



Norwegian University of
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Implementing Self-determination Theory in Mobile Applications

A systematic literature review of research in
the field of noncommunicable diseases

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Abstract

Noncommunicable diseases are the leading cause of global deaths. Many of these deaths could be avoided if people altered some of their habits, in regards to exercise and diet. For people to make changes, their motivation has to be changed. With smartphones becoming more widespread this seems to be a great tool to help people make positive changes in their life and reduce the impact of noncommunicable diseases. Self-determination theory, a theory for explaining motivation, splits motivation into three groups amotivation, extrinsic motivation and intrinsic motivation. Intrinsic, the personal desire for doing a task being the most effective of the three. When explaining how motivation for a task can be measured, self-determination theory introduce the terms autonomy, competence and relatedness. Autonomy is the feeling of being in charge. Competence is described as the feeling of learning and progression, while relatedness is the need for belonging and being part of a group.

The research topic for the thesis is how one can use principles from self-determination theory to affect a users intrinsic motivation to make them take steps in a positive direction to change their lives and move away from habits making the contraction of non-communicable disease more likely.

For this thesis there was conducted a systematic literature review to gather the information on the current state of affairs in the field of mobile motivational applications in relation to self-determination theory and noncommunicable diseases.

The findings of the review include a list of proposed techniques to implement in applications to help increase a users motivation by utilising the concepts of autonomy, competence and relatedness. Some of the proposed techniques are, goal-setting, motivational messaging and social networking functions. Other findings from the research are the need for customisation of the application to fit the needs of the users, and the various difficulties related to this.

Keywords: Noncommunicable diseases, self-determination theory, intrinsic motivation, autonomy, relatedness, competence, motivation, mobile application, digital health, ehealth, behaviour change.

Sammendrag

Ikke-smittsom sykdom, bedre kjent som livsstilsykdommer, er den globalt ledende årsaken til dødsfall. Mange av disse kunne vært unngått dersom man endrer noen vaner, spesielt knyttet til trening og kosthold. For at man skal endre seg må man ha motivasjon til å gjøre det. Smarttelefoner blir mer og mer utbredt, og ser ut til å kunne være et godt verktøy for å hjelpe til med å gjennomføre positive endringer i livet som kan redusere ikke-smittsom sykdom sin innvirkning. Self-determination theory, eller selvbestemmelsesteorien, er en teori for å forklare menneskets motivasjon. Den deler motivasjon inn i tre forskjellige deler, amotivasjon, ytre motivasjon og indre motivasjon. Indre motivasjon er når man har glede av å gjøre en oppgave uten å bli lokket med noen form for belønning. Denne typen motivasjon er den mest effektive av disse tre. Når selvbestemmelsesteorien skal forklare hvordan man kan måle motivasjon, introduseres begrepene autonomi, kompetanse og fellesskap. Autonomi er følelsen av å styre seg selv og å være den som bestemmer. Kompetanse er forklart som følelsen av å lære og å utvikle seg. Fellesskap er behovet for å være en del av en gruppe og å ha relasjoner med andre mennesker. Ved å øke følelsen av disse vil man nærme seg indre motivasjon på spekteret.

Forskningsemnet for denne masteroppgaven er hvordan man kan bruke selvbestemmelsesteorien til å påvirke en persons indre motivasjon for å få dem til å endre dårlige vaner, og å redusere muligheten for å pådra seg ikke-smittsomme sykdommer.

For å undersøke dette, ble det i denne masteroppgaven gjennomført en systematisk litteraturanalyse i den hensikt å få oversikt over hva status for forskningen er når det kommer til mobile motivasjonsapplikasjoner i relasjon til selvbestemmelsesteori og ikke-smittsom sykdom.

Funnene i analysen inkluderer en liste med foreslåtte teknikker man kan implementere som anslås å hjelpe til med å øke en brukers indre motivasjon. Listen er utarbeidet ved å relatere foreslåtte teknikker til konseptene autonomi, kompetanse og fellesskap. Noen av teknikkene er muligheten for å definere egne mål, motiverende beskjeder og sosiale nettverks funksjoner. Det ble også gjort funn i forhold til behovet for å skreddersy applikasjoner til å passe en brukers behov og de forskjellige vanskelighetene relatert til dette.

Preface

This master's thesis in Informatics was written during the spring and fall of 2018, as the final delivery in a Master of Science Degree, for the Department of Computer Science at the Norwegian University of Science and Technology (NTNU).

I would like to thank my supervisor Associate Professor Babak Farshchian, at the Department of Computer Science at the Norwegian University of Science and Technology (NTNU), for his guidance, support and patience during the thesis. I would also like to thank my family and friends who provided support and assistance in completing the thesis.

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Trondheim, 30th October 2018

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Acronyms

CET Cognitive Evaluation Theory.

ICT Information and communications technology.

NCD Noncommunicable diseases.

RQ Research Question.

SDT Self-determination Theory.

WHO World Health Organization.

1 Introduction

In this chapter the motivation for this study will be explained. The research question and the research method will be presented and there will be a brief explanation of the thesis structure.

1.1 Motivation for the Thesis

The leading global cause of death are noncommunicable diseases and in 2012 it cost as many as 38 million people their life. Many of these deaths can be avoided if people change to a healthier lifestyle and make healthier choices in their everyday life [2]. Together with this enormous social damage the diseases cause a substantial economic loss as well. The estimated losses in low- and middle-income countries for the period of 2011 to 2025 amount to 7 trillion American dollar if nothing is done[2].

With this knowledge one has to ask why people with the opportunity and the ability do not change the state of affairs. Knowing the risk should be enough for most people to find the internal motivation to change ones habits and decrease the possibility of attracting these preventable diseases and live a longer and healthier life. On a global politics level, with WHO's initiative, it seems that many countries are starting to move in the right direction.

The key to initiate change are found in the motivation of people, it is a complex part of human behaviour and can be a powerful force that makes us do incredible things, but it can also be an obstacle to overcome in moving our life in the right direction.

What triggers human behaviour and how one can influence a persons motivation to help them form healthier habits and reduce the risk of contracting noncommunicable diseases? According to a recognised motivational theory, self-determination theory [3], there are different types of motivation, intrinsic and extrinsic. The intrinsic side is your internal drive, while extrinsic is outside forces that make you act or do. The actions you perform only for yourself would be on the intrinsic side. In order to make a person change one would have to affect what is set in a persons mind regarding the actions they perform on a regular basis. With the current ubiquity of mobile phones, one approach could be to utilise this technology in reaching out and motivating people.

With the smartphone being so widely used around the globe one has the opportunity to directly influence people in their everyday life and attempt to motivate them to make smarter choices towards a healthier lifestyle. A lot of mobile application and web services have been created to try and make this goal a reality and help people lead healthier lives, but are they working? The opportunity to influence users that the smartphone offers are quite new and research is trying to catch up. The knowledge of the mechanics on

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effect and use of applications are sparse and we do not yet know a lot about how this impacts people and their way of life. To be able to further explore this topic it would be useful to sum up what has currently been done in a systematic literature review. This knowledge might be how applications can effect a users intrinsic motivation or how to design applications in order to achieve this effect. What tools and methods that have been found to be effective as well as if there even can be found a link between the application use and sustained intrinsic motivation. If research show that there indeed is an opportunity as described above and one were to be successful in doing this, one could make a great impact on human health and lifespan globally. Another hurdle is the cost of healthcare and the access to it which research could help overcome. By preventing noncommunicable diseases one would reduce medical expenses across the world and by using tools as widely spread as the smartphone and the internet, one could reach a larger portion of the population. Not all people have the opportunity or financial means for easy consultation from healthcare professionals or specialised equipment. These people could be better off if the tools were accessible and readily available. An application for self-care of some aspects of health management would be easy to scale for additional users and offer an affordable solution to this growing global issue.

1.2 Goals and Research Questions

The goal of this thesis is to explore the literature, and find what techniques and theories are used in mobile applications in order to effect a persons intrinsic motivation in the effort of combating the growing global issue of noncommunicable diseases. The application should be accessible for everyone that may need it without a substantial extra cost and specialised equipment. The goal is to learn what is being done on this issue today and to be able to make suggestions on what could be done in the future.

The research questions that serve as the basis for this thesis are:

- **RQ:** What do we know about SDT, implemented to affect user intrinsic motivation, in NCD related mobile applications?
 - **1.1:** How are SDT used to determine the techniques?
 - **1.2:** Examples of techniques used?
 - **1.3:** What methods are used in research?

1.3 Research Method

The research has been conducted as a systematic literature review. After a preliminary study of the topic field, a search string was created and applied on four suitable databases: PubMed [4], ACM [5], Web of Science [6] and Engineering Village [7]. The results were then processed by the author of this thesis and the thesis supervisor. This process is discussed more thoroughly in chapter 3. The chosen papers were studied and the results are presented in chapter 4.

1.4 Contributions

Computer science is a rapidly evolving field where new theories and concepts can change the world in a short amount of time. The smartphone and app development are still a new technology in the world. Scientific research does not move as fast as development of new technology which leaves a gap between the scientific proven knowledge and the state of the world. With the rapid expansion and the short lifetime of smartphones a lot of knowledge on how it effects the population in different ways has yet to be explored by scientific researchers. The combination of the power of mobile applications along with the knowledge of human behaviour and motivational theory can effect people to make better choices and maybe change their ways.

Using this question in the context of the issue of the increasing threat that is non-communicable diseases [2], and the fact that many of the deaths are preventable, it is of interest to examine the field of research in this combined area.

1.5 Thesis Structure

The thesis is structured as follows; Chapter 2 contains the background theory, Chapter 3 explains the method that was used in conducting the systematic literature review. Chapter 4 are the results from the review and in Chapter 5 these results are discussed. In the conclusion, Chapter 6, the discussion is summed up and further research is proposed.

2 Background Theory

This chapter presents the necessary theory to further understand the basis of this thesis as well as the topics discussed.

2.1 The Hypothesis

The hypothesis for this thesis is: to avoid contracting noncommunicable diseases, or cope living with it, requires a lifestyle change for most people. When changing ones lifestyle, whether one is successful or not is largely determined by motivation. ICT based mobile applications can help raise a users intrinsic motivation, through applying different techniques based on principles from self-determination theory. Implementing such techniques would aid the user in acquiring and sticking too new and healthier habits.

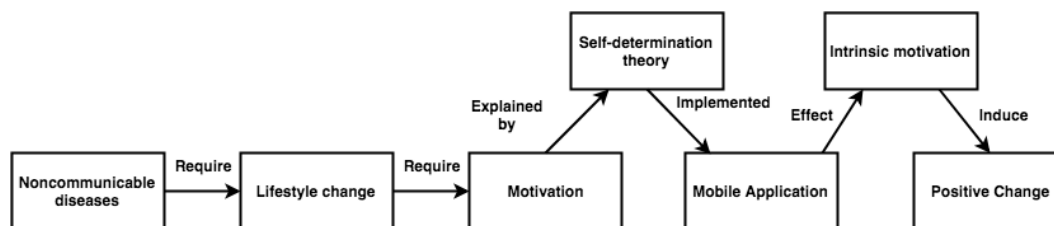


Figure 2.1: Diagram of the hypothesis

2.2 Noncommunicable Diseases

Noncommunicable diseases are also referred to as chronic diseases or lifestyle diseases. These diseases are non infectious diseases, such as stroke, cardiovascular disease, diabetes type 2, cancer and chronic respiratory disease. This group of diseases were responsible for 38 million deaths, 68 % of annual global deaths in 2012.

As many as 40% of these deaths are classified as premature, people under the age of 70. The majority of these premature deaths occur in low- and middle-income countries, as many as 82% [2]. This indicates that part of the problem is getting the information out there and making healthcare more accessible and affordable for a greater part of the worlds population.

