DESIGNING SELF-TRACKING TECHNOLOGY FOR SMOKERS

Master's Thesis 2014

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STUDENT REPORT

DESIGNING SELF-TRACKING TECHNOLOGY FOR SMOKERS

PROJECT PERIOD

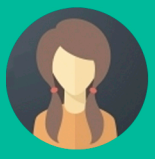
4th February 2014 -
10th June 2014

COURSE

Informatics, 10th Semester
Aalborg University

Pages Numbers

33



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ABSTRACT

This Master's thesis explores how mobile technology can play an important role in the context of smoking cessation. A smartphone app, Quitty, that combines self-tracking with personal counselling from a quitline was developed and evaluated in a three week field study with 13 participants followed by an interview session.

Based on the field study, remote data collection of the users' actions and analysis of the interview data, several findings are presented and discussed.

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RESUME

This Master's Thesis resolves around the theme "Health behaviour change" and focuses on how mobile technology can play an important role in the context of smoking cessation. The study presented in this thesis is an extension of our 9th semester pre-specialisation project conducted at The University of Melbourne in the fall of 2013 called *Persuading People – Using Technology to Change Health Behaviour*.

Based on a review of the health behaviour change literature and a review of currently available commercial apps in the app stores, in this study we develop a self-tracking smartphone application, Quitty, specifically designed to help smokers who want to quit. The aim of the application is to fill the gap in the health behaviour change literature and the limitations in currently available apps in the app stores. The application collects the time, location and the situation that triggers the smokers to smoke or crave cigarettes, presents it to the smokers in the form of simple charts, and uses this data to give the smokers regular personal counselling messages, written by experts from a quitline, directly to their smartphones. This was possible thanks to collaboration with Stoplinien, the biggest quitline in Denmark.

The app was handed over to the participants and evaluated in a field study with 13 smokers for three weeks. After the three week period an interview was held with each of the participants, focusing on their experience with the app and their reflection on their smoking habits during the three weeks. The research paper "Quitty – Using Self-Tracking to Provide Personal Counselling", which is the main part of this thesis, presents the design, implementation and evaluation of the smartphone application. Based on the evaluation, several findings of designing self-tracking technology for smokers are presented and discussed. Based on these findings the Quitty app is redesigned.

The main contribution of this thesis is that our study has shown that there is a big potential that is currently being overlooked in using self-tracking technology and using the self-tracking data to provide personal counselling written by real people to effectively influence smokers in order to change their behaviour.

PREFACE

This Master's thesis is the final step to become M.Sc. in Informatics at Aalborg University and the project period lasted from 3rd of February till the 10th of June 2014. The thesis revolves around the theme *Health behaviour change* and focuses on using mobile phones to help people who are undergoing a smoking cessation. The thesis is grounded by our work in our pre-specialisation study. During the pre-specialisation, we collaborated on research on smoking cessation at the Department of Information Systems, The University of Melbourne, Australia, in the period July 2013 - December 2013 and worked on the research project *Persuading People – Using Technology to Change Health Behaviour*. The research paper written during the pre-specialisation project is accessible in appendix 1.

The main purpose of this thesis is to use a technology probe to understand how mobile technology can play a role in supporting smokers to quit.

A smartphone application (iPhone and Android) was developed and evaluated with 13 participants in a 3-week field study. The design and findings from this study have been condensed into a scientific research paper.

We would like to thank Stoplinien for their valuable and helpful collaboration. We would also like to thank the 13 smokers who participated in the field study and Aalborg Kommune (council of Aalborg) for helping us recruit participants. Especially we would like to thank our supervisor Dr. Jeni Paay for constructive support and feedback during the last year.

The smartphone application can be accessed on the Apple App Store and Google Play Store or at quitty.dk/app. You can gain access to the app by using the following login information:

Username: **test**
Password: **test**

The thesis can be read and downloaded online as a PDF at quitty.dk/thesis.

READING GUIDANCE

The thesis consists of the following sections:

1. INTRODUCTION

Introduces to smoking related problems and the use of technology to promote health behaviour change.

2. LITERATURE REVIEW

Covers a review of HCI literature within health behaviour change including the domain of smoking cessation, focusing on the use of technology.

3. RESEARCH PAPER

Presents the research paper "Quitty – Using Self-Tracking to Provide Personal Counselling".

4. REDESIGN OF QUITTY

Describes the redesign of the Quitty app, based on the findings from the study.

5. RESEARCH CONTRIBUTIONS

Presents the main contributions from the research project and key points to consider, when designing technology for smokers who want to quit.

There will be a reference list for the research paper and one separately for this report. The referencing method used in the paper follows the IEEE standard while the rest of the report uses the Harvard standard. Since part of this thesis is grounded from the work done on the pre-specialisation, we recommend reading the research paper *Using Mobile Phones to Persuade People Undergoing a Smoking Cessation* as background, which can be found in the appendixes.

The appendixes are listed in the end of this thesis. Appendix 1 is attached to this report, while the rest are found on the attached CD.

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1. INTRODUCTION

Health is, and has always been an important topic in Human Computer Interaction (HCI). Our world sees more and more health risks for individuals and society to worry about. Focus on these health risks and the cause of them has increased over the recent years. Very common causes of health risks are obesity, smoking, alcoholism, improper diet and diabetes. The increased focus has led to better understanding of not only these health risks but also the importance of minimising the cause of them.

Recent studies show us that 50% of all illness across different age groups is caused by personal behaviour (Ryan, 2009). Despite the growing knowledge on health risks caused by personal behaviour, many people worldwide have not changed their behaviour causing them health issues and illness. Health issues are not only harmful to the human body, but also have great impact on the society and economy through welfare costs. This indicates a need to assist or even push people into changing their health related behaviour.

One major health behaviour that has been fought against for years is smoking. In a small nation like Denmark alone, the death rate of smokers is 14,000 every year (not including the 2,000 dying from second-hand smoke) (Danmarks Luneforening, 2014). Worldwide this number is a whopping 6 million plus 600,000 from second-hand smoke (World Health Oganization, 2013).

Many HCI researchers have used a highly emerging technology, smartphones, in health behaviour change studies and found it very useful. The smartphone which already has many features like internet connectivity, sensors and touchscreen, is still rapidly developing and are nearing the capability of computers. At the same time, it is available at low prices, making it available to most people. These factors mean that the smartphone has become a part of our daily life and follows us throughout our day, being available to use everywhere and anytime. This enables us and motivates us as researchers to explore the possibilities of using the smartphone in research.

This thesis tries to fill the gap in HCI literature on mobile technology based smoking cessation aid. We do this by designing, deploying and evaluating a prototype of a smartphone application, Quitty. This is documented in a research paper covering the field study of the prototype. Following the paper we redesign the application to meet the findings of the study.

2. LITERATURE REVIEW

To get insight and knowledge on work done in HCI on smoking cessation, we conducted a literature review. We chose to focus on how researchers in the field of HCI have used technology to help people change their smoking habit. Furthermore, we looked at how current commercial smartphone applications are designed and compared them to what literature prescribes. At the end of this literature review we will be able to find unexplored areas of smoking cessation in the field of HCI to look for research opportunities.

There have been many recent studies in HCI literature that focus on the use of technology within health behaviour change including: UbiFit, a system that records movement and where users are able to get data on their physical activity (Consolvo, et al., 2009); Playful Bottle, a system that aims to increase water drinking behaviour (Chiu, et al., 2009); and Morris, et al. (Morris, et al., 2010) created an app that offers in-the-moment support for users by using mobile therapy inspired by cognitive therapy interventions to cope with stress. When it comes to the context of smoking cessation, there are very few HCI research studies using technology to change people's behaviour. Strecher et al. (Strecher, et al., 1994) used computer tailored smoking cessation letters based on participants' cigarette consumption, interest in quitting smoking and other characteristics relevant to smoking cessation. They found statistically significant positive effects of computer-tailored health letters. There have been a lot of other studies that have confirmed the efficiency of computer-tailored content and a handful of the studies are within the context of smoking cessation (Schumann, et al., 2008), (Shiffman, et al., 2001), (Strecher, 1999). Graham et al. (Graham, et al., 2006) developed a web-based system called *QuitCoach* that provides quitting advice to users based on the stages of the *Transtheoretical Model* (Prochaska & Velicer, 1997). While many of the HCI literature within smoking cessation and technology have focussed on web-based systems, only a few studies have managed to explore the use of smartphones to help smokers quit.

In health behaviour research, clinical trials have used text messages (SMS) and evaluated their effectiveness in smoking cessation, with significantly better results than in the control group (Free, et al., 2011), (Free, et al., 2009). Their *txt2stop* pilot showed that the text message programme doubles the quit rate in the short term. In HCI research, Ploderer et al. (Ploderer, et al., 2012), (Ploderer, et al., 2012) conducted an interview study, where they presented some screen mock-ups of a fictional smartphone app called *Consider Quitting*, a shared photo diary, to provoke reflection among the users. They found that smokers were ambivalent about tracking and sharing personal health data. Ambivalence connotes strong simultaneous conflicting states, in the case of smoking cessation having both the desire to gain the benefits of self-awareness and motivation through such technologies as well as strong concerns about potential risks. The users know that changing their behaviour may be healthier and that tracking personal information can enhance their awareness and facilitate reflection for behaviour change, but at the same time they enjoy experiences associated with the behaviour and hence they can be reluctant to commit to change. The same team developed a smartphone app called *Distract me*, which provides different kind of distractions (through games, videos, images, etc.) and tips for the users to look up when they experience cravings. Their findings showed that distractions and cravings complemented each other - the distractions attracted the users to the app, but the tips kept the participants engaged for a longer periods of time. The tips were attractive because they gave the participants an opportunity to reflect on their addiction, prepare for their quit attempts and gain motivation. Furthermore, the study found that most participants preferred to read rather than to contribute.

Our previous work in this area, reported in the study by Srikandarajah et al. (Srikandarajah, et al., 2013) about the Quitty system looks into the use of mobile phones when persuading smokers wanting to quit. We designed and evaluated a smartphone application and found the mobile platform to be effective when working with smoking cessation. The aim of the study was to explore different kinds of content delivered through an app and how the smokers perceived them. The study is based on findings from earlier studies by Ploderer et al. (Ploderer, et al., 2013) which found that Tips were an easy implementable but strong element in a smoking cessation app. Furthermore, they found that personal Stories were popular among their participants. A third element, Motivators, was also included as this was proven to remind people of why they would want to change their behaviour. In a three week field study, every day the participants received one of each of the three content types. The participants would then rate each content on a scale from 1 to 5 how they perceived it. Following the field study, the participants were interviewed for further information gathering.

The study found the tips to be effective and the participants liked the easiness of reading and understanding them. They also found it to suit the mobile platform well, where too much information/text on a small screen would have a negative effect. Furthermore, the study found that whatever the content type was, positive loaded content was better perceived than negative.

Some interesting findings were related to relatability, SMS reminders, interaction and the use of smartphones. The study showed the importance of tailoring and relatability. All participants mentioned that they wanted content they could relate to, e.g. tips that match their own situation and demographics. Furthermore, they would like more interaction in the app. The app used in the study was very simple and would only show content and let the participant rate it. Participants expected their rating input on content to have an effect on future content (but it did not). Some participants even expressed that they wanted to be able to get in touch with a quitline or quitting expert using the app. Adding to the list of interactive functionalities requested by the participants, was the possibility to track their quitting progress. Overall, the participants appreciated the use of the mobile platform. They found it useful to have quitting tips with them always, able to pick up their phone and get instant help, compared to having to call a quitline, search forums etc. Furthermore the use of smartphones required the design to be simple and fast to use and the content to be easy readable. The participants appreciated both qualities. Lastly but importantly, the study found the use of SMS reminders very effective. Some participants would often not open the app before they had received the daily reminding message. What the participants liked about these was the personalisation of the messages. These would mostly include the participant's name and for example have a reference to the current weather or day of the week. This made the participants aware of that a person wrote these messages as opposed to machine generated messages.

