uses of activity trackers.

In particular, we want to understand why users use these tools and how their experience develops as they adopt them into their daily lives.

PARTICIPATION

We are targeting exclusively participants that use or have used an activity tracker before.

PROCEDURE

You will be asked to complete a short survey about the use of activity trackers. The survey consists of 8 questions and will take approximately 12 minutes or less.

CONFIDENTIALITY

All data obtained will be kept confidential and will only be reported in an aggregate format (the combined results from the study). All surveys will be concealed and no one other than then primary investigator and assistant researches will have access to them.

ABOUT THE STUDY

This study is conducted by Marco Leão, in the context of his Master thesis at Madeira University, Portugal.

What is your age?

12-17

18-24

25-34

35-44

45-54

55-64

65+

What is your gender?

Male

Female

Which of the following activity trackers do you own?

(Please choose the one you use more frequently)

Fitbit

Jawbone Up

Nike+ Fuelband

Moves Mobile App

Peeble Steel

LG G Watch

Samsung Gear 2 Neo

Adidas Micoach Smart Run

Airo Health Tracker

Archos Activity Tracker

Garmin Vivofit

LG Lifeband Touch

Sony Core Activity Tracker

Jaybird Reign

Atlas Fitness Tracker

Other

None

How long have you been using this tool for?

What is the first thing that comes to mind when you think about what you enjoy most when using the Activity Tracker you use?

What other words describe what you enjoy about using this Activity Tracker?

Using single, easy-to-understand terms, what do you use this Activity Tracker for ?

What uses of this Activity Tracker are most important to you?

Sport Trackers Survey

UNDERSTANDING THE USES OF SPORTS TRACKERS

NOTE: ALL ANSWERS WILL BE ASSESSED BEFORE ACCEPTANCE. VAGUE AND NON-RELATED ANSWERS WILL BE REJECTED!

INTRODUCTION

This survey attempts to collect information about the uses of sports trackers.

In particular, we want to understand why users use these tools and how their experience develops as they adopt them into their daily lives.

PARTICIPATION

We are targeting exclusively participants that use or have used a sports tracker before.

PROCEDURE

You will be asked to complete a short survey about the use of activity trackers. The survey consists of 8 questions and will take approximately 12 minutes or less.

CONFIDENTIALITY

All data obtained will be kept confidential and will only be reported in an aggregate format (the combined results from the study). All surveys will be concealed and no one other than then primary investigator and assistant researches will have access to them.

ABOUT THE STUDY

This study is conducted by Marco Leão, in the context of his Master thesis at Madeira University, Portugal.

What is your age?

12-17

18-24

25-34

35-44

45-54

55-64

65+

What is your gender?

Male

Female

Which of these devices or applications do you use to perform phisical activity?

(Please choose the one you used more frequently)

Garmin Forerunner

Polar FT80

Misfit Wearable Shine

Sports Tracker

Endomondo Sports Tracker

Strava Run GPS Running Tracker

Sportypal Classic

PureRunner

Biorunner Cardio App

Gym workout log book

Runastic Pro

SyncMyTracks

I.Run GPS Running coach

Nike+ Running

Other

None

For how long have you been using this tool for?

What is the first thing that comes to mind when you think about what you enjoy most when using this Sport Tracker, you use?

What other words describe what you enjoy about using this Sport Tracker?

Using single, easy-to-understand terms, what do you use this Sport Tracker for?

What uses of this Sport Tracker are most important to you?