2 Background Theory

Noncommunicable diseases differ from most other diseases by the fact that they, to a certain degree, are largely preventable. The diseases are contracted mainly from lifestyle choices, in regards to diet, activity level as well as tobacco and alcohol use[2]. Some of these choices can be forced due to economic constraints, living situation or other factors outside of an individuals control e.g. second hand smoking or healthy food often being more expensive. Knowing this the focus of this thesis is on the intrinsic factors and what a person by itself can alter.

The increasing epidemic of noncommunicable diseases are one of the largest problems the World Health Organisation tries to combat, in their "Global action plan for the prevention and control of noncommunicable diseases 2013-2020"[8] they state some objectives to reach their goal of reducing the preventable and avoidable economical, productive and mortality burdens that noncommunicable diseases inflict on the world. These objectives are to raise the priority and capacity, strengthen the health system for prevention and control, and monitor whether or not the programs are working as well as reducing the risk factors.

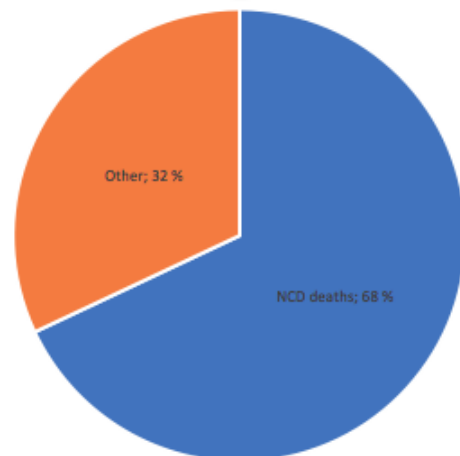


Figure 2.2: Global deaths

2.2.1 The main lifestyle-related risk factors

Several of the noncommunicable diseases are related to different risk factors. It is a complex and convoluted risk and effect matrix where most conditions contribute to the higher risk of others. Most underlying causes based on these risks makes many of the noncommunicable diseases more likely. The risk factors most relevant for this thesis scope are reviewed in the following sections.

Insufficient physical activity and a non healthy diet

The risks that occur from a bad diet and a lack of exercise are the increased possibility of obesity, diabetes, cardiovascular disease, cancer and stroke.

Insufficient activity is a major global issue in all layers of the population and is causing an estimated 3.2 million deaths a year [2]. To be considered physically active, by WHO standards, an adult, 18 years or older, must be active for more than 150 minutes a week. For children the recommended time is 60 minutes a day. In 2010, 23% of adults did not meet this standard and this average grew from the youngest group to the oldest. For the children it was a lot worse, 81% between 11-17 years of age did not meet the requirement [2]. Not being physically active leads to a lot of undesired health consequences. Increasing peoples activity level is an important part of obesity prevention and controlling ones weight.

Obesity are closely linked to poor health and higher mortality risk. Diabetes, hypertension and cardiovascular diseases are the most common noncommunicable diseases in relation to obesity. In 2014, 39% of adults, over the age of 18, were considered overweight. Globally 15% of women and 11% of men were considered obese [2]. It is a growing problem that has skyrocketed in later years. One of the WHO's proposals for a healthier diet, is to reduce the amount of salt/sodium that is consumed, in 2010 excess use of salt and sodium was attributed to causing 1.7 million deaths [2]. To try and remedy the non healthy diets the WHO action plan[8] propose that the governments implement recommendations in marketing of food, develop guidelines and recommendations for people to follow, get manufacturers to switch to healthier fats in food production and work for their citizens to increase the consumption of fruit and vegetables along with generally limiting the calorie intake. To increase physical activity some of the proposed measures are increasing the support for physical activities, campaigns to inform and motivate the public and making it a part of urban planning and infrastructure [8].

By following WHO's advice one would reduce the risk of cardiovascular disease, which is the leading cause of noncommunicable deaths with 17.5 million in 2012 and hypertension which caused 9.4 million deaths in 2010, and diabetes which was responsible for an estimated 1.2 million deaths in 2012 [2].

Tobacco and alcohol use

Two of the biggest contributors to many of the different noncommunicable diseases are tobacco and alcohol. Alcohol was estimated to be the cause of 3.3 million deaths while tobacco was the cause of 6 million deaths worldwide in 2012, and are the largest contributor to preventable NCD deaths. In addition 600 000 deaths were attributed to exposure from second-hand smoke, 170 000 of these were deaths among children [2].

Both of these factors are strongly associated with cardiovascular disease, cancer and liver disease.

Deaths caused by tobacco use are expected to rise and in 2030 be responsible for 8 million deaths or 10% of the worlds estimated deaths [2]. Since these deaths are preventable these are horrendous figures and many measures are being taken to start lowering these numbers. Several countries are imposing higher taxation, banning smoking in indoor public places, increasing the information on the dangers of use and banning tobacco companies from advertising, promotion and sponsorship [8].

The most common NCD deaths caused by alcohol use are related to cardiovascular disease and diabetes. Along with the risk of NCD from the use of alcohol, it also carries a higher risk of mental and behavioural disorders as well as injuries from violence and traffic accidents in relation to the use of alcohol. Many measures are taken to reduce the use of alcohol in different countries. The WHO's suggestions concerns awareness, pricing and taxation policies, availability, health service response and community action [8].

System-level risk factors

The access to healthcare and medicine is another great challenge in battling NCD. By making the equipment necessary for discovering and diagnosing the different diseases e.g. hypertension, a blood pressure gauge is needed, readily available, many people could be treated and have their lives prolonged. By increasing the availability of and lower the prices on basic medicine one would be able to extend millions of lives. In addition the access to healthcare personnel needs to be improved so people can get the necessary follow up and guidance when receiving care. To achieve this healthcare financing and national health strategies have to be improved. The WHO propose that countries take steps towards implementing universal healthcare coverage to make it an equal option for a larger part of the population. Strengthening and reorganising services and making it possible for all providers, for profit and non-profit, to address the issues posed by noncommunicable diseases while improving the effectiveness of services [8].

2.3 Self-determination theory

In order to understand how to influence peoples actions one have to understand what drives us. Why do people decide to do the things that we do? What drives our actions and decisions? Motivation is the answer to these questions. To be motivated is important. Motivation is ones internal drive and the reason behind all ones choices and actions. But motivation in itself is a vague concept where if asked everyone would provide their own definition and answer based on their personal experiences and believes.

There are a multitude of academic theories for motivation, dating back centuries. For the purpose of this thesis we are going to use a newer motivational theory that considers different types of motivation, self-determination theory as theorised by Deci and Ryan [3]. Self-determination theory is a recognised theory and one of the most utilised in the field of computer science and application research.

We have all felt the urge to do certain things because we find them enjoyable, for instance play sports, video games or go for a hike. You have also done a lot of tasks that you did not feel like doing, tasks that you did not come up with yourself, not enjoyable tasks you had to do to reach a goal, but still did it. Motivation plays a part in both of these categories, because if you were not motivated you would not have done anything. This difference indicates that there are different kinds of motivation.

Self-determination theory, SDT, focuses on the existence of different kinds of motivation. Not all motivation is the same. This theory is based on the understanding of competence, autonomy and relatedness, the three key psychological needs for how motivation works. These are essential to understand an individuals goal pursuits. *Autonomy* is the need for a sense of self or being in charge of your own actions. Doing the things that you want to do, following the path you set. *Relatedness* is the need to belong to something, a group, a tribe and having relationships. *Competence* is the need to feel accomplishments and having a sense of making progress, learning skills and being useful and competent.

Looking at figure 2.3 you can see how SDT categorises the different types of motivation and how they are structuring them into the three main types; Amotivation, Extrinsic motivation and Intrinsic motivation, from no desire to do a task all the way to autonomously feeling the need for doing it.

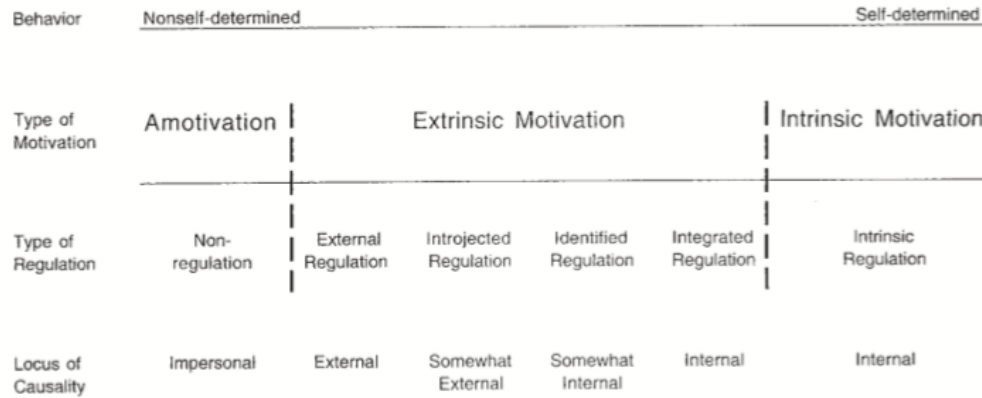


Figure 2.3: SDT scale of different types of motivation [1]

On the left side of figure 2.3 you find *Amotivation*, when you will not do something because you have no desire to do so. The reason for people to feel amotivation are when they lack the skills necessary to produce a good result or they lack control over the task [1, 3]. Moving to the right on the scale you get *Extrinsic motivation* the category that encompass all the aspects of motivation that come from outside sources, a task is done to attain a reward from someone else e.g. getting paid at your job. The different subcategories of extrinsic motivation varies from controlled to somewhat autonomous motivation. The degree to which you find internal motivation for the task. At the other end of the spectrum from amotivation we find *Intrinsic motivation* which is when the motivation is completely autonomous and comes from inside yourself. Doing something without the promise of any reward except the enjoyment of the task [1, 3].

Extrinsic motivation

Extrinsic motivation spans from "External" to "Integrated" in the degree which a person are influenced by others 2.3. Tasks are most externally effected when they are the least autonomous and not enjoyed. When we move towards "Integrated Regulation" you internalise the motivation of the task and find more autonomous joy in doing the task, the goal is something that you wish to achieve. When a person are on the external side, tasks only get done to stimulate some external demand or to receive a price or reward [3, 9, 1, 10].

2 Background Theory

Intrinsic motivation

Intrinsic motivation is doing something for the pure enjoyment or interest of doing it. Without being able to gain anything from doing it, you would still do it. Research has shown that if you start offering monetary rewards, or any sort of reward, for performance it undermines intrinsic motivation [1].

Intrinsic motivation is autonomous motivation, the type that most influence a persons actions, "...autonomous motivation and controlled motivation lead to very different outcomes, with autonomous motivation tending to yield greater psychological health and more effective performance on heuristic types of activities. It also leads to greater long-term persistence, for example, maintained change toward healthier behaviours." [3]. The reason for choosing to focus on intrinsic motivation in this thesis, is that it is viewed as the most effective for personal growth.

Cognitive Evaluation Theory

Cognitive Evaluation Theory, CET, is a sub-theory of the self-determination theory proposed by Deci and Ryan [10], to explain how external events or extrinsic motivators effect intrinsic motivation. CET suggests that extrinsic rewards or influence undermines and reduces, might even destroy, the intrinsic motivation for doing a task. Deadlines, goals, rewards, threats and the like, reduces a persons feeling of autonomy because it removes the feeling of determining your own life and tasks. In regards to competence it has shown that good feedback and positive reviews can give a heightened sense of self, and increase ones intrinsic motivation for a task. But you can not have one without the other, even if your feeling of competence for a task is high you will not find intrinsic motivation unless the tasks come with a sense of autonomy [11]. A person will never find intrinsic motivation for a task they do not find interesting to begin with, "...it is critical to remember that intrinsic motivation will occur only for activities that hold intrinsic interest for an individual—those that have the appeal of novelty, challenge, or aesthetic value for that individual" [11].