2.1 COMMERCIAL APPS

While there is limited research on the use of smartphone apps in the context of smoking cessation to be found in HCI literature, there are several apps on the Apple App Store[1] and Google Play Store[2]. Abroms and colleagues (Abroms, et al., 2011), (Abroms, et al., 2013) analysed a total of 98 most downloaded apps for Android and iPhone and categorised them according to the primary approach it used towards smoking cessation and the level of adherence to U.S. Clinical Practice Guideline for Treating Tobacco Use and

[1] https://itunes.apple.com/dk/genre/ios/id36?mt=8

[2] https://play.google.com/store/apps

Dependence (Fiore, et al., 2008). Their findings showed that calculator apps were the most common category, representing 38.8 % of all apps, followed by hypnosis apps 17.3 %. Furthermore, the study reported that the apps generally had low adherence to evidence-based practices. Too few apps provided practical counselling or advice on how to quit/stay quit, no apps referred users to a quitline and no apps included text messaging for smoking cessation, which is the most tested and proven application of mobile phones for smoking cessation (Abroms, et al., 2011), (Abroms, et al., 2013).

However, this review was conducted two years ago, and many new apps have been developed and published since. We therefore think it is important to look at how things are today.

In Denmark, there are two major organisations who fight for the cause of smoking cessation: Sundhedsstyrelsen, The Danish Health and Medicines Authority, and Kræftens Bekæmpelse, the Danish Cancer Society. Besides these two, there are only smaller private companies with each of their own (commercial) products. In return, Sundhedsstyrelsen and Kræftens Bekæmpelse are very big organisations and have significant influence on the Danish health domain.

The two of them cooperated to design two services that are helping smokers to quit their habits. The two services are very different from each other but have the same motive; to help smokers quit. The services called e-kvit and Xhale; the former being a computer-tailored messaging service (SMS and e-mails) and the former an app which provides computer-tailored content.

e-kvit is an online in-browser programme that gives the user content based on their profile. Their profile is based on the intro survey of 68 questions about their demographics and smoking habits. The design philosophy is that getting help in a smoking cessation situation increases the chance of success by five times according to their documentation (e-kvit, 2013). The users have their own profile page where they receive different content (texts and videos). They can also sign up for e-mail and SMS-services so they will receive content on more channels. The content that each user receives will be different according to their profile, making the content computer-tailored to their specific needs. e-kvit is using tailored content as research suggests (Srikandarajah, et al., 2013), (Strecher, 1999), but does not manage to provide this service fully on a mobile device. This may be due to e-kvit being targeted for people aged over 25.

Figure 1 – Xhale app

For people under 25, they designed Xhale. This relies on the same backend as e-kvit but to adjust to its target group, there are only 26 initial questions to answer. The content sent out to the users is the same found in e-kvit. The difference though, is that Xhale is a mobile application. This means that all activity related to the service happens on the users' smartphone. However, Xhale does not utilise the potential of the smartphone platform. It only moves the interaction of e-kvit to the smartphone but does not make use of the many functions and capabilities found in smartphones. This also means that the content provided to the user only relies on the initial survey answers, and may not be suitable to the actual situation of the user. Furthermore, both Xhale and e-kvit are designed for smokers who recently stopped smoking and not smokers who are preparing to stop / scaling down.

This is a pattern that can be seen when looking at the most popular applications found on both the Apple App Store and Google Play Store (iOS and Android). We reviewed the first 50 apps listed on the popular

list in the “Health and fitness” category in each app store and looked at their main approach. We then chose to do a detailed analysis of the five most popular apps from each app store. We decided this was appropriate, as the majority of the 50 apps reviewed follow the same approach of calculating the number of smoke-free days and saved cigarettes and present it to the users. This confirms what Abroms et al. found in their analysis in 2013 (Abroms, et al., 2013). The calculation of saved cigarettes, smoke-free days and money saved, is found in all the analysed apps except for two that focus on hypnosis.

A total of nine different apps were analysed, as one was found on both platforms. Table 1 shows the different apps and their main approach to smoking cessation.

Seven of the apps were based on the calculation approach, while four of these also added the element of achievements. This means that the user will unlock achievements for being smoke-free for certain periods of time. Both calculation and achievement unlocking are aimed at users who have already stopped smoking, and want to stay quit, hence it is not useful for smokers, who are trying to scale down. Furthermore, these types of apps are based purely on rough estimations calculated from a one-time user input. This is very imprecise and can be far from the actual situation. For instance, one user who used to smoke 30 cigarettes a day and another who smoked 3, would receive the same achievements of having cleansed their body of the same amount of toxins, which of course not is the situation.

Two of the top quitting apps used hypnosis to help users, where one of them was not specific to smoking cessation. Hypnosis was provided to the user as many different audio files that would each help in different situations. The user has to pay for each audio file they want to listen to. The apps lack interaction and do not utilise the smartphones’ full potential.

In previous work, we found that self-tracking technologies showed promising results within other health behaviour change domains, such as physical activity and healthy eating (Brinthaparan, et al., 2013). This was also requested by participants in the previous Quitty study (Srikandarajah, et al., 2013). However, none of the reviewed apps, which are currently the most popular, use self-tracking of any sort, neither real-time tracking, nor summed up tracking (data input at the end of the day). Therefore, there are no real links to the actual smoker’s situation, other than very simple calculations based on estimations.

The two apps designed by the two major Danish organisations are designed for users who have already stopped and wish to stay smoke-free. The same goes for 7 of the 9 analysed apps, which all calculate the number of cigarettes not smoked since the day the user stopped. Unfortunately, none of them use real data about the user’s current situation, but rely on imprecise calculations.

Only the two hypnosis apps can be used by users who are still smoking, but their functionality is not comparable with the other analysed apps.

We found that the number of downloads of the top five apps on Android was approximately 4.4 million. We can assume that this number is the same for iPhones. This indicates that a substantial number of smartphone users are looking for apps that can help them in their smoking cessation. Because of this demand, effective smartphone apps provide an important opportunity to reach smokers and to help them quit, hence it is important to understand the effectiveness of these apps. Much more research within this field is needed and exploring approaches other than calculations based on user estimations may reveal some interesting untested outcomes.

App name	Platform 3	Categorisation
Kwitt	iOS, (Android)	Calculation Achievements
Hypnose	iOS, (Android)	Hypnosis
Rygestop - Røgfri med hypnose	iOS, (Android)	Hypnosis
Xhale	iOS, Android	Computer-tailored content, Calculation
Kwit 2	iOS	Calculation, Achievements
Quit smoking – QuitNow!	Android, (iOS)	Calculation, Achievements, Community
Time To Quit Smoke	Android	Calculation
Stop Smoking	Android	Calculation, Achievements
Rygestop	Android	Calculation

Table 1 – Most popular apps and their approach to smoking cessation

2.2 SELF-TRACKING

Reviewing the above-mentioned apps, we noticed the absence of self-tracking capabilities otherwise found in the majority of other health related apps. In fact, none of the reviewed apps, which are currently the most popular, use self-tracking of any sort, neither real-time tracking, nor summed up tracking (data input at the end of the day). So there is no real link to the actual situation, other than very simple calculations based on estimations. However, self-tracking technologies have showed promising results within other health behaviour change domains, such as physical activity and healthy eating (Brinthaparan, et al., 2013).

Consolvo et al. developed a prototype mobile phone application, called *Houston* (Consolvo, et al., 2006), for encouraging physical activity by counting the steps one takes each day using a pedometer. This data was then presented to the user and they could be shared with other users. Chiu et. al. (Chiu, et al., 2009) created a system called *Playful Bottle*, which makes use of a mobile phone attached to an everyday drinking mug to motivate office workers to drink healthy quantities of water. A camera and accelerometer in the phone are used to track the amount and regularity of water intake. The users were then presented with a tree metaphor game, where the healthiness of the tree depends on the water intake by the user. Another game system called *Fish'n' Step*, created by Lin, is an interactive computer game that encourages physical activity by using a virtual fish in a tank (Lin, et al., 2006). The more the players walk, the bigger the virtual fishes grow. Similar to that, the *UbiFit Garden* system (Consolvo, et al., 2008) encourages physical activity by sensing and detecting physical activities and uses a virtual flower garden as a metaphor to show the activity level and several other studies use the same approach of tracking and using metaphors to present the tracked data e. g. (Lin, et al., 2006), (Toscos & Faber, 2006), (Lo, et al., 2007) All these studies have shown promising results in provoke reflection among the users.

Furthermore, a review of 60 HCI research papers from the last decade within health behaviour change indicates that tracking is the most popular and most evaluated technology approach to change health behaviour (Brinthaparan, et al., 2013). However, the majority of them have focused either on physical activity or healthy eating while a domain like smoking cessation seems to be less explored.

[3] Platforms in brackets means that the app is available to that platform but not among the top five

When the tracking data is gathered, either manually by user inputs or done automatically by use of devices and sensors, the majority of the studies focus exclusively on presenting the data to the users in different ways or sharing the data with friends (Brinthaparan, et al., 2013). While sharing information can generate commitment and support and it has been successful in a domain like physical activity, Ploderer et al. found that people undergoing a smoking cessation were reluctant to share their personal data with others (Ploderer, et al., 2012). Self-tracking technologies are able to collect valuable data and knowledge about the users' behaviour. These valuable data have the potential of being used for more than just sharing and presenting, why it is worth exploring how to use the self-tracking data in new ways in order to support health behaviour change.

This literature review reveals that there is limited work done on the use of smartphones to help smokers undergoing smoking cessation. Furthermore, a review of the currently most popular smartphone applications shows us that none of them uses self-tracking technology, which has shown promising results in other health behaviour change domains. We see this as an opportunity to explore how self-tracking can be used in the domain of smoking cessation.

3. RESEARCH PAPER:

QUITTY – USING SELF-TRACKING TO PROVIDE PERSONAL COUNSELLING

Quitty – Using Self-Tracking to Provide Personal Counselling

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ABSTRACT

In this paper, we design and evaluate a self-tracking smartphone application, *Quitty*, for smokers. Unlike other self-tracking studies in health behaviour change literature, we use the data to deliver weekly personal counselling to smokers, written by experts from a quitline. Results from a 3-week field study with 13 participants, focusing on the participants' experience with the app and their reflection on their smoking habits, show that combining self-tracking with personal counselling is a promising approach to influence smokers to quit. Our findings show that tracking contextual information like time, place and situation associated with smoking, makes smokers aware of when, where, why and how much they smoke. This, combined with personal counselling, makes it easier for them to create strategies to quit and hence change their behaviour. The human element of the counselling messages acted as a catalyst for the users' motivation to track and change their behaviour. Furthermore, our study shows that tracking resisted cigarettes can be counterproductive, leading smokers in an early quit stage to smoke as a reward for resisting.

INTRODUCTION

HCI research has for many years explored health behaviour change within different health domains such as physical activity, alcohol abuse, smoking cessation, healthy eating, stress management etc. These kinds of behaviours cause illness and of particular interest to us, smoking comes with many diseases such as cancer, lung disease (COPD), heart disease and poor blood circulation [25]. According to the World Health Organisation, nearly six million people worldwide die each year from smoking related diseases [36]. Illness and deaths from smoking are not only tragic but also influence the economy within social welfare systems, in terms of treatment of people afflicted by tobacco related diseases. As a result of this, smoking cessation organisations worldwide put a lot of effort into fighting the smoking of tobacco. However, despite their comprehensive work, the global consumption of tobacco is growing [36]. This gives us, as researchers, reason to further explore methods to help smokers change their smoking habits towards quitting.

Smartphones is a rapidly emerging technology that has already found its way to almost every pocket and purse of people in developed countries, and even many under-developed countries [34]. They hold many features such as internet connectivity, GPS-sensor, accelerometer and computer-like processing power, making it easier to design advanced systems that are easy to use in everyday daily life for the users.

We see good potential in smartphones and see an opportunity to design a technological help to smokers trying to quit. The smartphone is accessible in the many different situations people smoke in. Our approach to reach the smokers with their smartphones is to design an application, Quitty, which utilises the technological possibilities of smartphones.

RELATED WORK

The consequences on the human body from smoking have been known for a long time, and research in the health domain has been ongoing for many years. But when it comes to supporting smoking cessation using technology, there are only a few studies to learn from. Early studies [32] used computer-tailored health letters to support participants' smoking cessation and found significant positive outcomes from this approach. Since then, other studies have confirmed the efficiency of computer-tailored content, as opposed to non-tailored content, in both general health domains and smoking cessation [27, 28, 33]. While all these systems were web-based, only a few studies have explored the use of the mobile platform to support smoking cessation.

Looking at mobile systems, txt2stop by Free et.al [13, 14] found that sending helping text messages to participants, doubles the quit rate in the short term. Other studies have explored the usefulness of smartphones. *Distract Me* by Ploderer et al. used distractions and tips to keep the users from smoking [21]. Distractions attracted the user's attention while tips kept them engaged for a longer time. The study also found that the users preferred to read rather than contribute. This confirms their finding in [23] where they describe ambivalence among smokers - they want to quit smoking and want to prove it to others, but on the other hand still like smoking and are afraid of sharing their information with others in fear of failing.

Most relevant to our study is the work by Srikandarajah et al. [30] who explored different types of content that could help a smoker to quit. Besides findings on the content types, they also found the smartphone platform to be convenient for users. Furthermore, the users demanded content that they could relate to and wanted interaction in the form of contact with a quitline or tracking their own habits in order to better engage with the app.

As studies reported in HCI literature on using technology to change smoking behaviours were limited, we conducted

a review of the 50 most popular smoking cessation apps from Apple App Store and Google Play Store. Reviewing these apps gave us insight into what methods commercial apps are using to change people's smoking behaviour. Analysing in detail the top ten of these apps revealed a general use of calculations as a type of self-tracking. These calculations (cigarettes saved, money saved, smoke-free days etc.) were based on estimates input by the user. Four of these apps also added the element of achievements that would be unlocked based on the calculations, e.g. a user would unlock *the achievement* of staying quit for 10 consecutive days.

Two of the apps analysed used hypnosis to help the user quit smoking. Hypnosis was provided as sound files available to the user to (pay for and) download. Besides of the two hypnosis apps, the others all focused on users who had already stopped smoking and were trying to stay quit. None of them were suitable for users who were considering quitting or preparing to quit.

Common to all analysed apps is that none appeared to be evidence based or a product of empirical research. This is confirmed by the two studies by Abroms et al. [1, 2] who reviewed a total of 98 apps for Android and iPhone. They categorised the apps according to their approach towards smoking cessation and their level of adherence to U.S. Clinical Practice Guidelines for Treating Tobacco Use and Dependence [35]. The study found that almost half of the reviewed apps used calculations based on estimates input by users and that the apps generally had low adherence to evidence-based practices.

One thing we noticed when reviewing apps from the app stores was that none of them used tracking technologies to approach smoking cessation, despite the fact that self-tracking technologies have shown promising results in other health behaviour domains. Many self-tracking systems have been designed and evaluated, for example, *Playful Bottle* is a system that monitors the amount of water office workers drink and gives them feedback on that in terms of how healthy they have been [7]. Consolvo developed an app, *Houston*, for smartphones that counts the user's steps [8]. *UbiFit Garden* is a smartphone app that tracks physical activity and presents the data in a playful way to the user [9].

Furthermore, our previous review of 57 HCI research papers on different types of health behaviour change indicates that tracking is the most popular and evaluated technological approach in the field [5]. We found that the studies we reviewed focused on presenting the tracked data to users in different ways or on using different approaches on how to share it with others. However, a recent study by Ploderer et al. found that people undergoing a smoking cessation were reluctant to share their personal data with others [23].

THE QUITTY APP

Based on findings from earlier HCI studies concerning smoking cessation and health behaviour change literature and the limitations evident in currently available commercial smoking cessation apps, we have designed a new smartphone app prototype for smoking cessation, Quitty. Quitty combines self-tracking with personal counselling aiming to extend previous work by using empirically proven smoking cessation techniques incorporated into the app design and evaluated "in the wild" with real smokers [26].

Cognitive behavioural therapy recommends that smokers write down the kinds of activities and the contextual attributes associated with it, that triggered them to smoke or crave cigarettes [20]. Contextual attributes like time and place while smoking can become conditioned cues to smoke. Certain situations trigger strong cravings, for example, working, drinking coffee or dealing with stress. Keeping track of these triggers and other contextual attributes can help smokers to increase awareness of their behavioural patterns and help to make strategies to change them [6]. Based on this, the Quitty app tracks contextual attributes like time, location and the trigger - the situation that triggered the user to smoke or crave a cigarette. By tracking both the smoked cigarettes and resisted cigarettes, users are able to follow their intensity of cravings over time. Furthermore, Quitty can therefore be used by smokers who are thinking of/preparing to quit, smokers who are trying to quit by either gradually reducing their consumption or going cold turkey, and smokers who are trying to stay quit. In designing for both smokers who are preparing to quit and smokers scaling down or going cold turkey, we counteract one of the biggest limitations in current apps, which are only useful for smokers who have already set a quit date and have stopped smoking.

The number of smoked cigarettes, resisted cigarettes and their associated time, location and trigger-situations as entered by the users in real time, are then presented back to them in an easy and understandable way. While reviewing their own self-tracked data, users are made more aware of own activity patterns. Many studies have tried the technique of presenting tracked data to users but with varying success. Hirano et al. found that this data can be ignored by users unless it is coupled with, for example, advice or guidance regarding how to improve their health behaviour [16]. Participants in a study conducted by Doyle et al. noted that getting beneficial feedback from their

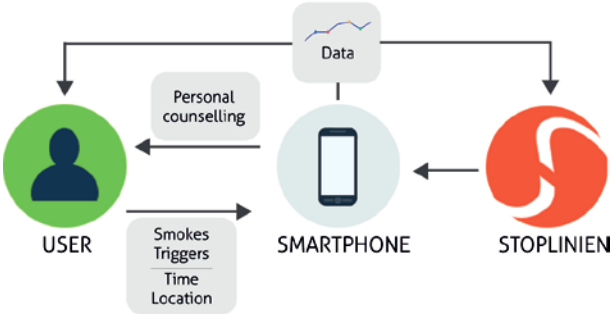

Figure 1 - Concept of Quitty and Stoplinien counselling collaboration

inputs into the system would motivate them to use the system more often [10].

In the design of Quitty we apply an alternative way of using self-tracking data than those presented in related literature, that is, using the data to give smokers regular and personalised counselling from a quitline expert, delivered directly into the app. Counselling has proven to be effective and increases the rate of smoking cessation [31, 35] and using counselling in an app has the potential to reach users who otherwise would not seek help. Stoplinien is the national quitline managed and provided by the Danish Health and Medicines Authority who collaborated with us to write personalised counselling messages to users based on their self-tracking data.

Design of Quitty

As this study builds on previous work [30], we decided to re-use the name of the initial prototype app – Quitty. This refined version of Quitty presented in this paper is designed to track the user's smoking habits and present them in an easy readable way to the users themselves. Based on findings from our previous study about successful smoking cessation techniques, we updated the app with daily tips and motivators (motivational facts about smoking).

The functional and graphical design of Quitty was kept as simple and easy to use as possible. Furthermore, we ensured that the interaction with the app would work efficiently and without delay. The reason being that slow and buggy applications spoil the user experience [30].

An important decision that we made was that it was necessary to develop native applications for the two most popular mobile platforms, iOS and Android. The initial Quitty prototype was developed as a web-app, which ran in the phone's browser. This was found to be slow to use and was limited in the technological possibilities that we could design into the app. Developing native applications ensured the graphics looked as intended and we were better able to exploit the technological advantages of the smartphone platform. Moreover, a native app runs faster than a web-app delivered through a browser.

Making an app for each platform also makes it possible to design with respect to the design principles of that operating system, taking advantage of people's interactive familiarity with their own phone, so that the apps would be more intuitive to use.

The first time the app is opened, the user will be prompted to log in. The participants' user-accounts were created prior to delivering the app, but it was also possible for users not already recruited for the study to sign up for the app through one of the public app stores. This provided an additional channel to reach new participants for the study.

Quitty has three tabs corresponding to the three screens that make up the app: *Track, Mine Data* and *Tips* (which in English translates to *Track, My Data* and *Tips)*. In this way we have kept interaction with the app very simple and easy to use to encourage people to use it as an addition to their regular activities whenever they feel like smoking.

Track

The *Track* screen (figure 2 a)) has very few elements and very simple interaction. There are two major buttons at the top, labelled *Smoked* and *Resisted*. Beneath each of these, there are 10 *triggers* to choose from. The user selects whether they just smoked one or more cigarettes or resisted a craving for one. If they, smoked, they need to press the *Smoked* button the exact number of times that corresponds to the number of cigarettes smoked at that particular moment. Following this, the user is asked to choose what triggered them to smoke a cigarette. They are able to choose as many triggers as are relevant to that situation. If they *resisted*, they are given the same list of triggers to find out what triggered them to feel like a cigarette. To ensure that they always have at least one trigger to choose from, one option was *Other*. To complete the input, the user presses *Save* at the top of the screen. This operation collects the following data about the smoking episode - user input (number of cigarettes and triggers) and smartphone generated input (the current location with coordinates and address, and current time and date) - and sends that data to a server which was monitored by the researchers.

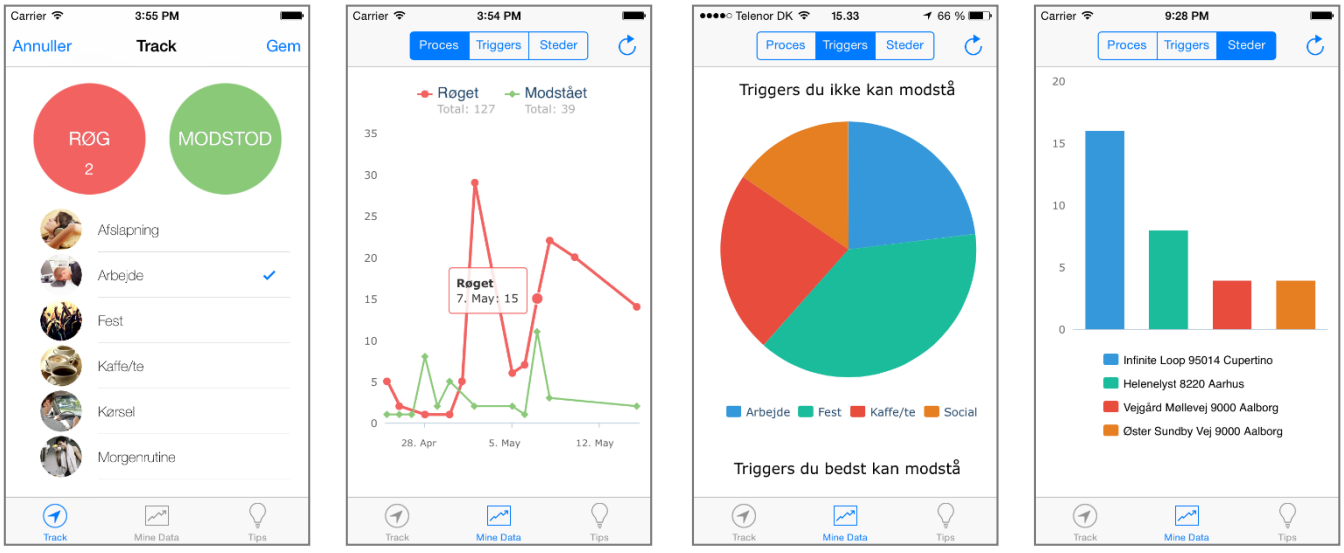

Figure 2 – Quitty app screens: a) Track b) My Data: Process c) My Data: Triggers d) My Data: Smoking places

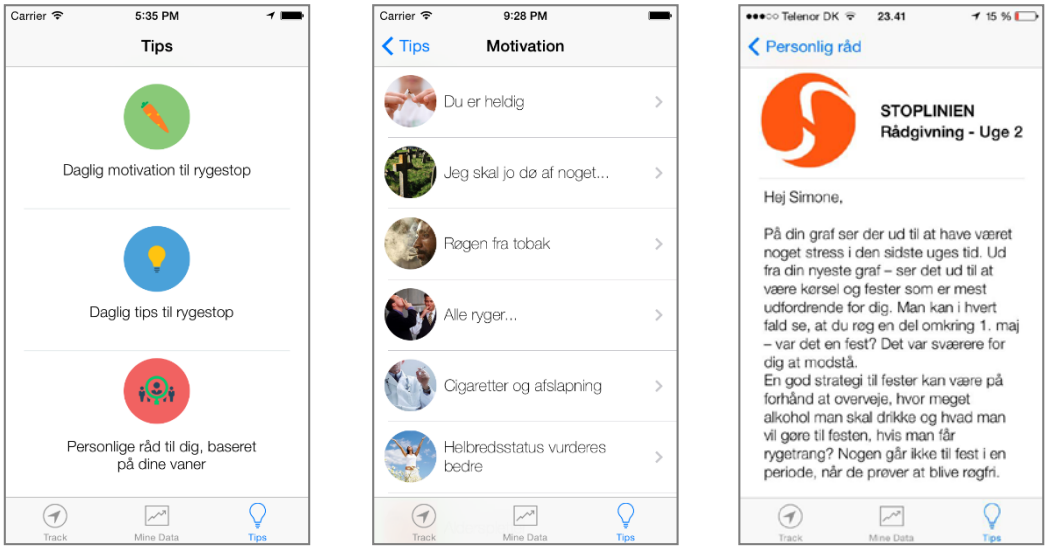

Figure 3 – Quitty app screens: a) Tips b) Tips: Motivations list c) Tips: Counselling

My Data

The *My Data* screen (figure 2 b), c), d)) presents the user entered data in an easily readable way. First it is presented as a process chart (figure 2 b)) showing the amount of smoked and avoided cigarettes per day. The chart provides a simple visualisation for the user to see whether they are improving at staying quit or reducing their cigarette consumption. We decided to show both the number of cigarettes smoked and the number resisted in the same chart so that the user can easily compare the two, enabling them to see if there is a correlation between the number of smoked cigarettes and the number craved. Above this chart, the app also shows the total number of smoked and craved (therefore avoided) cigarettes for the duration of the study (that is, since they started using the app). By tapping any point on the process chart, a popup with the total number of cigarettes smoked or resisted that day is shown.