2.4 Technologies for Motivation

2.4.1 Gamification

When researching motivations connection to computer science, gamification is one of the first topics you come across, it is a growing academic field and a popular subject [12]. Gamification is in essence to use techniques from games and apply them to different task in the hope of making the tasks more interesting or fun to do, gamifying regular activities. Classic examples of this type of technique are applications giving you rewards, allowing you to work at achieve badges, high scores and tracking your use to see improvements etc. Social interaction and rewards and recognition are a big aspect of gamification, connecting you to other people trying to achieve the same goals to give you someone to compete against and making ones awards more meaningful [13]. Gamification tries to

alter your motivation, which has been shown to work, but it might work mostly because of the "novelty effect", and not be useful in the long term [12].

2.4.2 Persuasive ICT

Persuasive ICT is a commonly mentioned method when researching behaviour change related to motivation. Persuasive systems are computer systems designed with the intention of being persuasive and alter, reinforce or change the behaviour of a user according to Fogg [14]. The ways one can go about creating persuasive technology, according to Fogg [14] are by constructing software that reduces barriers and increase the likelihood of the desired behaviour, make wanted behaviour seem achievable through increasing self-efficacy, providing information that helps the users decision making as well as channel a users behaviour by shaping their mental model. There are many ways of constructing persuasive ICT to help improve peoples lives, but it is very important to remember the ethical aspects of this kind of technology and take it into consideration when creating applications and services. Persuasive technology is shown to have an effect, especially when the users are interested in the behaviour change that the technology seeks to implement, but they have struggled taking the steps on their own [15].

2.4.3 Motivational ICT Applications

There exists a large and growing number of applications in the different app stores. Some of these are in the realm of motivation or fitness and health. In may 2013 in the category for health and fitness, 17,756 apps were available in the Google Play store and 23,490 in the Apple app store [16], and the number has been growing since.

From this large number three of the more well known applications for motivation and behaviour change have been picked to serve as examples in this category, Strava[17], MyFitnessPal[18] and Habitica[19]. We are taking a look at these three apps, to see where they intersect with the base principles of SDT, and motivation.

Applications do not advertise with saying they utilise SDT in their apps, so knowing the thought process behind an application and the techniques they have decided to use are nearly impossible, but also not necessary. Applications in this field endeavour to influence the users desire and motivation to perform different tasks. When trying to effect motivation almost no matter what technique is used you can describe it using the SDT framework and the keywords, autonomy, competence and relatedness. The main function of these apps are summed up in the following bullet list.

- **Strava:** According to their website "The #1 app for runners and cyclists" [17]. An app that helps you track and analyse your exercise, with functions like recording your routes travelled and time spent, etc. Currently it has over 10 million downloads in the Google play store alone[20].
- **MyFitnessPal:** Application for counting calories in the food you consume and the exercise you do. It has been downloaded over 50 million times from the Google play store[21]

2 Background Theory

- **Habitica:** Application that uses gamification to promote habit change and increasing your productivity. According to its website there are currently 3 million users of the application [19].

All three applications are popular and have accumulated many users because of the techniques they have chosen and how they have implemented them. The applications have a lot in common in how they operate in regards to SDT theory and how they use the important motivational influencers.

All the applications give you the opportunity to share your results and communicate, and in some cases work together, with other users in the application or on different social media. Using these functions gives the user a sense of belonging, which fills the relatedness aspect of SDT.

To effect autonomy, they allow the users to set their own goals and tasks. This gives the user a sense of deciding their own faith and choosing their own path. By allowing the user to decide how to reach a goal, when to reach it and simultaneously tracking their progress the applications are supporting the user on their journey to fulfilling their goals, with instruments of autonomy.

The last of the three SDT needs for motivation is competence. To achieve this all three applications give the user feedback and awards to create a feeling of accomplishment. They also provide the ability to track your progress which gives the user a tangible measurement of their improvement and progress while becoming more competent. Together these functions fulfill a users competence need and completes the three cornerstones of SDT.

To present these findings in a clear and more intuitive manner we will use a table to visualise the techniques and what part of a users motivation they are effecting. The findings described above are shown in table 2.1.

Technique	Autonomy	Relatedness	Competence
Goal and task setting ability	X	-	-
Give awards and trophies	-	-	X
Deliver feedback on activities	-	-	X
Social networking functions	-	X	-

Table 2.1: Example technique classification

On the screenshot from the Strava application in figure 2.4 the different most active motivational elements have been marked. This particular screenshot shows how a recorded run is presented in the social "feed" of the application. The first element is the recorded time and pace, along with the GPS tracked route of the runner, this gives a clear overview of how the runner did, and where they went. This makes it easy both showing the run to other users as well as something for the user to utilise in depicting their own progress. The second element is the achievements the user have earned from this run, it has a prominent place and are depicted as medals. The remaining highlighted elements are the social media interfaces. Number three are where other users can like,

comment or share the activity and the fourth element is where the application can send you notifications and you can invite friends to activities.

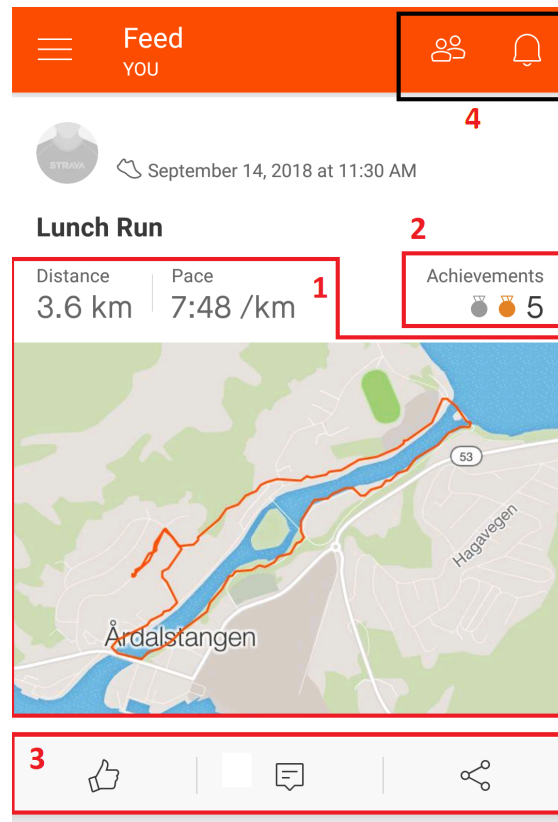


Figure 2.4: Strava recorded activity example

There are many more functions and elements in the application, like challenges, the ability to run different distances competing with other runners times and recording activities. There are also a lot more information available about each individual run.

When using the Habitica application a user creates a character that tries to accumulate experience points by doing tasks that the user specify and if the tasks are not completed you lose health points. These two elements are shown in the box marked with the number one, on figure 2.5. The main application page shown in this figure is a sample page. The second marked area shows the overview of user defined tasks to be completed. The Round "+" button allows the user to create new tasks to put on this list. The fourth box, marks the other lists of tasks and todos a user can define. The rewards tab allow a user to buy things in the game with coins earned in the application.

Earning experience points and creating rewards for tasks are common gamification techniques, used by the Habitica application. The screenshot in figure 2.6, shows the different "social" options in the application, you can join other players in doing tasks, and talk to other users.

2 Background Theory

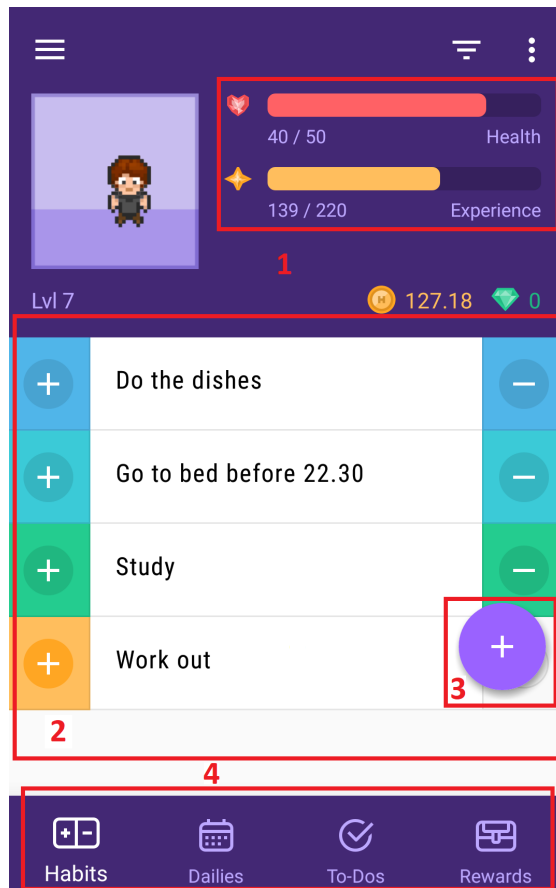


Figure 2.5: Habitica taskpage

These are some examples of how one can see application elements and classify them according to their SDT relation.

The apps focus on different aspects of your life, Strava[17] is just exercise, myFitnessPal[18] tracks your diet and exercise, and Habitica[19] helps you alter your habits and make you a more productive person through gamification. The applications use many of the same techniques to influence human behaviour. This is what this shallow inspection of the applications and how some of their functions can be classified using the SDT theory, hope to illustrate.

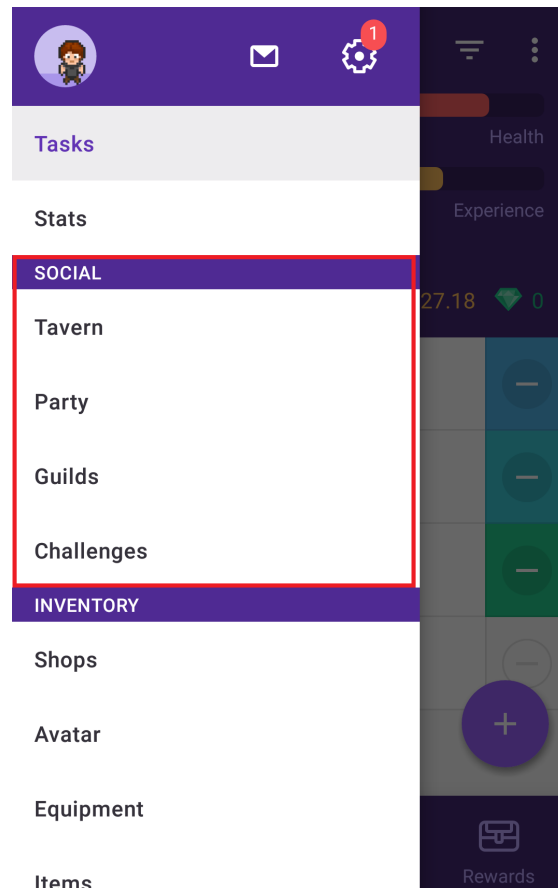


Figure 2.6: Habitica menu overview

2.5 Chapter Summary

In this chapter the major global problem of noncommunicable diseases are explained. In order to remedy this problem lifestyle change is needed. Mobile applications utilising motivational techniques can be a good starting point for these changes. To be able to use these techniques the self-determination theory framework for motivation is needed to classify how the techniques affect a user through autonomy, competence and relatedness. How SDT will be used later in the thesis are exemplified when examining applications in the section above.

3 Methods

In this chapter the systematic literature review that was conducted, with all the steps and the reasoning behind the choices, will be explained. The reason for choosing a systematic literature review as the method was that the interest for the thesis lay in conducting a survey of the current state of the field around how applications are trying to aid in the fight against noncommunicable diseases, and how they are trying to effect a persons intrinsic motivations to make healthier choices.

3.1 Search strategy

The research process was modelled after a proposed strategy in "Researching Information Systems and Computing" [22]. The figure from this book 3.1 depicts the different paths a researcher can take when conducting different kinds of research. The path that was chosen for this thesis is marked by the red border around the squares in figure 3.1.