The second chart (figure 2 c)) is a pie chart which shows the proportions of each of the triggers that the user has indicated. Each trigger, indicated by different colours, shows the proportion of cigarettes smoked caused by a particular trigger. This gives the user insight on what triggers them the most to smoke. The same type of chart is used to show which triggers the user is able to resist. By tapping each segment, a popup will show the exact number of smoked or resisted cigarettes.

A third chart (figure 2 d)) shows the locations where the user smokes the most. This is represented by bars, indicating the number of cigarettes smoked at each location. This gives the users a good understanding of where they tend to smoke the most. This should help them reflect on the kinds of locations they need to avoid, or be more aware of resisting their cigarette cravings.

Common to all charts is the intention of provoking self-awareness by providing self-tracking. Existing research in both health behaviour change and other fields suggests that self-tracking can lead to people changing or adjusting their behaviour, as they become more aware of their existing behaviour [4, 12].

Tips

The *Tips* screen (figure 3 a)) gives access to the three content types: *Daily Motivations*, indicated by a carrot on the button, *Daily Tips*, indicated by a light bulb on the button and *Counselling*, indicated by a person "in focus" on the button. Selecting either of them will navigate to the respective list of the content (figure 3 b)). Each content has an icon associated with it to raise the user's interest.

The lists of *Daily Motivations* and *Daily Tips* (figure 3 b)) are updated automatically every day, giving the participants one new *Daily Tip* and *Motivation* a day. Previously received content is stored and is accessible at any time in the list.

Daily Tips and *Motivations* used in the app derive from various online sources including QuitVictoria[1], Sundhedsstyrelsen[2], e-kvit[3], WebMD[4] and LiveScience[5]. A sample *Daily Tip* is, "*Some smokers say that the taste of citrus reduces cigarette cravings. Start your day with a big glass of orange juice or half a grapefruit*" while a *Motivation* could be, "*Cigarette smoke contains over 4000 chemicals and 69 of these are known to cause cancer. Even if you don't smoke you can still get sick from these poisonous chemicals just by breathing in other people's smoke.*" The difference is that a *Daily Tip* is an easy implementable piece of advice, whereas a *Motivation* is a factual statement about pros/cons of smoking (cessation).

The content types *Daily Tips* and *Daily Motivations* have proven to have a good effect on health behaviour changing

[1] http://www.quit.org.au/

[2] http://sundhedsstyrelsen.dk/

[3] http://ekvit.dk/

[4] http://www.webmd.com

[5] http://www.livescience.com/

contexts, both together [30] and individually; Langford et al. call them informational support and found them useful in achieving behavioural change [18]. Furthermore, both major Danish and Australian smoking cessation organisations (Stoplinien, QuitVictoria) make extensively use of tips. In terms of the content of Tips and Motivators, Morris found that reminding people of what they could potentially gain or lose by quitting smoking versus continuing smoking, has a significant impact on behaviour [31]. This is supported by Mann et al. who say that gain and loss messages are strong persuasive communicators within a healthcare context [19].

Counselling

The counselling messages as seen on figure 3 c), arrive once a week and the list includes the logo of Stoplinien and the date the message is received. The messages are written (by Stoplinien) to contain the participant's name and are initiated with a follow up, rewarding text. Based on the survey answers and self-tracking data, the message may contain personalised advice, tips, guides and motivation that fit the participant's situation. Each message includes Stoplinen's free quitline phone number, allowing users to call Stoplinien as a follow up to the advice, if they wish.

Technical Implementation

Both apps (iOS and Android) are designed and developed from scratch and in native language. iOS app was developed using Objective C in XCode for OSX. Eclipse was used to develop the Android version in Java.

As we are using the participants' location to distinguish between places where the participant would smoke, we were obliged to collect precise location information. This meant using the phone's GPS, which causes a massive power drain if not used sparingly. At the same time, it takes some time for the phone to receive signals from GPS satellites and calculate coordinates. To overcome this, the app only starts fetching location information when one of the *Smoked/Avoided* buttons is pressed. The GPS antenna is then turned off immediately after the smoking input is saved or discarded. This gives the phone some time to receive and calculate the current position, while the user is selecting the triggers.

A service called Parse[6] is used as the backend data storage for Quitty. This acts as a database for all user data collected by the app (number of smoked/resisted cigarettes, triggers, timestamp and location). Parse also holds all tips and motivations that were sent out to participants.

Push notifications and SMS reminders

Quitty has an in-built function of receiving push notifications. This means that we can send out short messages to the user's smartphone at any time. Push notifications are widely used by many smartphone apps, so it is assumed that the users will know about these. We use push notifications when the user receives a new counselling message from Stoplinien. This way they do not have to complete any extra steps other than tapping on the message, taking them to the app directly. This simple interaction should encourage users to read their counselling messages as they arrive.

In our previous study we found that it was very useful to send reminders to use the app by SMS to the participants [30]. Furthermore, we found that when the participants realised that the messages were sent by a person and not a machine, they were more likely to respond to the reminders. In this study we write all messages individually so it is clear for the participants that they are written by a person and specifically to them.

The two types of messages are intentionally divided so the participants will not confuse notifications on newly arrived counselling with the daily reminders.

Extensive testing and an expert usability evaluation of the app were conducted before it was deployed to the participants.

Field study

The aim of the study was to use Quitty as a technology probe [17] to explore how quitting smokers would respond to using tracking of their behaviours and to presenting them with this data for self-awareness and personal reflection on their smoking habits. Furthermore, we explore how this data can be used to give personal counselling and how this can help the participants.

The field study was conducted in Denmark in spring of 2014. The participants used the app for a period of three weeks.

When recruiting participants, they were asked to complete a survey which helped us get to know them better. They were asked about basic demographics and about their smoking habits. The participants were asked to use the app every day for a period of three weeks. However, they were also reminded by daily SMS messages to use the app. Following the three-week period the participants were invited to an interview. Prior to interviewing the participants, a pilot interview was conducted to test and refine the questions.

Participants

The participants in the study were recruited through Aalborg Kommune's (council of Aalborg) smoking cessation courses, advertisement on Stoplinien's web page, through Facebook connections, forums and by using posters placed around the university campus, libraries and around the Aalborg city centre.

Furthermore, we contacted people who downloaded the app from Apple App Store and Google Play Store and asked them if they would like to participate in the study. The requirement to participate in the study was that people were either currently smoking or had just stopped smoking and were trying to stay quit. The participants were required to have either an iPhone or Android device with an inbuilt GPS.

There were 13 participants in the study, 4 males and 9 females. Their ages ranged from 22 to 52 years old, with

[6] https://www.parse.com

an average of 35. Seven of the participants had an iPhone and six had an Android device.

All of the participants except for two had previously tried to quit smoking. 6 participants were thinking about quitting, 4 participants were preparing to quit and 3 were trying to stay quit. Based on Fagerströms test of nicotine dependency [15], we calculated each participant's dependence score. Three participants scored 0 (no dependency), two scored 1-2 (very low dependence), six participants scored 3 (low to moderate dependence) and two scored 5+ (high dependence).

Data collection

All participants completed an online survey in order for us to collect information about them. The first part of the survey consisted of demographic questions about, age, occupation and place of residence. The second part of the survey consisted of questions about their smoking habits, such as which smoking stage they to quit and what their reasons were to quit smoking. The survey included a short version of the Fagerström test in order to considered themselves at (in respect to the six stages of TTM [24] how long they had been smoking, why they smoked, in which situations they were most likely to smoke, how motivated they were measure the participant's nicotine dependency. Based on the type of phone they own (iPhone or Android), they were then handed the respective introductory guide which gave them access to install the app themselves.

During the three-week trial period, each participant was asked to use the app whenever he/she smoked a cigarette or had a craving. All participants had their own personal login which was created for them beforehand and they all received a new *Daily Tip* and *Motivation* each day through the Quitty app, as well as a daily SMS message to remind them to use the app. All the data from the Quitty app was monitored remotely during the study period to ensure that any technical problems were discovered and solved as quickly as possible.

Once a week, the tracked data for each participant, which consisted of number of smoked cigarettes, resisted cigarettes, the associated triggers, time of the day and the location for every entry, was collected and converted into an easily understandable document including graphs of the participant's behaviour and data from the initial survey. A document was created for each participant and sent to Stoplinien. Based on the answers from the survey and the tracked data during the week, Stoplinien wrote personal counselling messages to each participant, typically 15-25 lines long. These messages where then saved in the database and then sent to the app. Besides the weekly counselling texts, all participants also received daily tips and motivations. All content sent to the participants remained accessible to users at all times, so they had the possibility to read it as needed.

After the three-week field study, a semi-structured interview, approx. 45 minutes long, was conducted with each of the participants. The purpose of the interviews was to discuss their experience with the app during the three-week trial, and the role it played in their smoking cessation. Two participants did not want to participate in an interview. A questionnaire was made and sent to them instead. The first questions were about the general impression of the Quitty app and what they liked and disliked most, followed by questions about the tracking screen and its usefulness. We then asked them about the usefulness of the different charts, what they learned from looking at them and the impact this had on their smoking behaviour. Each participant was presented with a table of their use pattern and their interaction with the app, collected by data logging, and were asked follow up questions in regard to their specific use of the system. We also discussed their impression and perception of the personal counselling messages from Stoplinien and what impact these had. During the interview the participants were asked to come up with suggestions to improve the app including functions that they thought were missing and design changes to make the app better. Finally, we were interested in their reflections on their smoking habits and whether they felt they had changed during the study period. As we did in the initial online survey, we again asked how motivated they were to quit smoking to see if their motivation had changed by the end of the study. All interviews were audio recorded.

Data Analysis

Since this was not a theory building study but an exploration of the use of Quitty and understanding of its impact on the participants and their behaviour, we did not create a full transcription of the interviews. Instead, we used qualitative content analysis with partial transcription [3], where we played the recording, noted what was being discussed during each minute or so and fully transcribed the parts that were found to be relevant.

FINDINGS

The 13 participants used the app differently and ranged from 6 to 198 database entries (one entry may contain more than one smoked cigarette), averaging 57 entries per participant during the three week period of use. When asked in the interviews, all 13 participants expressed that they found the use of the app easy or very easy, "*Yes very, it was easy to use, even to me who is bad at using technology.*" Furthermore, we asked them whether they found the app too time-consuming to use where 10 did not find it to be so, "*Easy and fast. It takes a quarter of a second to open and then you just press save and 'bang', you are done.*", and "*No, it did not take much (time), it only takes a couple of seconds if you are already with a cigarette in your mouth and has some time to kill anyway.*" Despite finding it easy and fast to use, a few users sometimes forgot to use the app, but would remember it before going to bed and enter in all smoked/resisted cigarettes from memory. This supports the participants' general liking and interest in tracking their habit. We also found that no matter the age, all participants were keen on using a smartphone app in their smoking cessation. In fact, the participants aged over 25 were particularly enthusiastic about using the app. This is in stark contrast to how The Danish Health and Medicines Authority have divided young and adult people to use different platforms (young: app, adult: SMS/e-mail service) [11].

Feedback

Looking at the three different charts (process, triggers and locations), 7 out of 13 participants stated that they learned something new about their habit that they were not aware of, "*I found out that I smoke the most at home and when passing time. I can see that more than half were because of time passing. I always thought that if I smoked, it was because I was stressed. So my justification to smoke is not really honest.*"

Even though the rest of the participants did not feel that they learned anything surprisingly from the charts, they found it highly motivating to get a visual representation of their smoking habit.

"*It became clearer. You don't think about it when you smoke, how many you smoke and where you smoke. It becomes clearer. So maybe you should be more careful.*" Even the participants that did not input so much data, because they had stopped smoking and only had few cravings in a week, found it motivating to see that they were on the right track. "*I think it is extremely motivating, that you can see that you are on the right track. Instead of looking at a plain number, you can see a graph of it. I think that is very motivating.* "

We asked the participants about how they wanted their data to be represented and if there was anything they would like to change. All participants were fond of the charts as they found them simple and informative. However, they all mentioned that they wanted the ability to choose the time frame of the data visualisation, allowing them to compare their consumption and behaviour with previous week's usage.

SMS reminders

Most of the participants found the daily SMS reminders useful and did not mind receiving them every day. These participants found them to be good reminders to remember to use the app every time a craving would occur. A peculiar finding about the SMS reminders is that those who liked them were more motivated to stop smoking. Those who were not currently motivated did not like being reminded on using the app.

Counselling

The study showed that there was a good correlation between the participants' motivation to quit and how they perceived the counselling messages. Eight of the participants who took their quitting attempt serious and wanted to do something to change their habit, were very positive and found them very personal, motivating and helpful, while the rest indicated that they were not ready to quit and did not see smoking as a problem right now, hence they felt that counselling made them feel pressured.

Participants appreciated that the messages were tailored, personalised and written specifically to them and their situations, "*It gave me more motivation. That I am going to make it. It helped me a lot. It was really personal. And the counselling helped me find out by myself that I was ready to stop*", and "*It means a lot that it was written specifically to me, what I should do, and not what others should do.* "

One participant compared Quitty with a smoking cessation service called *e-kvit*, provided by the Danish Health Medicine Authority, which she found very annoying due to the lack of personalisation, "*I receive messages from something called e-kvit. They are really annoying. It's the same all the time. I think I have received three now that said 'It's now one month since you stopped smoking'. Right! It is so obvious that it is something sent by a computer because I have three e-mails saying the same thing. Yes, yes, well done (ironic).*"

This also highlights the importance of the human factor, that the messages were written by real people and this was confirmed by many other participants who also mentioned that knowing that other people have put their time and effort into writing counselling messages to them was a huge motivation to take a step further in their quit attempt, "*Yes, I was surprised that it suited me that well. Someone really wants this. It meant that I had to pull myself together because someone is actually following my progress and spending time on me and thinking of how I can do better.*"

Some participants liked the convenience of receiving counselling rather than having to contact someone directly in order to get help. They preferred this both because they found it transgressive to call but also because they would have postponed it over and over, "*I'm afraid of calling them. If I were to write down in my calendar that I should call Stoplinien to quit smoking… I could keep writing that for a year that I should do it. I probably wouldn't do it anyway. This way it is much easier to go in and say; now I have read this and understood it, done!*"

All the participants would be willing to share information about their personal smoking habits with the counsellor as long as these were used to give feedback and felt that doing so, would improve the quality of the counselling even more.

Resisting

We found that the use of the *Resisted* button in the app was welcomed differently corresponding to the participants' quitting stage. Participants who were trying to stay quit found the *Resisted* button and graph useful and liked how they could see their progress of craving less cigarettes over time. This kept their motivation high. However, participants who were thinking of or preparing to quit said that when inputting resisted cigarettes, it made them crave a cigarette even more. Ironically, one participant would reward himself with a cigarette for resisting one, "*I think it can have a psychological effect that you take up your phone to say that you resisted one, 'Good job, you have done well, smoke a cigarette for that.*" Others found it inconvenient to choose what triggered their craving, as this just made them feel like having the cigarette instead. These findings show us that tracking resisted cigarettes is only helpful to those who are trying to stay quit, while it can be counter-productive for people who are still smoking.

Motivation and reflection

We asked the participants about their motivation to quit smoking both when recruiting them and after the three week trial of the app. All participants except one increased or held the same motivation during the period. The average

motivation on a scale from 1 to 10 went from 5,8 to 6,4. These numbers are also supported by participants saying that the app helped them be more aware of their habit, "*I think that it's when you are more aware of it. Mapping of my habit.*" When asked what changed, one participant answered, "*It is the visualisation, giving me a visual overview of my consumption, instead of making the visualisation in my head which most likely will be less because you will not admit you smoke that much.*" None of the participants used other remedies to help them quit.

When asked about whether their smoking habits had changed after the three week period of using Quitty, 6 participants said that they had reduced their consumption and changed their routine and 3 participants said that Quitty had supported them in staying quit, "*Before it was just a question about pulling one out of the pack and then done. But then you have just… I have started to think: 'Should I really? No you'd better not'. Then maybe one hour later I might smoke one anyway but I still skipped the one before. I do not smoke quite as much anymore. I do not smoke when I'm at home, only when I am at school. Before, I smoked all the time, also when I was home*" and "*I have slightly decreased my consumption. The app had a major impact; it has helped me to think about my consumption. It helped to postpone cigarettes. Has gone from over 15 to less than 10.*"

The other four participants did not change their habits. However, they stated that Quitty made them reflect more on their habits and think about their consumption. "*No not really yet, but I am aware of how my smoking habits are. You think more about it. I could maybe do without this cigarette. You just have to think differently. I am currently quite busy so not really motivated to quit. I absolutely think that I am pleased with the app*", and "*I have found out where my weaknesses lies. I think more about it every time I light a cigarette.* "

DISCUSSION

The main contribution of this paper is to fill the gap in HCI literature on combining self-tracking and personal counselling within health behaviour change and to overcome the limitations in commercial smoking cessation apps currently available in the app stores. Very few studies have examined the use of smartphones in smoking cessation and little is known about how the advantages of smartphones can be used to support smoking cessation. Our review of the most popular smartphone apps for smoking cessation on the app stores showed that none of the apps made use of self-tracking and none of them were aimed at smokers who want to reduce their consumption. In this study, we have designed a self-tracking app for both people looking to reduce their cigarette consumption and people who have quit and looking to stay quit. By using a technology probe in a field study, we have gathered empirical understanding about how smokers trying to quit actually respond to different quitting techniques - both through their actions, as gathered by remote data collection, analysis of that data and through how they respond to and perceive these techniques and the effect on their smoking habits, as gathered through interviews with participants.

Self-tracking technologies have showed promising results in other health behaviour change domains. We see evident benefits of tracking contextual data of smokers' behaviour; Being aware of when, where and why they smoke, and calling for them to take actions to change their behaviour. Based on this we recommend implementing contextual data tracking in future designs.

While self-tracking technologies in health behaviour change literature have used the tracked data to visualising and offered for users to share this data with friends, we have in this study combined self-tracking with personal counselling from a quitline sent to the user's smartphone. To our knowledge, this is a new approach, not seen before in the health behaviour change literature within HCI.

The participants responded generally positively to the counselling messages. In particular, participants who were highly motivated to quit and took their quit attempt seriously found this type of in-app counselling surprisingly personal and helpful. While many studies have offered computer-tailored content to users based on survey data e.g. [28], our findings show that, using real people to write counselling messages specifically to a user, is a huge motivator to change behaviour. Furthermore, the study shows that using the self-tracking data to write personal counselling keeps the users motivated to manually input tracking data, hence motivating them to keep using the app. This confirms the findings of Doyle et al., which indicated that users were motivated to manually input data when getting beneficial feedback [10].

Most developed countries have a free quitline and courses to help smokers quit. But it is not all smokers who take the step to call a quitline or attend a course. A participant said that, she would never contact a quitline by herself because this made her feel weak. "*I don't have the guts to contact them. It's like I can't take care of myself and I feel like a chicken. To me, it's like going to the doctor. It's easier that it [help] comes to me.*"

Other participants expressed that they would like to call a quitline but due to their busy everyday life they would have postponed it over and over and never made the call in the end. The convenience of receiving help right into their pocket in the form of counselling messages in an app, made it easy and shameless for the users to establish contact with a health counsellor.

Self-tracking technologies have the capability to collect valuable information about users' health behaviour. Our findings suggest that using these data to provide personal counselling and thereby let the help come to the users, has a great potential to reach and influence a broad range of users.

Privacy is an important topic when it comes to self-tracking technologies. A previous study has shown that smokers are reluctant to share personal health data with others due to the feel of commitment and fear of failing [22, 23]. However, our study shows that smokers are

willing to or even want to share their personal health data with a counsellor as long as it could improve the quality of the personal health feedback.

During the three-week period, we noted that sometimes participants did not track anything for a whole day, but in the evening, they tracked many cigarettes in very short time. When asked, they answered that they had forgotten to use the app during the day and when they remembered, they wanted to register all the cigarettes from memory. This indicates an interest in tracking all events to ensure accurate data. Furthermore, manually tracking data helped participants reflect on their habits, "*It helped me abstain from smoking some cigarettes. I have thought about it. You should also press the Resisted button instead of just sitting here smoking.*" Sohn and Lee found that manually registering smoking incidents was a powerful reminder of their desired goal [29]. However, their users found it annoying to register manually, indicating that optimised design can counteract the task of registering. It may also be the feedback given to our participants (charts and counselling) that motivated them to register, as the study by Doyle et al found that getting beneficial feedback from input would motivate users to use their system more [10].

A peculiar finding about the charts was the previously mentioned ambivalence of smokers [23]. While all participants liked the charts and found them useful, one participant expressed that the crude honesty of the charts sometimes had a repelling effect, *"Yes, but when I found out how much I smoked... I was disgusted with myself. I had a guilty conscience. I should make an example of myself. It was because the charts show you in black and white how much you actually smoke."* This participant stopped looking at the charts for a while after realising how much she actually smoked. But at the same time she became aware of her consumption and ended up reducing it during the three-week period by following her progress on the charts. While we can confirm only a single occurrence of ambivalence about the charts, we also find that this will not refrain them from using the application due to the beneficial feedback.

The study provided the participants with two types of content: *Daily Tips* and *Motivations*. These were updated every day so that the participants always had new content to read. Our findings show that people mostly read the content when they opened the app to register a smoked/resisted cigarette. This confirms the findings by Ploderer et al. in the study of their mobile application called *Distract Me* [21]. They found that distractions attracted users to the app while the content (tips) kept them engaged for longer periods to cope with cravings and strengthen their commitment to quitting. Some participants opened Quitty when bored or passing time, and read tips and motivations. This indicates a similar tendency of interest in strengthening/maintaining their commitment.

LIMITATIONS

Despite using acknowledged techniques in the study such as online surveys, technology probing, semi-structured interviews and qualitative content analysis, it has some limitations.

The number of participants for this study was quite small, which means we cannot claim any statistically significant findings. Adding to this, the length of the study was limited to one semester, resulting in only 3 weeks left for the field deployment of the app after spending time on developing it and leaving time for analysis of results. The use of a qualitative approach, did however give insight on each user's experience with using the app.

Furthermore, when recruiting, the participants would also be part of a lottery to win one of two gift certificates as motivation to enrol to the study. This reward may have influenced their interest in participating.

Finally, all participants were Danish and so our findings are limited to that context.