Based on experiences and the motivation described in "Motivation for the thesis" 1.1, research questions were created around the broader goals described in the introduction 1.2. It was decided that the best way to conduct the research related to the goals was through a systematic literature review. When conducting such a review, one survey the documents in the field to select the articles that fit the criteria of the review. To process these select documents a qualitative data analysis approach was utilised, given that this is an analysis of textual data. The rest of chapter 3 will describe the steps taken to conduct the review.

3.1.1 Query

The first step in conducting the document gathering in a systematic literature review is to create a basis for a query to be used on selected databases. To find the keywords and the combinations of them that would yield the best return, an investigation in to the subjects were conducted. This resulted in some keywords and phrases in different categories. These results were then expanded using a thesaurus [23] to broaden the search. Some test searches on keywords and combinations were conducted to gain a better knowledge of what kind of results different search terms would generate.

This approach generated the keywords in table 3.1. The three categories chosen were "Motivation theory", "Disease and health" and "Technology", and each column contains keywords related to its category inside the parameters of the main RQ, "What do we know about SDT, implemented to affect user intrinsic motivation, in NCD related mobile applications?" 1.2. The motivation category will contain all the SDT and intrinsic

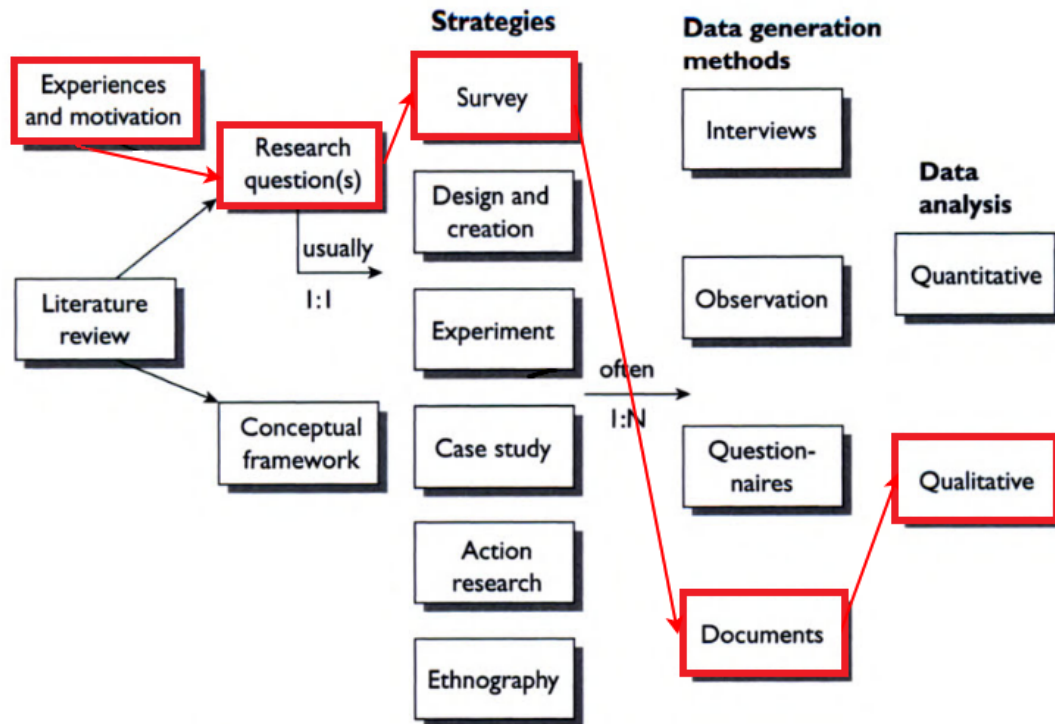


Figure 3.1: Model of chosen research process

motivation related keywords, disease and health category contains all NCD related topics while the last category, technology concerns the platform and different technologies that we are interested in researching. With the combination of these selected categories every part of the RQ is covered and relevant results should be found in the search. If the main RQ can be answered, the sub RQs will also be answered by the same papers.

To conduct the query a search string had to be created from the keyword table. When constructing this search string, the ability to add Boolean operators, "AND" and "OR" were used along with quotation marks to search for specific phrases. Adding "AND" between each category and "OR" between each term in the separate categories, makes sure that the returns of the queries at least contains a keyword from each column. Quotation marks were used to make sure that the database search engines searched for whole phrases e.g. "self-determination theory" instead of "self", "determination" and "theory". The string that was used can be viewed in table 3.2.

The databases

The search string was used on four different databases: Engineering Village [7], PubMed [4], ACM [5] and Web of Science[6]. These were chosen to get a broad spectrum of results

Motivation theory	Disease and health	Technology
cognitive evaluation theory	noncommunicable disease	mobile
cet	diabetes	smartphone
self determination theory	cardiovascular	tablet
self-determination theory	heart and lung	smartwatch
sdt	fitness	wearables
intrinsic motivation	weight loss	mhealth
relatedness	recovery	mobile health
competence	heart disease	m-health
autonomy	obesity	
	stroke	

Table 3.1: Search query table

("cognitive evaluation theory" OR cet OR "self determination theory" OR "self-determination theory" OR sdt OR "intrinsic motivation" OR relatedness OR competence OR autonomy) AND ("noncommunicable disease" OR diabetes OR cardiovascular OR "heart and lung" OR fitness OR "weight loss" OR recovery OR heart disease OR obesity OR stroke) AND (mobile OR smartphone OR tablet OR smartwatch OR wearables OR mhealth OR "mobile health" OR m-health)
--

Table 3.2: The search string

and to cover multiple fields, both science and medicine.

- "Engineering Village, the essential engineering research database, provides a searchable index of the most comprehensive engineering literature and patent information available" [24]. This was a natural choice to cover a lot of ground in searching across disciplines.
- PubMed, US National Library of Medicine National Institutes of Health, "PubMed comprises more than 28 million citations for biomedical literature from MEDLINE, life science journals, and online books" [4]. The database used to cover the medical aspect of this thesis.
- ACM digital library is published by the Association for Computing Machinery "a leading global source for scientific information" and "the ACM Digital Library (DL), a comprehensive and expanding database of literature and detailed bibliographic resources for computing professionals from a wide range of publishers." [25].

3 Methods

- Web of Science, a brand from Clarivate analytics is a trusted database containing science papers.

After searching these four well-renowned databases the results should cover the different aspects of the intersecting fields that concerns this review as well as removing any single database bias.

The query yielded the results in table 3.3. The majority of the results came from Engineering Village, which is not surprising considering it is the broadest database and there was some overlap with different fields. In total the number of papers were 1074.

Database	Result
Web of Science	132
ACM	80
Engineering Village	694
PubMed	168

Table 3.3: Search results

3.1.2 Inclusion and Exclusion Criteria

The next step in the process is to filter the result of the query, and extract the papers that contain information relevant for the research questions. The reference lists were downloaded from the websites and imported into Endnote [26], a common reference managing software. Under the import Endnote automatically removed 140 papers as duplicates, down to 934. A manual check uncovered another 102 duplicates leaving 832 papers.

To decide which of these papers were relevant a inclusion and exclusion criteria list was created. The list is presented in table 3.4, some of the criteria are explained in more detail in the following bullet list.

- **Mobile or Web:** To have the application available on most mobile devices, to reach the broadest audience, and be less geographically restricted.
- **Noncommunicable diseases:** The application is used to prevent diseases, like a fitness application, or support people living with it e.g. keeping track of diabetes related data.
- **Intrinsic motivation:** The paper had to focus on how to effect or what effect they had on intrinsic motivation.
- **Self-care and no healthcare personnel:** Since the focus was on a persons intrinsic motivation and internal drive, the user should not be influenced or driven by a third party.
- **Journal article:** Journal articles are more recognised as a valid source that have been through tougher scrutiny than conference papers.

Inclusion criteria	Exclusion criteria
The article is about a mobile or web-based application	Not complete research e.g. a study without results
The application is relevant in regards to noncommunicable diseases	Not a journal article
The article has results regarding the use of intrinsic motivational techniques	Paper not available in English
The application should be for self-care, not involving caretakers or other assistance.	No access to complete article
	Healthcare personnel involved in process
	Highly specialised equipment e.g. EKG-monitoring, prostheses
	The application is part of a multistep program.
	Designed for children(Under age of 12)

Table 3.4: Inclusion/Exclusion Criteria table

- **No access:** Even through NTNUs extensive database access, some papers may not be available.
- **Specialised equipment:** The tools should be available to everyone with Internet access and not be restricted by additional expensive equipment and hard to come by resources.
- **Multistep program:** The application should be a freestanding tool, not a part of a larger treatment plan as one small step in a program.
- **Not children:** Children would not be solely responsible for using an application in this category. Parents, teachers or other adults would have to play a role.

This screening was done separately by the author of this thesis and the thesis supervisor, Babak Farshchian. The reason for this was to reduce bias in the selection and missing any papers. The only part of the articles that was checked when conducting this screening was the papers title and abstract, so the initial lists were compiled based on what the papers disclosed here. After the screening papers were compared and discussed, 14 papers met the requirements for further reading and ultimately coding. The process was done this way to ensure a greater scientific credibility to the study, by having two

3 Methods

separate processes that yielded one collective result. The papers are listed in table 3.5, and the process can be viewed in figure 3.2.