CONCLUSION

This study entered unexplored territory in the HCI domain of smoking cessation. We developed and deployed Quitty, a mobile app combining self-tracking and personal counselling, which offers self-awareness and personalised guidance to people wanting to quit smoking. The self-tracked data included contextual information, which gave the user detailed insight on their smoking behaviour. This detailed data furthermore helped Stoplinien provide the user with personalised guidance and advice. Users who were serious about their quitting attempt found the counselling messages helpful and all participants would be prepared to provide Stoplinien with even more information about themselves to improve the quality of the counselling. While smokers who were trying to stay quit found tracking of cravings beneficial, it could be counterproductive for smokers in the earlier stages of quitting. Furthermore, we found that when providing beneficial feedback on the user's tracked data, they are willing to manually track their behaviour, which also increases their awareness of their behaviour. Some participants were really surprised when they saw details of their behaviour that they were unaware of on the charts. This shows us that self-tracking is considerably more accurate than smokers' own perceptions of their smoking.

FUTURE WORK

Based on the findings of this study, a refined version of Quitty should be designed. Furthermore, this design should be deployed to more users for a longer period, to evaluate its impact on people undergoing smoking cessation. We would like to see a trial period lasting a full quitting attempt - from thinking of quitting to actually doing it.

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5. REDESIGN

Following our study findings and future work recommendations, we redesign the Quitty app to give a visual impression of a revised version. This redesign of the app is based on the findings from the study, gathered by interviewing the participants who used the app. This section is divided into subsections of each screen of the app and its functions. For each subsection, we will describe the design issues found in the study and afterwards we will describe the redesign of that particular section.

5.1 THE TRACK SCREEN

The *Track* screen is where the user tracks their behaviour by inputting information about number of cigarettes smoked and what triggered them to smoke.

5.1.1 Smoked/Resisted button

DESIGN ISSUE

The interviews revealed a difficulty for smokers that we did not anticipate. Some participants pointed out the difficulty of resisting a cigarette when in the stage of thinking of or preparing to quit smoking. They found this noticeable when trying to register the resisted cigarette in the app. Registering a resisted cigarette in the current design, includes the steps of pressing the green *Resisted* button, choosing a trigger and pressing the *Save* button. As described in the findings of the study, we see a correlation between the quitting stage of the user and how they respond to resisted cigarettes, as our study shows that people who are still smoking and trying to quit, should not be reminded of smoking. Doing so when they resist a cigarette may backfire and make them crave a cigarette even more. People who has stopped smoking and are trying to stay quit have no use of the Smoked button as the use of it would mean a relapse into smoking, in where they will return to the mode of smoking in the app.

REDESIGN

Our solution to this is to divide the app into two modes – one for people in the stage of thinking of or preparing to quit, another for people trying to stay quit. We have redesigned the system to have only one button on the *Track* screen - If the user is in the stage of thinking of or preparing to quit, the button will be red and with the text "*Smoked*". If the user is in the stage of trying to stay quit, the button will be green with the text "*Resisted*".

5.1.2 Tracking

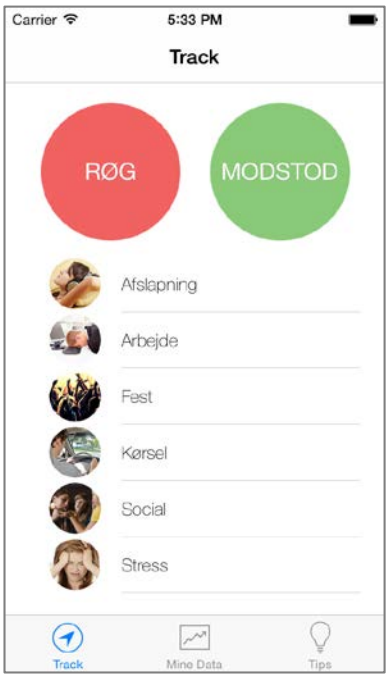

Figure 2 – Old Track screen

DESIGN ISSUES

While interviewing the participants we found that manually entering data into the app improve the user's awareness of their behaviour and that the participants were willing to do so as they benefitted from the feedback of the charts and counselling. However, two participants mentioned the Save button to be unnecessary. This is the Save button that appears in the top right corner of the screen immediately after pressing either the Smoked or Resisted button. In order to save one's input to the database, the Save button should be pressed. This was implemented so users would not mistakenly input wrong data to the database and ensuring that they are in total control of what they save to the database.

Looking at our data from all users, we see that less than 5% of the data inputs contain more than one *Trigger*, indicating that the need to select multiple *Triggers* per data input is very limited.

In the current design it does not matter whether the user chooses *Triggers* or the *Smoked/Resisted* button first. Both elements are equally visible as seen on Figure 2. We want to change this so users should follow predetermined pattern. We want the users to first indicate whether they smoked or resisted and afterwards choose a *Trigger*.

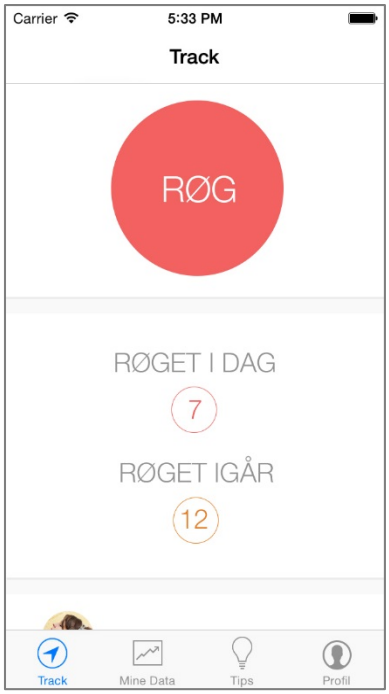

Figure 3 – Track screen redesign

REDESIGN

To force this interaction to the users, the triggers will be further down and only partly visible as shown on Figure 3. This gives focus to the button rather than to the *Triggers*. When the Smoked/Resisted button is pressed, it and the list of *Triggers* moves up so the *Triggers* fill up the most of the screen, taking focus from the *Smoked/Button*. When the appropriate *Trigger* is chosen, the data will be saved instantly without the need to press a *Save* button. This will also reset the screen so that the *Smoked/Resisted* button will be in the middle and the *Triggers* at the bottom.

Changing the layout of the *Tracking* screen makes room for motivational data to the user. When in default mode (nothing has been pressed), the app will show statistics from the day before and the current day. The statistics will be the number of cigarettes smoked both days, giving the users a simple and easy accessible way to compare their consumption to the day before. During interviews, participants mentioned the importance of being able to compare data on the process chart. For example one participants said, "*I could see the number of cigarettes I had smoked and then I could say to myself, 'Today I should smoke less' The chart shows me if I exceed it, but I should be going the other way and smoke less.*" By showing the two numbers next to each other on the *Tracking* screen, the users will be presented to this as the first thing each time opening the app, making them aware of their consumption even before looking on the charts on the *My Data* screen.

5.2 TRIGGERS

DESIGN ISSUES

We learned that while the participants did not miss any important triggers to choose from, they felt that they had to compromise on some of their selections, forcing them to think whether their situation would fit in any of the 10 or it should go into "*Other*". We had chosen the 10 most common *Triggers* to smoking which covers most common smoking situations like working, stress, drinking coffee etc. However, when talking to the participants, some expressed a desire to be able to choose their own personalised *Triggers*. They would find themselves in a situation where they would choose "*Other*" because none of the others would fit their situation well enough. This meant that when they looked at the pie chart of what *Triggers* them to smoke, a big part of the cigarettes will be in "*Other*". This means that the participants have no way to know what triggered them to smoke, thus meaning that Stoplinien will also not be able to know why, resulting in weaker counselling. "*But it is difficult. There are so many different situations in just a day. Because I pressed 'Other'... It's difficult, but I think the basic ones are there. [...] There has been some situations where I was like... Okay I'm doing this, what should I register it as? I'll just choose 'Other'. But when I go and see my statistics, I see 'Other'. What was 'Other', what did I do? It could be anything to me. So it's more for my own sake - what does 'Other' mean?*"

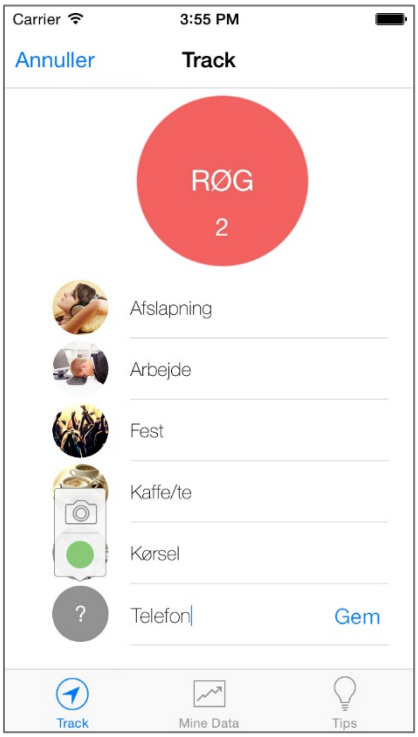

Figure 4 – Custom trigger

REDESIGN

To overcome this, we will give the users the option of creating their own *Triggers* to choose. It works by the user pressing the "*Other*" *Trigger* when none of the others are suitable to their situation. Figure 4 illustrates how the "*Other*" *Trigger* changes to a blank trigger for the user to customize. The text-field will go blank for the user to type in a name to the situation. Furthermore, the circular image to the left of the *Trigger*-name will be selectable for the user to choose between coloured circles or choose the camera icon which will allow the user to take an image of the situation to store to the *Trigger*. This way the users are able to customise the *Trigger* to fully suit them and will be able to take an picture that they can easily recognise. We also ensure that no user will end up with a pie chart showing a big block with the label "*Other*", as it is no more possible to choose "Other" (unless the user themselves create a "*Other*" *Trigger*).

One participant briefly mentioned in the interview that he sometimes had to scroll through the list of 10 *Triggers* to find the right one. While he did not see this as a problem, we think it gives opportunity to improvement to ensure good user experience to all users. The improved list of *Triggers* will be sorted according to the most used *Triggers* by the user. This way, the most used *Triggers* will be on the top of the list. To give an example, if a user is mostly triggered by work, which would normally be in the bottom of the alphabetical list, he/she would have to scroll down to "Work" every time they used the app. Such a scenario is eliminated by the new design.

5.3 MY DATA SCREEN

The *My Data* screen is where the user is able to see charts of their tracked data.

5.3.1 Charts

DESIGN ISSUES

During the interviews, we asked the participants if they would prefer the charts to show data from their whole tracking period or just the last short period of time (e.g. seven days). Although asked to choose either of them, all participants wanted to be able to choose between different time spans. When asked, they told us they would like to compare different periods to each other, to see if there were any improvements or changes to their behaviour. This not only emphasises the great interest in self-monitoring by our users but also tells us that these users want to learn from their data in order to change it.

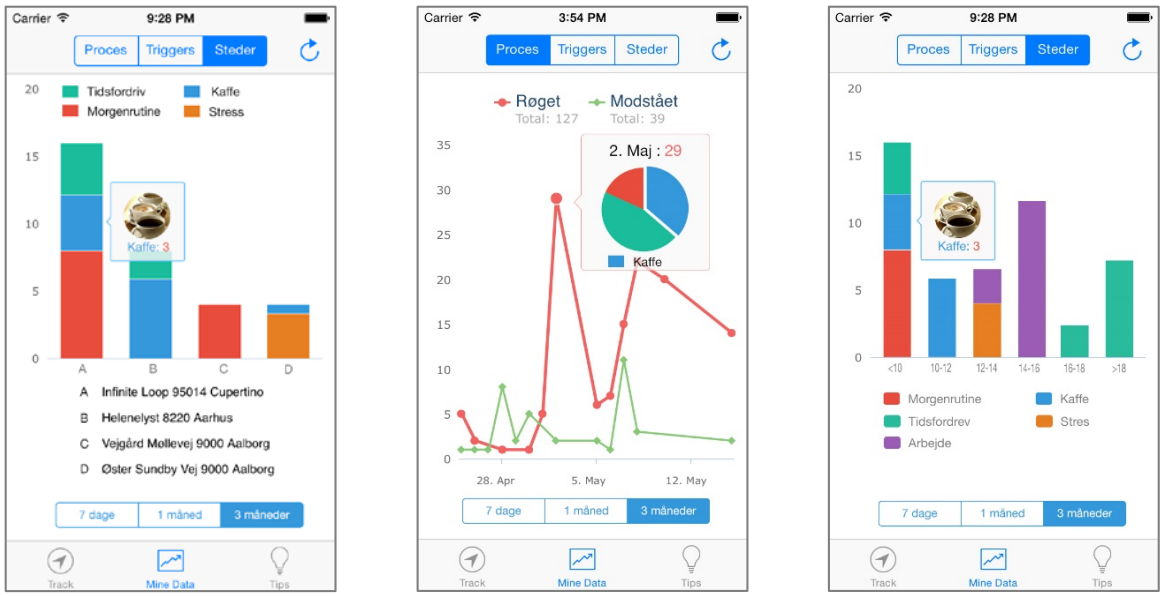

Figure 5 – a) Combination of location and Triggers b) Triggers on process chart c) Time of day chart

REDESIGN

The solution to this is simple. By adding a tab-selector in the bottom of each chart, as seen on Figure 5, we allow the user to choose the time span from which data should be presented. This allows for fast and easy comparison of charts.

As an addition to the existing three types of charts, one participants suggested cross-type charts, combining data from two charts. He wanted this addition in order to better understand his habits by for examples see what triggered him the most one day. Figure 5 a) shows how we combine the location bar chart with *Triggers*, by dividing each bar in sections of *Triggers*. This allows the users to see what triggers them the most at each location giving them a better understanding of why they smoke at different locations. We also extend the design of the process chart to include a single-day presentation of a trigger pie chart. When pressing on a point on the process chart, a popover window will show a small pie chart as shown in Figure 5 b). When tapping on a section of the pie chart, details of that section will be shown in the bottom of the popover. We also add a new chart showing how many cigarettes the user smokes on different times of the day (Figure 5 c))

5.4 TIPS SCREEN

The *Tips* screen is where the user can choose too se lists of *Daily Tips*, *Daily Motivations* and *Counselling Messages*.

5.4.1 Counselling

DESIGN ISSUES

We found that all the participants who read their counselling messages believe that the counselling will be of more value if the counsellor knows more about them. One way to provide the counsellor with more information is to contact them directly. We learned that some participants were interested in asking follow up questions to the counsellor. This meant that he wanted to contact Stoplininen to tell correct the information in order to receive proper counselling. While interviewing all participants we asked how they would prefer to contact Stoplinien in case of questions or if they wanted to talk to a counsellor. Most participants answered that depending on the length of the conversation and the topic, they would either call them or text them through an in-app chat-system.

REDESIGN

Seeing that the app runs on a smartphone that the users will bring and use everywhere throughout their day, we see it fit to meet the participants' wish to choose how to contact them, as calling might not be an option in all situations. As contacting Stoplinien will only be regarding the counselling, we place the contact option within the counselling screen of the app. Each counselling text-header will include two buttons: one to call Stoplinien, the other to open a chat with a counsellor (Figure 6).

Figure 6 - Call and chat button on counselling message

5.4.2 Profile

DESIGN ISSUE

As we have changed the concept of Quitty to differentiate between users who are thinking of or trying to quit and users who are trying to stay quit, it is necessary for the users to choose their appropriate stage. This may be necessary as it is common to relapse during a quitting attempt. Furthermore, we should consider the necessities emerging when designing the app to be able to work by itself (without the need of researchers managing it). In order to the counsellor at Stoplinien to know their demographics, quitting stage etc., the user should be able to enter this data themselves. The study showed that participants were willing to provide additional information about themselves in order to receive better counselling messages. This will also be possible in *My profile*.

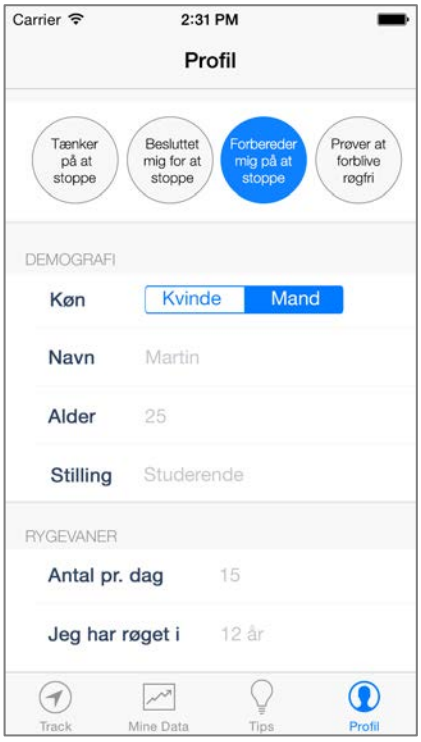

Figure 7 – Profile screen

REDESIGN

We implement this by adding a fourth screen called "*My Profile*". This is a simple settings screen where the users will choose their quitting stage, which will have direct effect on the app's look and function. Furthermore, they will be able to choose demographics like gender, name, age and occupation as seen on Figure 7. It is likely that when deploying the app in the real world, there are more settings to add to the list, but these are the vital information needed to the app and counsellors in order to provide optimal quitting help and guidance.

To sum up the changes made to Quitty; the concept of Quitty has changed so the app is divided into two modes – one for smokers thinking of or preparing to quit, another for people who already quit and are trying to stay quit. The difference between the two is that the *Smoked/Resisted* buttons now belongs to each of the two modes. To make the app faster to use, the *Save* button has been removed. Users now have the ability to create their own *Triggers* to better suit their smoking habits. Charts are now more advanced, showing combined data and letting the user choose to see data from different periods of time. To meet the users' wish to be able to contact Stoplinien, the app now has in-app shortcuts to calling and chatting with Stoplinien. Lastly, we implement a *My Profile* screen for the users to type in their details which will be available to Stoplinien. This is also where the users will set their quitting stage which will automatically set the mode of the app.

6. RESEARCH CONTRIBUTIONS

This thesis deals with the use of mobile technology to raise self-awareness and support smokers to change to healthier behaviour and has contributed several interesting findings to this area. We have developed a self-tracking smartphone application for smokers who want to quit. The main contribution of this thesis is that we discovered a big potential in combining self-tracking with personal counselling to promote health behaviour change and that user's not only respond positively to this combination, but also saw great benefits in terms of their reduction of cigarettes smoked during the field study. By tracking contextual information like time, place and the situation that triggers a smoker to light a cigarette and using this data to provide personal counselling messages to the smokers, written by experts from a quitline, we provided a new and innovative approach to the use of self-tracking data in smoking cessation applications. Furthermore, we have designed an app useful for smokers who are trying to scale down and smokers who are trying to stay quit as opposed to current popular apps available in the app stores, which are primarily designed for smokers who have already set a quit date.

TRACKING CONTEXTUAL INFORMATION HIGHLIGHTS WEAKNESS

The study shows that using charts to visualise the user's smoking habit, is very effective in provoking reflection among smokers. While this has been done before in health behaviour literature, presenting contextual attributes to let the smoker know where, why and how much they smoke in a graphical visualisation makes it easy for them to understand and highlights their weaknesses in resisting cigarettes, hence motivating them to take action and change it.

INFLUENCE OF QUITTING STAGE

While tracking smoked cigarettes led to reflection and increased motivation to take action towards a healthier behaviour by reducing their consumption, tracking resisted cigarettes can both be a motivation to continue the good behaviour by staying quit and for some smokers lead to the opposite - making them want to smoke a cigarette as a reward for their good behaviour. This shows that a technique can be beneficial for some smokers while the same technique can be counterproductive for others. It is therefore, not just important but necessary to investigate how smokers in different stages of quitting respond to a given technique when designing technology for health behaviour change domains that deals with dependency.

THE HUMAN FACTOR IS A HUGE MOTIVATOR

Smokers who are serious about their quitting attempt and have high motivation, find the counselling messages very helpful and as a huge motivator to take action against their bad smoking behaviours. Furthermore, the human element in the form of a real counsellor deeply influenced people compared to computer-tailored interventions. Knowing that real people are using their time and effort trying to personally help them as an individual, makes it harder for users to ignore the content, makes them feel guilty about their habits and increases the chances of them considering the counsellor's advice.

However, smokers who are not ready for change and do not see smoking as a problem will find counselling as a pressure and will not gain anything beneficial, showing that this type of counselling should only target smokers who are at least in the quitting stage of "decided to quit".

BENEFICIAL FEEDBACK OVERSHADOWS CONCERN OF SHARING

An interesting finding in this study is that participants are willing to share their personal health information and self-tracking data with a counsellor and even wished that they could share more, without worrying about privacy. This is in contrast to many self-tracking studies that showed that people were concerned about sharing

personal health data with others. Our study shows that in a context of counselling through smartphones, users respond differently and are willing to share their health and private information as long as they feel they get something beneficial in return.

MANUAL USER INPUTS INCREASES AWARENESS

Many studies have focused on using external devices and sensors or a smartphone to track health data automatically and one may think this is better than requiring the users to manually input data. However, our project shows that letting the users manually track health behaviour definitely has some advantages. The participants did not have any problems with manually typing in every time they smoked or resisted, and did not felt that it was time consuming as long as they got beneficial feedback from it. Since they had to manually type in some of the data, it increased the time spent on using the app and reflecting on the charts hence increasing the chances for behaviour change. An automatic data collector may be more accurate and precise but if it does not require user input, it may be forgotten. Future designers should create a mix of both approaches, automatic tracker with some regularly required user inputs to achieve accurate data and ensure that the users will spend enough time on using the app to raise and maintain their awareness of their habit.

Based on these contributions we can conclude that self-tracking technologies have the capability to collect valuable information about users' health behaviour. Tracking and presenting this data to users promotes self-awareness and provoke reflection about their behaviour. Using this data to give personal counselling by a counsellor, acts as a huge motivator, pushing the users to take action, hence increase the chance for health behaviour change.

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8. APPENDICIES

APPENDIX A: Previously conducted study paper found attached to this thesis

Using Mobile Phones to Persuade People Undergoing a Smoking Cessation

APPENDIX B: Files found on attached disc

Recruitment material

Participant survey

Partial transcriptions including interview questions

App screenshots

App content

APPENDIX A:

USING MOBILE PHONES TO PERSUADE PEOPLE UNDERGOING A SMOKING CESSATION

Using Mobile Phones to Persuade People Undergoing a Smoking Cessation

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ABSTRACT
In this paper, we report on a study designed to get a better understanding of how a mobile application can play an important role in persuading users to quit smoking. The study introduces three content types: stories, motivators and tips supported by two labelled sources of recommendation: experts and community. This content was provided using a purpose-build mobile application. This study contributes with new knowledge on the perception of stories that may be perceived as fake if not in the right structure. The study confirms that, tailored content is an important factor when persuading users to stop smoking in order to make it relatable and achievable for them. Furthermore, this study stresses the importance of push messages, reminding and persuading users to perform a certain task. Proposals on how to improve these are also described. We suggest that the findings from this study can be applied to other domains within behaviour changing mobile applications.

Author keywords
Persuasive technology, Smoking cessation, behaviour change, online participation.

INTRODUCTION
It is a well-known fact that smoking cigarettes can have serious health risks. Smoking can cause cancer, lung disease (COPD), heart disease and poor blood circulation, to mention a few of the many health risks [19]. Besides the health risks, smoking also have economic impacts on social welfare systems in terms of paying for treating people afflicted by diseases caused by smoking [22]. Because of the effects caused by smoking, multiple anti-smoking organizations worldwide spend money and effort in trying to reduce the number of people smoking.

According to the latest data on tobacco usage by WHO (World Health Organization) 22% of the world's population aged 15+ are smokers [25]. Smoking has been steadily decreasing, for example in Victoria, Australia where smoking rates for adult smokers has reduced by 15% since 1983 [20]. This decline can be a result of a number of reasons, for example: A greater knowledge about smoking and its health risks and anti-tobacco campaigns conducted by the many anti-smoking organizations (e.g. [19]). An example of effort in reducing the number of people smoking are the warning labels found on cigarette packages in selected countries. By having these warning labels on the package, smokers are more likely to be aware of the health risks associated with smoking cigarettes [7].

"Mobile technology can layer information into our moment-by-moment lives in a way that changes our behaviour" (Fogg, et al., 2002) This quote by B. J. Fogg describes the benefit of using mobile devices in a behaviour changing field. The mobile phone has become a device that everyone carries with them and therefore makes a good platform to reach users in multiple situations. Furthermore, the amount of functionalities in a smartphone makes it a useful tool for people, improving the impact and engagement of health behaviour changing applications.