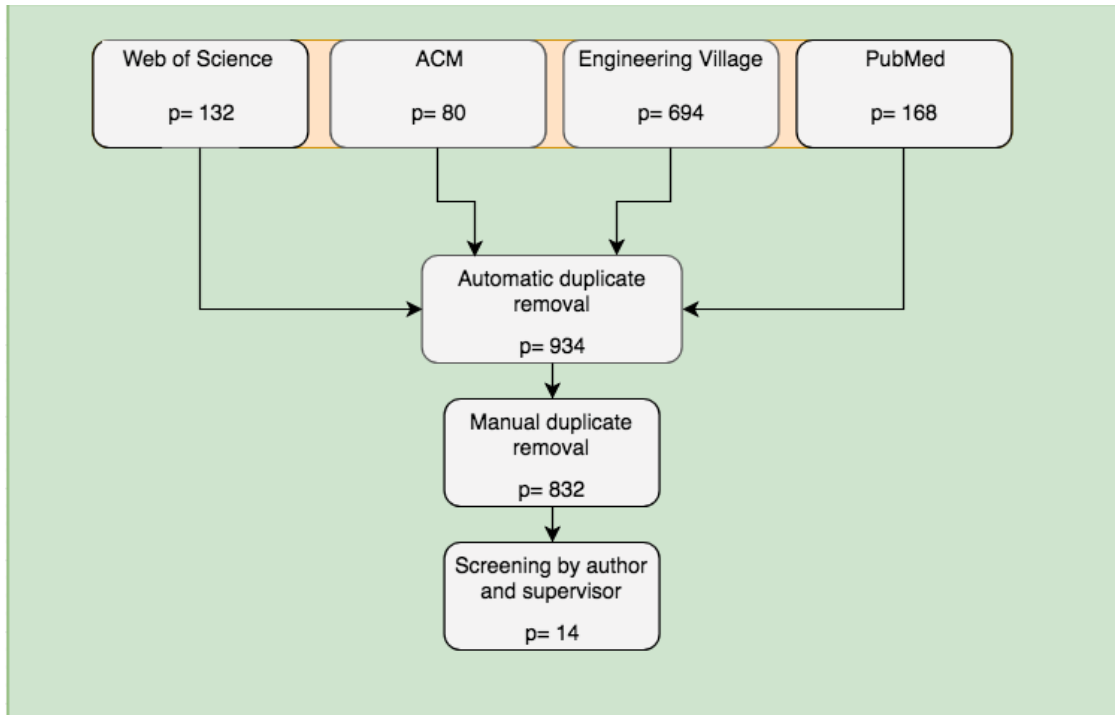


Figure 3.2: Model of paper screening process

Title	Authors	Ref	Year
Motivation and User Engagement in Fitness Tracking: Heuristics for Mobile Healthcare Wearables	Asimakopoulos, S. et al.	[27]	2017
Exergame Apps and Physical Activity: The Results of the ZOMBIE Trial	Cowdery, J. et al.	[28]	2015
Integrating visual dietary documentation in mobile-phone-based self-management application for adolescents with type 1 diabetes	Froisland, D.H. et al.	[29]	2015
A smartphone application to support recovery from alcoholism: a randomized clinical trial	Gustafson, D. H. et al.	[30]	2014
Explicating an Evidence-Based, Theoretically Informed, Mobile Technology-Based System to Improve Outcomes for People in Recovery for Alcohol Dependence	Gustafson, D. H. et al.	[31]	2011
Effectiveness of a smartphone app in increasing physical activity amongst male adults: a randomised controlled trial	Harries, T. et al.	[32]	2016
Exploring the Influence of a Smartphone App (Young with Diabetes) on Young People's Self-Management: Qualitative Study	Husted, G.R. et al.	[33]	2018
Gender differences in gratifications from fitness app use and implications for health interventions	Klenk, S. et al.	[34]	2017
Assessing the sustained impact of a school-based obesity prevention program for adolescent boys: the ATLAS cluster randomized controlled trial	Lubans, D. R. et al.	[35]	2016
Development and implementation of a smartphone application to promote physical activity and reduce screen-time in adolescent boys	Lubans, D. R. et al.	[36]	2014
Mobile Health Physical Activity Intervention Preferences in Cancer Survivors: A Qualitative Study	Robertson, M. C. et al.	[37]	2017
Feasibility of PRIME: A Cognitive Neuroscience-Informed Mobile App Intervention to Enhance Motivated Behavior and Improve Quality of Life in Recent Onset Schizophrenia	Schlosser, D. et al.	[38]	2016
Understanding persistence in the use of Online Fitness Communities: Comparing novice and experienced users	Stragier, J. et al.	[39]	2016
Sustainable Lifestyle Change-Participatory Design of Support Together with Persons with Obesity in the Third Age	Wiklund Axelsson, S. et al.	[40]	2016

Table 3.5: List of papers for coding

4 Findings

In this chapter the resulting papers from the review 3.5, were coded and analysed, the findings are presented here.

When crosschecking the papers actual content with the inclusion/exclusion criteria, it was revealed that many of the papers diverged from several of these criteria, this can be seen in table 4.9. Most of the papers did not match all the criteria but it was decided to keep all but one. The paper by Schlosser et al. [38] was excluded since it concerned mental disorder and not NCD related illness.

Some of the remaining papers were strongly connected. The two papers by Gustafson et al. [31, 30] considered the same application to prevent relapse in recovering alcoholics. The first paper, from 2011, proposes the idea and what the application should contain, the second one is a test of the outlined application. The two papers by Lubans et al. [36, 35] are from the same tests in the same program, to reduce screen time in adolescent boys. One is concerning the whole program where an application is a smaller piece and the other considers the development and the implementation of this application.

This means that there are 13 different papers from 11 individual sources.

Few of the papers had direct results regarding intrinsic motivation and the use of it in the NCD application related field.

4.1 Motivational findings

When coding the papers they were checked for any reference to, and use of self-determination theory and specifically intrinsic motivation. If this was mentioned the extent of how it was utilised was noted. The papers and their connection to SDT are found in table 4.1. This table shows that of the thirteen papers eight mention or use SDT, of these only four directly reference intrinsic motivation and offer results or design implication regarding this specific type of motivation. The degree to which the papers that mention SDT use it varies, from a strong focus and assigning functions directly to autonomy, relatedness and competence [27, 34] to merely mentioning it in the text [40]. The same can be said for the focus on intrinsic motivation, from a mention of the concept to offering some results. The paper by Harris et al. [32] uses the wording intrinsic motivation but does not mention self-determination theory.

The papers do not focus a lot on intrinsic motivation, so most of the results are extrapolated from other data and mapped by the author of the thesis.

4 Findings

Cite	Paper	SDT	Intrinsic Motivation
[27]	Motivation and User Engagement in Fitness Tracking: Heuristics for Mobile Healthcare Wearables	X	X
[28]	Exergame Apps and Physical Activity: The Results of the ZOMBIE Trial	X	X
[33]	Exploring the Influence of a Smartphone App (Young with Diabetes) on Young People’s Self-Management: Qualitative Study	-	-
[29]	Integrating Visual Dietary Documentation in Mobile-Phone-Based Self-Management Application for Adolescents With Type 1 Diabetes	-	-
[34]	Gender differences in gratifications from fitness app use and implications for health interventions	X	X
[31]	Explicating an Evidence-Based, Theoretically Informed, Mobile Technology-Based System to Improve Outcomes for People in Recovery for Alcohol Dependence	X	-
[30]	A Smartphone Application to Support Recovery From Alcoholism	X	-
[32]	Effectiveness of a smartphone app in increasing physical activity amongst male adults: a randomised controlled trial	-	X
[36]	Development and implementation of a smartphone application to promote physical activity and reduce screen-time in adolescent boys	-	-
[35]	Assessing the sustained impact of a schoolbased obesity prevention program for adolescent boys: the ATLAS cluster randomized controlled trial	-	-
[37]	Mobile Health Physical Activity Intervention Preferences in Cancer Survivors: A Qualitative Study	X	-
[39]	Understanding persistence in the use of Online Fitness Communities: Comparing novice and experienced users	X	-
[40]	Sustainable Lifestyle Change: Participatory Design of Support Together with Persons with Obesity in the Third Age	X	-

Table 4.1: Motivation inclusion results

4.1.1 Motivational Techniques

The papers have different approaches for gathering data. Four have based their analysis on existing and well known applications, downloaded from the app stores, and the

user communities of these applications. Five of the papers have developed their own application and tested it while the remaining four papers have a theoretical approach to determine what functions users would like to see in their applications. The papers from each category can be found in table 4.2.

Paper	Exploratory Data	Own Application	Application from app store
[27]	-	-	X
[28]	-	-	X
[33]	-	X	-
[29]	-	X	-
[34]	-	-	X
[31]	X	-	-
[30]	-	X	-
[32]	-	X	-
[36]	-	X	-
[35]	X	-	-
[37]	X	-	-
[39]	-	-	X
[40]	X	-	-

Table 4.2: Where papers have gathered data

This means that some of the techniques found are tested, while others are only proposed to possibly have an effect. This, in addition to whether the applications have mapped their techniques to SDT, influences how the techniques that were found are presented in this section. All functions/techniques that are mentioned in the papers are presented in the tables, whether or not it is a good technique has not been evaluated.

The techniques in the following subsections are the findings from the papers. When coding the papers, all techniques mentioned was coded and assigned to the different SDT categories. Autonomy if the technique would help a user feel in-charge of their own actions. Competence if it induced the feeling that they were completing tasks, achieving goals or learning, or Relatedness if the technique got the user to feel like being a part of something like a group or having relationships. To which of these they were assigned depended on what they were interpreted to do. If the paper had assigned a technique to the categories, that was used. If the paper did not assign the technique it was coded by the author of the thesis.

Techniques mapped by paper, according to SDT

The four papers Asimakopoulos et al. [27], Klenk et al. [34], Stragier et al. [39] and Gustafson et al. [31] arrange the techniques they have utilized according to autonomy, relatedness and competence. The three first mentioned papers used existing applications developed by others to do their research and have accumulated results as to whether these functions are useful. The view of Klenk et al. [34] is not on specific techniques but

4 Findings

rather on feedback from the users on why they continue using the application. The last paper, is a theoretical discussion about functions to put into a future application, this application is tested in the other paper by Gustafson et al. [30]. Most of the techniques from this paper are assigned by Gustafson et al. Those that are not was mapped by the author of the thesis and are denoted by (A) behind the description of the technique in table 4.4. The techniques are presented in table 4.3 and 4.4.

Paper	Technique	Autonomy	Relatedness	Competence
[27]	Dashboard - provide the user with an overview of their specific performance	X	-	X
[27]	Real-time percentages metrics to goal data	X	-	X
[27]	Map user awareness and their achievements to provide targeted support	-	-	X
[27]	Encourage reflection, giving opportunities for receiving constructive feedback	-	-	X
[27]	Socialisation of fitness data	-	X	-
[34]	User can compare their results with other users	X	-	X
[34]	User can compare their results with them self	X	-	X
[34]	The app makes the user feel less lonely	-	X	-
[34]	Use the app because everyone else is doing it	-	X	-
[34]	Application helps the user achieve goals	X	-	X
[34]	Enjoy using the app	X	-	X
[39]	Close self monitoring of exercise data and view the progression over time periods in detailed graphs	X	-	X
[39]	Goal setting, e.g. completing a run on a specific time	X	-	X
[39]	Social networking functions	-	X	-

Table 4.3: Techniques mapped according to SDT by paper part 1

4.1 Motivational findings

Paper	Technique	Autonomy	Relatedness	Competence
[31]	Discussion groups/ ask an expert(A)	-	X	X
[31]	Various access to information (A)	X	-	X
[31]	Filling peoples calendars with healthy events that they are interested in	X	-	-
[31]	Social networking technology to link people in the same situations	-	X	-
[31]	Ongoing contact with case managers, social support and teaching coping skills	-	-	X
[31]	Tailor information to people after assessing their personal goals	X	-	-
[31]	Alert when approaching their high risk areas(A)	X	-	-
[31]	Alerts and reminders for meetings and tips of the day	-	-	X
[31]	Panic button-if risk is near press for instant help and support(calls a loved one or supporter)	-	X	-
[31]	The application gets set up and tailored to needs and can be changed underway (A)	X	-	X

Table 4.4: Techniques mapped according to SDT by paper, part 2

Techniques, not mapped with SDT, tested in papers

The papers in this grouping have made their own applications and done some testing, they have not used SDT terminology when addressing the techniques used in the applications. The techniques here are mapped by the author of the thesis. Two of the papers in this section Husted et al. [33] and Froisland et al. [29] focus on learning adolescents how to live with diabetes. Both these applications are designed to give the users a larger sense of autonomy by increasing their competence. The third paper is Harries et al. [32], this paper focuses on how effective a smartphone application is in increasing physical activity in adults. The techniques from these papers can be found in table 4.5. The other two papers are the strongly connected papers by Lubans et al [35, 36] that concerns a program to reduce screentime and increase the activity in adolescent boys, the techniques are presented in table 4.6.

4 Findings

Paper	Technique	Autonomy	Relatedness	Competence
[33]	Chat room - not feeling alone anymore	-	X	-
[33]	Sharing experiences and practical knowledge	-	X	X
[33]	Felt safer having the app - increased freedom and peace	X	-	-
[33]	Breaking the Ice -sharing thoughts and feelings/asking for help	-	X	-
[33]	Suggestions from users: include goal setting and easier tracking	X	-	X
[33]	Suggestions from users: Lack of motivating factors - not enough content	X	-	X
[29]	Defining treatment challenges	X	-	X
[29]	Taking pictures of their own food, learning from the process, improving understanding	X	-	X
[29]	Easier communication with health-care professionals, grater feeling of being in charge	X	-	-
[29]	Application helped increase social acceptance	-	X	-
[29]	Visualisation through pictures of their food	-	-	X
[32]	No need for data entry or extra equipment, just the phone	X	-	-
[32]	Measure activity continually no need for activation	X	-	-
[32]	No self goal-setting, auto generated informal goals	-	-	X
[32]	View tracked data	X	-	X
[32]	Running number of steps taken, calories burned	X	-	X
[32]	Compare what you have done to others	-	X	X
[32]	Reminders to walk more	-	-	X
[32]	Receiving feedback on your walking	X	-	X

Table 4.5: Techniques, not mapped with SDT, tested in papers. Part 1

Techniques from theoretical discussions

Of the total of 13 papers, four were pure theoretical discussions without testing their statements. Of these four, two are part of the Gustafson et al. [31] and Lubans et al.

Paper	Technique	Autonomy	Relatedness	Competence
[36]	Statistical/graph view of steps over-time	X	-	X
[36]	Pre-designed workouts of different difficulties, time used considered result	-	-	X
[36]	Could get help from a peer an asses their technique in exercises which was used as a score	-	X	X
[36]	Set and review goals(Goals from a few select customisable tasks)	X	-	X
[36]	Tailored motivational messaging (Push-prompt)	X	-	-

Table 4.6: Techniques, not mapped with SDT, tested in papers. Part 2

[35] pairs and was tested in the other paper by the respective author. The ideas from the other two theoretical papers Wiklund Axelsson et al. [40] and Robertson et el. [37] are presented in table 4.7. Both used focus groups to gather data, the participants in these groups were mainly older, Wiklund Axelsson et al. [40] 55 or older and Robertson et al. [37] had a mean age of 63.7. The participants in Robertsons focus groups were cancer survivors. The techniques from the papers are more a wish list of functions than a list of specific ways to achieve motivation, but it can be coded in the same way as the techniques from the other tables, charting what SDT aspect the function would effect.

The remaining paper

There is one paper that is not mentioned in the tables above, it is the paper by Cowdery et al. [28] that researches whether exergames have an effect on a users physical activity. This papers does not look at what the applications offer in regards to different techniques, only whether they work or not. The only discussed technique are the sending of motivational messages based on SDT theory that they did on top of the application used by the people in the trial.

Do the techniques work?

The different papers provide some results in regard to their testing of the applications. The main point from the papers that have tested functions and techniques in specific applications are summarised below.

The paper by Asimakopoulos et al. [27] concludes "...that users' motivation and self-efficacy are highly dependent on successful data, gamification, and content design of the apps as well as sensing context and providing appropriate motivational feedback to the user." They also come with an additional list of suggestions for improving the user experience but states that these depend on further research.

4 Findings

Paper	Technique	Autonomy	Relatedness	Competence
[37]	Message tone preferences-casual, concise and positive messages	-	X	X
[37]	Tool for Personal Goal Attainment: the app a tool to achieve personal goals	X	-	X
[37]	Use the app to enlist social support	-	X	-
[37]	Give periodic reminders to be active	X	-	X
[37]	Role model narratives: stories from people who have lived it and overcome obstacles(relevant stories)	-	X	X
[37]	Small social groups, no public posting, not interested in competing	-	X	-
[37]	Concrete activity suggestions from trusted sources, related to their goals	-	-	X
[37]	Be presented with and educated about new ways of being physically active	-	-	X
[37]	Deliver a highly tailored experience for the individual user	X	-	X
[37]	Not input data themselves, the information should flow from app to user	X	-	-
[40]	Focus on health rather than weightloss	-	-	X
[40]	Becoming aware of bad habits	-	-	X
[40]	Reminders and awareness on uncovered behaviours	X	-	X
[40]	Support and a sense of belonging	-	X	-

Table 4.7: Techniques from theoretical discussions

Cowdery et al. [28] states that "The intervention group did show an increase in autonomous (intrinsic) motivation to exercise regularly, perhaps as a result of the use of the Exergames or the addition of motivational messaging. Although not statistically significant, participants in the intervention group also reported higher levels of perceived competence and of overall enjoyment of physical activity consistent with previous research on the use of Exergames."

The results from Husted et al. [33] indicates that "...app appeared to be a motivating factor in young people's self-management..." it goes on to point out that "In particular, peer-to-peer support, exchanging messages with health care providers, and looking at the

YWD with parents were useful in supporting self-management.". Specifically referencing the aspects for increasing relatedness.

Froisland et al. [29] "...concludes that implementing a visualization tool is an important contribution for young people to understand the basics of diabetes and to empower young people to define their treatment challenges. By capturing a picture of their own food, the person's own feeling of being in charge can be affected and better self-treatment achieved.". Increasing the competence and sense of autonomy had a positive impact on the users of the application.

In the paper by Klenk et al. [34] they conclude among other things that "... to promote physical activity should include features that allow users to document their activities and elicit social support in the form of encouraging (i.e., live tracking) or supportive messages (i.e., voice coach). Here, behavioral change techniques such as goal-setting or social support ...might help to inform the best features to use for mHealth interventions."

The two papers considering an application to support people recovering from alcoholism, Gustafson et al. [31, 30], concludes that their "...findings suggest that a multifeatured smartphone application may have significant benefit to patients in continuing care for alcohol use disorders.". They also found competence to be the most important of SDT's three categories when trying to solve their specific question.

Harries et al. [32] comes to the conclusion that their application for increasing physical activity in adult males can have a positive impact, but their social feature implementation showed little effect.

For the the application created by Lubans et al. [36] to be a part of their program, it has little to no results because the application was not required used by their participants and it saw little use. The application also experienced some technical difficulty as a result of lack of testing.

Stragier et al. [39] states that applications just collecting data has little purpose before they present the data in a way that adds to the users knowledge. Presenting data in a useful and informative way is important, but to keep users the application need an enjoyable social experience as well.

4.2 General Findings

In this section the more general findings in relation to the inclusion/exclusion criteria 3.1.2 are found and presented in table 4.9.

4.2.1 NCD Connections

When coding the papers they were placed into a category of NCD that fit the main focus of the paper, this can be seen in table 4.10. The categories in the table were the main ones that the papers touched on, these are concentrated on part of the NCD field, especially around physical fitness and healthy diet where nine of the papers are focused(Fitness, Fitness and diet, and Obesity). The most dominating of all the fields are exercise apps, and applications only for increasing and helping people sustain habits

4 Findings

for physical health. The different papers consist of either testing conceptual applications or applications from the different smartphone application stores.

Two of the papers focused on diabetes, specifically mobile applications for adolescents and "young people" to increase awareness and improve self-management of the disease. Both papers also focused mostly on diabetes type 1 rather than type 2 which is more often connected with NCD.

The last category ,Alcohol, contains two papers that are strongly connected and discuss the same application. Before developing it and after results from testing.

Which papers that were specifically placed in what category can be found in table 4.9.

4.2.2 Self-care, Healthcare professionals, Special equipment and Multistep programs

When checking the thirteen papers in relation to the inclusion/exclusion criteria it was discovered that many of the papers had elements from these unwanted categories, what papers this concern can be found in table 4.9. The criteria, self-care and no healthcare personnel, are strongly related when looking at the table. The reason some of the papers diverge from the criteria are because the application users receive some kind of assistance from trained professionals. Such as counsellors, doctors or motivational messaging (from a person not auto generated in an application). Most of this contact is minute and just an addition to the application.

When considering special equipment, outside a smartphone and simple heart rate monitors and the like, the only mentioned equipment was a pedometer, for tracking steps, and a glucometer, for measuring blood sugar. Neither of which is considered very expensive or hard to come by in most parts of the world, they also played a small part in the overall application.

In regards to the application being a standalone application, not part of a larger program, some of the papers diverged a bit. In the papers by Gustafson et al.[31, 30] and the papers by Lubans et al. [36, 35], the application was a part of a larger treatment program. Gustafson's application was to support recovering alcoholics after an initial treatment. Lubans application was to support exercise in a larger plan to heighten the activity levels of adolescent boys.

4.3 Additional Findings

This section elaborates on some findings that are interesting to note, but that was not the main objective of the research.

4.3.1 Year of Publication

All the papers are quite new, the oldest Gustafson et al.[31] are from 2011, the rest of the papers are published from 2014 to 2018, the average of all are 2015.5 , when rounded. This gives us an indication of the age of the field and how recently this topic has become

an interesting subject for researches. The publication year of the papers can be seen in table 3.5, the calculation is done on the papers that was kept in the results.

4.3.2 Customisation

Several of the papers point out the importance of customisation and fitting the application to the individual user. The paper by Klenk et al. [34] explores the gender differences in how and what users appreciate in fitness applications. They find some support for the fact that there are gender differences in application use. "When using mobile media for physical activities, women found enjoyment and goal-setting more important than did men. This might reflect higher motivation of women for health-oriented behavior.... Men were more inclined to share their results and to use the live tracking function."

Froisland et al. [29] a paper that concerns diabetes supportive application for adolescents talks about the need for adapting the application to the user based on "Young people's lack of advanced cognitive function due to late maturation of the frontal lobes in the brain is a limiting factor highly underestimated by health professionals. Self-care is dependent on a high level of perceived efficacy with integration of lots of information mixed with practical skills and competence. When cognitive functions are limited we need to develop systems that ease the understanding of diabetes and execution of self-treatment."

The theoretical study by Wiklund Axelsson et al. [40] concerning older people, wishes for a highly tailored experience for the individual user and Robertson et al. [37], where the focus groups were made up of cancer survivors would like the social aspects of the application to be for small non competitive groups as opposed to the open and competitive norm in most popular fitness applications.

Gustafson et al. [31] talks about "that many patients in recovery may benefit from personalized treatment." and how "information technology makes it possible to provide tailored interventions to each person in a cost-effective manner."

Paper	Mobile	NCD	Self-care	No, healthcare personnel	No, special equipment	Not multistep
[27]	Yes	Yes, Fitness	Yes	Yes	Yes	Yes
[28]	Yes	Yes, Fitness	Yes, some received additional messaging	Yes	Yes	Yes
[33]	Yes	Yes, Diabetes	Partially, some parental support	Partially	Yes	Yes
[38]	Yes	No, Mental illness	Partially, coaching	No, trained therapists sending motivational coaching via SMS	Yes	Yes
[29]	Yes	Yes, Diabetes	Partially, could communicate with doctor	No, patient doctor communication	Partially, glucometer	Partially
[34]	Yes	Yes, Fitness	Yes	Yes	Yes	Yes
[31, 30]	Yes	Yes, Alcohol	Partially, counselor involved	Partially, counselor involved	Yes	Partially, a supplement after other treatment
[32]	Yes	Yes, Fitness	Partially, some additional motivational messages	Yes	Yes	Yes
[36, 35]	Yes	Yes, Fitness and diet	No, part of a program	Partially, additional instruction through school	Partially, pedometers	No
[37]	Partially, cusgroup about app	Yes, Fitness	Yes	Yes	Yes	Yes
[39]	Yes	Yes, Fitness	Yes	Yes	Yes	Yes
[40]	Partially, cusgroup about app	Yes, Obesity	Yes	Yes	Yes	Yes

Table 4.9: Criteria completion

4.3 Additional Findings

NCD	Number of papers
Fitness	6
Fitness and diet	2
Obesity	1
Diabetes	2
Alcohol	2

Table 4.10: NCD categories

5 Discussion

The papers in the selection comes from many different areas of the field, from exergames [28] to applications specifically designed for cancer survivors [37], to what older people would like to see in applications for preventing obesity [40]. This suggests that the results are not concentrated around a single point of interest all though most of the papers are related to the physical activity aspect of NCD. Since the number of papers are not very large and the data they contain are not very uniform in nature, the findings are more of an indication of what takes place in the field of research, rather than a solid foundation to form a conclusion of what specifically works.

5.1 Data Collection

The different papers used mainly three methods of data generation; creating their own application and testing them, using an existing application created by others, or a theoretical approach, either, holding focus groups to gather data or they collected data through papers, to lay the foundation for an application. Which paper did what is shown in table 4.2. Of the thirteen different papers, four opted for the theoretical approach, gathering exploratory data, five created their own applications and the remaining four used existing applications created by others. This difference in approach means that the papers based on exploratory data are not tested. Whether they conclude with valid techniques and functions are hard to ascertain. Only the same proposed techniques that are found in the tested apps can be seen as valid, the rest merely as suggestions. For the tested applications, the goal of their testing is what decides if it is usable results or not. Most of the papers tested the app as a complete entity, and not the different aspects separately, this have an impact on the results, as it makes the specific effect of different techniques not determinable. Also when testing with an application developed by someone else, it is hard to ascertain every function involved, and what theory, if any, is behind the different functions.

Because of this, what method was used in testing the techniques made them have different validity when looking at the selection to determine a subset of the seemingly best techniques to implement.

5.2 Motivational Techniques

When determining how the different techniques effect intrinsic motivation 2.3, one has to look at how they affect autonomy, competence and relatedness, the three pillars

for determining motivation in self-determination theory 2.3. As explained in the SDT section, the theory is based on where the motivation a person feels for a task can be placed on the scale from amotivation, not doing it, to intrinsic motivation, doing it because you gain pleasure doing the task, figure 2.3. Autonomy, competence and relatedness, are the three different components one use to measure motivation for a task. When these increase the motivation a user feels for a task move towards intrinsic motivation on the scale. To try and achieve intrinsic motivation for a task, all the three different measurements have to be experienced by the doer of the task.

What specific things do an application which hope to influence these three points do? They implement many different elements and functions in one application and hope to effect the three determinants enough that it moves the task, it is made to support, further or all the way to the intrinsic side of the scale.

5.2.1 How is SDT used to determine techniques?

When searching the papers to compile the list of techniques used, it was discovered that of the thirteen papers, only eight used or mentioned the SDT terminology and only four of the papers gave results relating to, or even mentioned, intrinsic motivation, see table 4.1 for specific paper relation. One of the papers mentioned intrinsic motivation as a concept without using SDT. Using SDT or intrinsic motivation meant that the papers, built their study around the theory or used it to explain their findings. The degree to which the papers did this varied. Some papers like the paper by Asimakopoulous et al [27], regarding "Motivation and User Engagement in Fitness Tracking" explained their results using SDT and mapped their techniques according to theory. While a paper like Wiklund Axelsson et al.[40] mentioned SDT as a concept, but does not relate their findings to it in any way. The results seem to suggest that the papers did not take a controlled theoretical approach regarding motivational theory when doing their research. Some treat motivation as more of an abstract concept that they do not define according to any theory. This is a shortcoming of the papers and is something that if used would give them more credibility. Regarding the finding of little focus on intrinsic motivation in the papers are less surprising, given that intrinsic motivation is the optimal goal state for a persons individual motivation for doing a task, and is in it self hard to obtain. The focus here could be altered to rather be on SDT and its ability to increase motivation towards this goal state rather than obtaining it. The specific way SDT was used to determine techniques was, to identify which of autonomy, competence and relatedness, the different techniques influenced and then determine if it was a influential technique or not.

Because of how the papers used, or did not use, the techniques from SDT there was a lack of direct mapping between the functions or methods used and the theoretic background. This is why there are so many different tables in chapter 4. Since the papers did not map the methods, it was done during the coding of the papers, this means that the functions may not have been understood correctly and could be assigned another function than what was intended. The reasoning behind the mapping can be found in the appendices.

5.2.2 The techniques

When connecting techniques with their respective three SDT pillars of motivation, there is a lot of overlap, one technique might influence more than one of the three pillars and as such a direct one to one mapping for all the techniques does not occur. When reviewing the findings, first the ones that are suggested to impact only on aspect and then move on to those that effect multiple. At the end it will be joined together and there will be a list of general suggested techniques for implementation.

Autonomy

Autonomy is the need for feeling in charge of your own actions and having a sense of self. The techniques solely suggested for heightening the sense of autonomy are functions that removes the need for manual data input and activation 4.5, 4.7, which frees the user and removes a hurdle for use. When one has to register use, and manually input data the task often becomes tedious and troublesome and the use will seldom last for an extended period of time. When the information flows from the app to the user as suggested in the paper by Robertson et al. [37], the user experience becomes more fluent and does not add additional stress for the user. Gustafson et al. [31] and Lubans et al. [36] both suggests tailoring motivational messages in relation to user goals, this is thought to give the user a sense of being right and moving in a positive direction, boosting the feeling of making correct decisions by themselves. The users of the two diabetes applications [29, 33], explained that the application itself helped them to feel greater autonomy, by having information readily available at any time made them feel safer 4.5. It aided the communication with healthcare professionals by making them feel like they were in control of the communication 4.5. This indicates that the application can have an effect even when it is not being used, just by existing and being available the application helped some users feel more autonomous.

Removing the need for data input, providing goal focused motivational messaging and giving a sense of security in being available, are all contributing to increasing a users sense of autonomy.

Competence

The suggested techniques and methods for increasing a users sense of Competence, the need for being useful, making progress, learning and achieving goals, are mostly methods that reminds or educates. Messages reminding the user to walk more, notifying the user of bad habits and messages based on the users achievements, that provide targeted support, are mentioned in all the different table groupings 4.3, 4.5, 4.7. These reminders and messages which are suggested, would be most effective if delivered in a casual, concise and positive language according to Wiklund Axelsson et al. [40]. For education purposes, activity suggestions with instructions, designed workouts or auto generated informal goals are suggested as possible techniques. Increasing the users competence through easy to follow/level appropriate instructions can be a valuable tool. Encouraging reflection

and making it possible to receive constructive feedback through the app 4.3 are another approach for heightening a users feeling of competence according to Asimakopoulos et al. [27]. When getting a user to consider their actions and review their feedback one activate a learning process that can help trigger the feeling of competence.

Relatedness

Everyone has the need to be a part of something, feeling like they belong, this need is conceptualised through Relatedness in self-determination theory. In the effort to help the users feel heightened relatedness through the application almost all the papers mention some form of social networking functions. Husted et al. [33] mentions a chat room they built in their application, this was well received by their test group as it made them feel like being part of a group 4.5. Other papers mentions the use of application to enlist social support 4.7, or to socialise your fitness data 4.3 e.g. making others aware of what you are doing in order to receive support or find others who are working towards similar goals. Another interesting mention are users reporting the user base as a reason for their use of the application, "...because everyone else is doing it." 4.3 this counts as a strong urge to fit in with the rest and become a part of a larger group.

Autonomy and Competence

A technique or method that influences both Autonomy and Competence are the most common classification in the findings. They are functions that makes the user feel like they are following their own path, achieving goals and increasing their knowledge at the same time.

All the different techniques from the tables can be separated in to two main techniques;

- Tracking and monitoring ones current and previous activity/exercise/performance
- Goal setting, defining ones own goals and challenges

The two technique groupings are also connected, e.g. tracking if you meet the goal for number of steps you set for the day. Tracking and monitoring makes it possible to see changes in ones performance over time. Are the actions the user are taking working, will they reach the goals they set? Accumulating and reviewing your data gives the user a sense of competence for what they are doing and trying to achieve by learning from their actions and history.

Some techniques in this section have already been covered in the single effect sections, like reminders and receiving feedback. This is expected because of the unspecific nature of the phrasing of the different techniques and it depends on the assigners understanding of both SDT and what is the intended meaning of the method or technique.

Relatedness and Competence

The other grouping of SDT affecting techniques are Relatedness and Competence, when interacting with other users cause learning and a heightened sense of competence.

This combination is seen when users are sharing experiences in chat rooms, different forums or discussion boards. The user is relating to other users and their experiences to form new knowledge that they can use to improve their own lives. E.g. they could be working together with other individuals to teach or learn exercise techniques from each other 4.6. One specific function that was mentioned was in the paper by Robertson et al. [37] where cancer survivors wanted role model narratives, stories from people that had overcome similar difficulties before, as a part of the application to help increase physical activity.

5.2.3 General recommended techniques

When it comes to what is proven to be effective techniques, the results of the different papers vary to a certain extent. The result of what techniques are determined to be the best are strongly dependant on the specific use for the application. Husted et al. [33] points to relatedness as the most successful factor for their diabetes support application, Gustafson et al. [31, 30] states that competence is most relevant for their application that supports alcoholics in recovery, while Stragier et al. [39] and Klenk et al. [34] both point to functions, like data presentation, goal setting and social support, techniques that are connected with all three pillars of motivation in self-determination theory. This indicates that what function the developer should focus the most on in an application varies according to their specific intentions. Based on the available data a list of general recommendations are proposed here.

After discussing the techniques above, some general themes stand out. These will be presented here in table 5.1. To fill the need for *Autonomy*, there needs to be a way to make your own choices and set your own goals. Using the application should not be an laborious endeavour, it should generate data and make it presentable to the user without great effort on the users end. There should also occasionally be motivational messages to help give the user a small boost. For *Competence* there should be means of educating and learning in the application, this could be new knowledge in the area where the application attempts to educate or information gathered by the application and presented to the user e.g. in statistical graphs. To cover *Relatedness* the application should provide some way to interact socially with people in a similar situation, the users friends and peers.

The techniques in the table 5.1 are a subset of the most common functions from the findings and are proposed as a guideline for functions that could be helpful for increasing motivation in an application. What is most important is to cover Autonomy, Competence and Relatedness and not forget one of theses important building blocks of motivation.

5.2.4 Need for customisation

There are no one solution fits every problem for motivational influencing applications. A number of papers point to the importance of applications being tailored to fit the needs of the individual user, for details on the papers see section 4.3.2. This is highly interesting. When tailoring functionality there are many factors to consider. Who are

Technique	Autonomy	Relatedness	Competence
Goal-setting possibility	X	-	X
No need of continuous user data input	X	-	-
Motivational messaging	X	-	-
Means of education	-	-	X
Displaying current status or progression, as well as historic	X	-	X
Reminder messages	X	-	X
Social networking function	-	X	-

Table 5.1: General recommended techniques

the primary user group?, Do you wish to reach someone specifically or as large a group as possible?, Who are the users and what do they care about?.

One possible solution is for the application to slightly alter design and functionality based on questions one asks the user and the data gathered from their use. For instance if the sex of the user could have an effect as shown by Klenk et al. [34], a fitness application could focus more on enjoyment and goal setting if the user is female and more on sharing results and live-tracking when the user is male. Age is also an important indicator of application functionality, Froisland et al. [29], states that young people lack advanced cognitive functions and Wiklund Axelsson et al. [40] specifically proposes design for older users, who wish for a health focus rather than a weight focus in their obesity prevention application.

Because of physical differences, users in each end of the age range might not find an application that proposed exercises usable, if age or other restrictions are not taken into consideration. An application providing bad advice would discourage use.

When considering social factors, most applications enable sharing to the world, specific friends or a list of friends. The focus of these functions is often a competitive view, e.g. I ran this fast, now try and beat me. Robertson et al. [37] discovered, that this was not what their users, cancer survivors, wanted. They were interested in a non-competitive smaller community, sharing support rather than competition.

The papers that do not express opinions on customisation are the ones where the applications are trying to reach the highest amount of users. They use generic techniques that are suitable for most users, usually a subset of the techniques in table 5.1 can be found here. These applications can probably increase their user base employing some customising techniques, without losing their broad user acceptance. This is difficult because users would not take kindly to being treated differently and not be able to use the same functions as other users, even if the intentions were good.

The papers suggest that there is a need for customisation depending on the use intended for the application. The more specific the user group the more customisation can be implemented, knowing who is going to use the application allows the developer to tailor the experience for a specific user group. If there is no specific user group, the

design has to be unspecific enough that most people would feel somewhat at home in the application. This could be achieved by implementing general guidelines and functions as proposed in table 5.1.

If one were to try and design an application that alters dependant on user provided information, slight alterations in how one promotes the different functions, rather than large differences in functions and design, would be the advisable thing to do. The best thing at the moment are probably to either aim for a generic application that fits as many as possible or make a highly specific application for a specific user group.

5.2.5 The ideal SDT application

With this information can the ideal motivational application based on self-determination theory be built, or does it already exist?

If one were to implement all the functions from the table 5.1, and add customisation options as discussed in section 5.2.4, would this be the perfect application for influencing user motivation.

This is a highly complex question, the techniques in the table are a collection of what was proposed in the papers, their effect is however still being discussed and is dependant on the intended use. Some categories are more important in some areas than others, as mentioned in the general recommended techniques 5.2.3. The effect of a technique is determined by how it effects the individual user in a given situation.

Could this be fixed by customisation, tailoring the application experience to the individual users needs? To achieve this would entail an immensely complex application where one could not be sure one would get the desired effect, and the cost of developing such an application could not be expected to be justified, based on what is likely to be a small gain in influence on the users motivation. The more one makes the application customisable the harder it is to have control of the user experience and know what happens at what time, and what activates the different functions during the use of the application. Having this control is important in knowing that the right action for controlling motivation happens at the correct time and as a response to the right event.

The answer to both initial questions are, maybe. One could build an application using all the information available, but it would not effect everyone and everything. Effective applications require customisation to fit both the user and the problem area that one is trying to fix. One have to settle for a design that would fit most people or highly customise it for specific individuals. With time and more research on the topics discussed, as well as research on the specific techniques individual effect one will come closer to being able to make the ideal application. As the research stands today, there are to many unknowns, for all the papers there are several different techniques involved in all the applications, and the results consider the whole clusters effect. This means that some of the mentioned techniques may not have any effect, some techniques only work cohesively, while some are essential to creating a influential application.

We know more about what can effect users motivation and have the tools more readily available than ever, but we do not know enough to make it consistent for all users and

situations. The applications can provide support and give an extra boost, but it will not change a user that does not want to have their motivation changed.

5.3 Year of Publication

The papers are all quite new, with a 2015.5 average as stated in the findings chapter 4.3.1. This indicates that the age of research in this specific domain, mobile applications and their effect on users, are a new research subject that currently is gathering a lot of interest. The current research is therefore limited in both the amount of studies and the range of studies themselves. What the long term effects and implications of this growing application use and the constant availability of applications will have on users are too early to tell, because of how relatively new the technology is and subsequently how far research in the field have had time to progress in this limited time frame. The fact that the papers in the study are all from recent years indicate that a lot of research on these topics are probably underway and the knowledge in the area will grow immensely in the years to come.

5.4 Noncommunicable Disease

The table 4.10 in NCD findings 4.2.1 show somewhat of a close clustering around the topic of physical activity and diet, with nine of the thirteen papers, mostly focused on increasing the users physical activity to help with controlling weight and becoming a fitter person. Achieving this is a major positive step in reducing the risk of multiple of the NCD's, among them obesity, diabetes, cardiovascular disease, cancer and stroke. More on the NCD risks related to these diseases can be found in the section on "Insufficient physical activity and a non healthy diet" 2.2.1 in the background chapter.

The other two problem areas that are explored in the results are diabetes and alcohol, with two papers each. The diabetes papers are specifically directed at helping adolescents in the period where they start to take control over their own treatment and are relying less on their family members to aid them. The applications are designed to be of assistance in the users continued care, and as such reduce the need for healthcare personnel. This would help relieve the system and could be classified under the system-level risk factors category 2.2.1. The application in the alcohol related papers was designed to help people recovering from alcohol addiction, not stop or minimise use before it became a problem. More info on the alcohol issue of NCD can be found in section 2.2.1.

The problem with little physical activity is what the majority of the papers address, this is also the problem that effects the most people. The applications wants to get people on their feet and start being active. The reason that most of the applications deal with this particular problem is because this is a large problem in the smarthphone heavy population, as well as it has become a popular area of use for smarthphones, and there exists a multitude of applications seeking to remedy the issue. Being overweight is also a very visual problem and something that a person can not hide. Being physically fit is highly valued in our culture and can as such be seen as a goal for a large part of

the population. This suggests that it is one of the first problems many would seek to address when trying to avoid contracting noncommunicable diseases.

Making money of the application are also something that one has to consider when looking at which problem areas one would attempt to solve first. Fitness and weightloss products are a large industry and something people are willing to pay for, this makes it a much more lucrative market than most of the other NCD related issues.

The aspect of NCD that is less covered are helping medical care become more accessible for everyone, this makes sense because a service like this need more extensive resources than the applications in the papers. One would most likely require a much larger investment in time and money, and you would also need arrangements with existing medical services, or your own staff of healthcare professionals for answering questions and making sure that the standard of care and service are acceptable. There are services like these starting to appear but they are not accessible for most people, especially for less affluent people and regions.

6 Conclusion and Future Work

6.1 Conclusion

The goal of this review was to find out what is known about how SDT and intrinsic motivation is used to affect the user in NCD related mobile application.

The research has yielded findings on two levels, both implication for research and practice in making applications for altering motivation.

The findings for practice are a set of techniques to implement in an application where one wish to improve the users motivation for doing the tasks supported by the application. The techniques are presented in table 5.1. The techniques can be summed up as; the ability for the user to form their own goals, and create their own challenges, not need large amounts of continuous manual data input, notifications both to motivate and remind the user, ability to view progression and status, means for the user to educate them selves and social networking functions. Together these functions influence all of the three pillars of motivation in SDT, Autonomy, Competence and Relatedness.

The finding with the largest impact is about the need for customisation of the application. This need create many difficulties and might even make it impossible to create an application that will fit almost everyone in the user groups. It makes the need for the developer of an application to make a choice very clear, either one can try and reach many people through a general design or one can make it specific and more effective for a smaller group. The trade-off is making a smaller impact on a larger group or a larger impact on a smaller group.

With these things in mind, one should be able to make an application that has the ability to affect user motivation, and possibly change lives for the better.

The findings with implications for research are the need for motivation to not be treated as a vague concept and start using motivational theories when doing the research. There is a need for more crossover between the fields of computer science and psychology, to fully be able to understand both sides of the issue, when doing research on these topics where both parts are vital to the success of the research.

6.2 Limitations

When conducting the research three databases were used, there exists many other databases that could have been included. This could have helped expand the number of papers in the result. The sample size that the research was conducted with was rather small and more sources would have helped solidify the research. The fact that the field is new and a lot of studies are currently being conducted are part of the issue and will

6 Conclusion and Future Work

resolve itself in the future. The choice for the study to focus specifically on intrinsic motivation, as opposed to self-determination as a whole, may also have constricted the results slightly, and not been of much help to the result of the study.

After the initial paper selection, which was conducted by two people in a parallel process, only one person conducted the coding. This could mean that the findings are biased based on the researchers opinion and classification of techniques.

6.3 Future Work

In the future more research is needed on the effect of individual techniques to find what actually alters user motivation. Research on self customising applications in relation to the users data input and use patterns would be very interesting. This along with figuring out the dependencies between the techniques, and if they are dependant on each other to function are needed. This research collected some techniques that has an effect, all though the degree is uncertain. The research above would help reveal how much the implementation of these techniques actually contribute to altering a persons motivation.

The use of motivational techniques in relation to noncommunicable disease was also limited with a majority being in the scope of fitness and diet applications. More research and development are needed to effect the parts of NCD problem less covered in this thesis.

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Appendices

The reasoning behind the mapping of techniques

In the tables below the reasoning behind why Autonomy, Competence or Relatedness have been assigned the different techniques by the author of thesis, are explained.

Paper	Technique	Autonomy	Relatedness	Competence
[31]	Discussion groups / ask an expert	-	A social act, and the user can experience it as becoming part of a group	The user learns from other users or health-care personnel
[31]	Various access to information	The user decides whether to use the information or not	-	Learns information and gaining skills
[31]	Alert when approaching their high risk areas	The user are in charge, this is an available backup that makes it easier to trust one self	-	-
[31]	The application gets set up and tailored to needs and can be changed underway	Getting a sense of self, deciding what happens	-	Learning and making progress
[33]	Chat room - not feeling alone anymore	-	A social act, and the user can experience it as becoming part of a group	-
[33]	Sharing experiences and practical knowledge	-	A social act, and the user can experience it as becoming part of a group	Learns information and gaining skills
[33]	Felt safer having the app - increased freedom and peace	Easier to do as one wants, being in charge	-	-
[33]	Breaking the Ice -sharing thoughts and feelings/asking for help	-	A social act, and the user can experience it as becoming part of a group	-
[33]	Suggestions from users: include goal setting and easier tracking	Following the goals one sets for oneself	-	Learning from tracking
[33]	Suggestions from users: Lack of motivating factors - not enough content	Lack of things one can decide to do	-	No learning becomes boring

Table 1: Reasoning for the mapping of techniques

Paper	Technique	Autonomy	Relatedness	Competence
[29]	Defining treatment challenges	Following the path one sets for oneself	-	Learning from completing challenges
[29]	Taking pictures of their own food, learning from the process, improving understanding	Trust in own decision making increases	-	Learning from the process
[29]	Easier communication with health care professionals, grater feeling of being in charge	Greater feeling of being in charge	-	-
[29]	Application helped increase social acceptance	-	Accepted as a part of the group	-
[29]	Visualisation through pictures of their food	-	-	Learning from the process
[32]	No need for data entry or extra equipment, just the phone	Following ones own path, no distractions	-	-
[32]	Measure activity continually no need for activation	Following ones own path, no distraction	-	-
[32]	No self goal-setting, auto generated informal goals	-	-	Learning from the process
[32]	View tracked data	See what one decided to do	-	Learning from the process
[32]	Running number of steps taken, calories burned	Reaching goals one has set oneself	-	Learning from the process, completing tasks
[32]	Compare what you have done to others	-	Part of a group sharing results	Learning from what others do

Table 2: Reasoning for the mapping of techniques

Paper	Technique	Autonomy	Relatedness	Competence
[32]	Reminders to walk more	-	-	Learning when you have not moved enough
[32]	Receiving feedback on your walking	Positive feedback on own decision	-	Learning if you are doing the right thing
[36]	Statistical/graph view of steps over-time	See what one decided to do	-	Learning from the process
[36]	Pre-designed workouts of different difficulties, time used considered result	-	-	Learning from the process
[36]	Could get help from a peer an asses their technique in exercises witch was used as a score	-	Part of a group, working as a team	Learning from the process
[36]	Set and review goals(Goals from a few select customisable tasks)	Following the goals one sets for oneself	-	Learning from the process
[36]	Tailored motivational messaging (Push-prompt)	Positive confirmation on ones decisions	-	-

Table 3: Reasoning for the mapping of techniques

Paper	Technique	Autonomy	Relatedness	Competence
[37]	Message tone preferences-casual, concise and positive messages	-	Feeling a relation	Learning
[37]	Tool for Personal Goal Attainment: the app a tool to achieve personal goals	Following ones own path to goals	-	Learning from the process
[37]	Use the app to enlist social support	-	Feeling like a part of a group	-
[37]	Give periodic reminders to be active	In charge, gets to make a decision	-	Learning from the process
[37]	Role model narratives: stories from people who have lived it and overcome obstacles(relevant stories)	-	Not being alone	Learning from the process
[37]	Small social groups, no public posting, not interested in competing	-	Feeling like a part of a group	-
[37]	Concrete activity suggestions from trusted sources, related to their goals	-	-	Learning from the process
[37]	Be presented with and educated about new ways of being physically active	-	-	Learning
[37]	Deliver a highly tailored experience for the individual user	Supplement to ones own path	-	Learning, being useful
[37]	Not input data themselves, the information should flow from app to user	Following ones own path, no distraction	-	-
[40]	Focus on health rather than weightloss	-	-	Learning
[40]	Becoming aware of bad habits	-	-	Learning
[40]	Reminders and awareness on uncovered behaviours	Overview of own path, and easier decisions with more information	-	Learning
[40]	Support and a sense of belonging	-	Sense of belonging	-

Table 4: Reasoning for the mapping of techniques