The book "Persuasive Technology: Using Computers to Change What We Think and Do" by B. J. Fogg (Fogg, et al., 2002) presents different persuasive principles usable to persuade people into a behaviour change. His principles has led to the discovery of new persuasions in the field of health behaviour change such as the work by Morris [13], stressing the increased interest of persuasive technology. When taking into account smokers' struggle when attempting to quit, persuasive technologies could be helpful in accomplishing their goal of becoming smoke-free.

This paper is structured as follows: First, we present related work that has been done in the field of smoking cessation. This includes both an ongoing study regarding the subject, as well as the use of mobile devices as a platform to change people's behaviour. We present details about the design process, implementation and deployment of a mobile application prototype using principles of persuasion in order to support the users in their quitting attempt. Finally, we present the findings of a conducted field study, which is discussed and reflected on. We conclude by considering future work within smoking cessation and the use of mobile devices in this context.

RELATED WORK
Several studies regarding changing people's behaviour in a smoking cessation context have been conducted. This study extends the work of Ploderer et al. [14] [15] [16] within this field. Their work introduces the ambivalent socialiser as being a person who is simultaneously keen but also reluctant to engage with others via social media due to failing a quitting attempt is highly likely [14]. It is assumed that contact with peers through a persuasive technology can offer support and guidance within smoking cessation. In their study, they discuss the rationale for applying four different types of user involvement (structured socialising, incidental socialising, eavesdropping and trace sensing) and suggestion on how

to facilitate these in a social media application. When working with ambivalent socialisers it is important to consider their current individual needs, as their behaviour may change over time.

In another study conducted by Ploderer et al. [15] they examined the relationship between stage of change and social support by analysing messages posted on a public Facebook support group for people trying to quit smoking. The study shows that the type of support is related to the stage where the users find themselves. The supportive response and leadership in the support group mainly came from people who just started their quitting attempt rather than from people who considered themselves as ex-smokers.

Their latest work introduces a distraction app, which makes use of different kind of distractions and tips for the user to apply when experiencing cravings [17]. The findings from the study shows that distractions and tips complement each other in interesting ways. While the distractions attracted users to the app, the tips kept the users engaged for longer periods of time in order to prepare for quitting, cope with cravings and strengthen commitment to stay quit. The popularity of personal stories throughout the application suggested that they may have a value as a separate feature to the app, which could be implemented in another version of the system.

In this study, we want to incorporate the findings from previous research, by implementing stories and tips in a mobile application to get a better understanding of their value and impact in the context of smoking cessation. Furthermore, we add a third type of content, motivators, to study the perception and usefulness. The main goal is to explore these different types of content in the context of health behaviour change. The study also looks at two labelled sources of recommendation of different types of content to see whether they have an impact.

RESEARCH DESIGN

This study examines the motivating qualities of three sources of content (stories, tips and motivators) presented on a mobile device. The study also introduces two sources of recommendation (experts and community). Each of the three content types are labelled as recommended by one of two recommenders, resulting in six different types of content being sent to participants during the study. (see Table 1). Each of these content types were examined in respect to how effective they were in persuading people to change or reflect on their smoking habits. The content was provided through a mobile web-application (app) called Quitty. The prototype app was developed and deployed to 11 people (living in Australia), who were interested in or currently trying to quit smoking.

	Recommenders	
	Social proof (**Community**)	Expertise (**Expert**)
Stories	Stories Recommended by **community**	Stories Recommended by **expert**
Tips	Tips Recommended by **community**	Tips Recommended by **expert**
Motivators	Motivators Recommended by **community**	Motivators Recommended by **expert**

Table 2 - Table showing the six different types of content sent to the users

Each participant was asked to fill out a survey prior to a three-week field study. The purpose of the survey was to get a better understanding of the participants' demographics, smoking habits, attempts to quit smoking, reasons to quit and also if they previously used a quitting application and/or website. After completing the survey, the participants were given a link to the app, which also gave them an introduction and purpose of the system. The app explored different ways of supporting users in their quitting attempt with information to give them better knowledge on how to quit and change their current thinking and/or behaviour. Following the three-week field study, the participants were invited for a post-interviews which focused on the usage of the app and their reflections on the different content types and sources of recommendation.

Quitty

The main aim of Quitty was to explore whether people who were interested in, or attempting to quit smoking, found it supportive to be given helpful information about quitting. Furthermore, we investigated the potential impact and benefits when participants received content from different types of recommenders. We asked the participants whether they found the content and its source of recommendation trustful, and how they responded to the given content.

One of the key functions of this study was to utilise realistic content for the users to explore. Therefore, we contacted Quit Victoria in order to obtain information and stories written by smokers, ex-smokers and experts on the topic. Thus, the content was reliable and from a trustworthy source - aiming to persuade the participant with its sense of genuineness, whilst providing information that is assured by Quit Victoria to not be detrimental to their health. Despite the fact that the app presented in the paper may be perceived as a technological probe, the central goal of this study was to explore various content types used whilst advising participants, rather than exploring the technical aspect or usability of the software itself.

Expert evaluation

Before the participants were given access to the app, an expert evaluation was conducted with lectures, PhD students and researchers from the University of Melbourne in the Department of Computing and Information Systems. They were able to access the app, familiarise themselves with it, and then asked to perform a set of simple tasks to find usability problems and obtain useful feedback.

DESIGN OF THE QUITTY APP

The Quitty app has been designed to prompt the user upon their first log in to the app, enabling them to be guided via a walkthrough tour, highlighting both the purpose and how to use the app. This walkthrough contains a welcome screen, a description of the content, an explanation of recommenders and a description of the rating system (see figure 1). The user will only encounter this walkthrough on the first login. However, users are able to access this information via the help menu within the app.

The home screen of Quitty has three menu items: Stories, Tips & Motivators (see figure 1). Each day a user would receive one piece of content within each of these menus.

Stories menu

The 'Stories' menu provided a vast selection of real-life, first-hand experiences of quitting smoking, written by smokers and ex-smokers. The app provided a variety of stories, which were each aimed and focused at different stages of quitting.

We included stories as a central part of our content sources, due to the fact that the use of stories as a health behavioural change strategy has increased [8]. Hinyard argues that stories are a comfortable, familiar and non-confrontational way of receiving information, that supports people to make a behavioural change [8]. According to Diamond et al., storytelling is how people learn and exercise agency, shape identity and motivate people to act [3].

Tips menu

The 'Tips' menu provides the user with helpful advice and guidelines on how to quit and/or maintain their non-smoking habits. These tips were written by experts from Quit Victoria, which takes into account different stages and situations that smokers may experience when attempting to Quit (note: the Quitty app, however, does not take into consideration the individual quitting state of a particular user).

We included Tips as one of main content types, as studies show the effectiveness of using tips to support people in a healthcare environment. Tsang [26] argues the usefulness of these tips, however also stresses the importance of delivering these tips carefully, in the right way and at the right time. Tips are also widely used by major quitting cessation organisations and websites such as Quit Victoria[1] [26]. Another study by Langford et al. describes informational support or tips, and validates the use of these to better achieve a behavioural change [10].

Motivators menu

The 'Motivators' menu contains different reasons and motivations that remind a user as to why they are/should be quitting. The motivators were written by experts from Quit Victoria and considers different topics such as health reasons, social reasons, statistical reasons, facts etc.

We have included motivators as a content type as Morris [13] argues through her paper that reminding people of what they can gain or lose as a result of smoking versus quitting smoking, has a significant impact on user behaviour. This is further supported by Mann et al. that illustrates that gain and loss messages is an efficient communicator of both positive and negative persuasive appeals within a healthcare context [12].

For each of the menu item pages, it is possible to view previous content by clicking on the 'All' button; this gives participants the ability to look at all of the content, in case

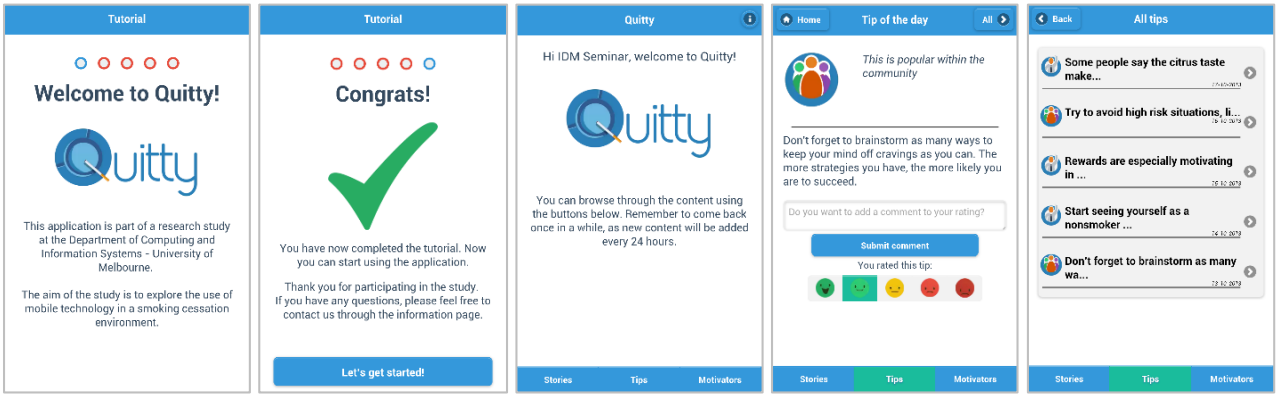

Figure 8 - From the left: Quitty tutorial page 1, tutorial page 5, Quitty start screen, tip of the day screen and all tips screen

[1] A joint initiative in Victoria, Australia established in 1985 set to reduce the consumption of tobacco

they miss it one day, or perhaps want to review content that they have previously read.

Two recommendation sources

Each of the content types were labelled as recommended by either an expert or the community, which is illustrated by two different icons on the type of content (see figure 2).

Expert recommendation

The expert recommendation represents a recommendation from an expert within the health organization, Quit Victoria. We have used this because Fogg explains in his book *Persuasive Technology* (Fogg, et al., 2002) the use of expertise as a way to persuade people to do a specific behaviour. He argues that advice from a credible source such as an expert, authority or verifiable figure, has the potential of appearing as trustworthy, which is an important factor (as credibility and reliability are essential) when attempting to persuade a person's behaviour.

Figure 2 - The Quitty icon for the Expert recommendation (LHS) and the icon the community (RHS)

Community recommendation

The community recommendation, as included in our design, represents the popularity of the content within the Quit Victoria online community. Cialdini argues in *Influence: Science and Practice* [1] that the principle of social proof determines what is right by finding out what other people think is correct. This specifically applies to the way in which people make decisions in order to constitute and justify correct behaviour. A behaviour is observed to be correct in a specific situation by the degree to which we see other people performing it as well.

Pathamanathan et al. [18] built two mobile apps to encourage pro-environmental behaviour in two different contexts: watering gardens, and electricity usage in households. The systems used both expert and community information to advise the users. The study showed that using expert and community information was a useful way to persuade users' behaviour.

The labelling of content as being either recommended by an expert or the community was randomised, allowing us to determine whether this characterisation had an impact on its perception and rating by a user.

The rating system

To gather data during the three-week study period, the system makes use of a rating system. This system contains of five 'smileys', wherein the icon on the far left indicates the highest rating, and the icon on the far right illustrates the lowest rating (see figure 3).

The app asks the user, 'How helpful was this motivator/tip?' and 'What did you think of this story?' This allows us to gain feedback on the content; furthermore, through the addition of optional comments to a users' rating, we are able to get a better understanding of the

Figure 3 - Five smileys used in the Qutitty app to gather user feedback on the content provided, from extremely happy (far left) to very unhappy (far right)

rational of their rating. During the three weeks of using the system, a user has the ability to re-rate a particular content, if they happen to change their minds in retrospect. This was a mechanism put in place on the basis that a particular content might have been helpful on one particular day, but not on another day, for an infinite amount of possible factors and reasons.

Incoming messages

During the three-week study period, the participants received a text message each day on their mobile device, notifying them that new content had been added to the app. Each of these messages had different phrasings to incite some interest for the participant to return to the application, and avoid seeming monotonous. According to Fogg, who conducted a healthcare study, using SMS-messages to notify people as an enormous potential to trigger users to a proposed behaviour [4]. Other research points to text-based messages as being the most effective in order to avoid psychological reactance [21]. To help participants believe that these text messages were not automated, we included their names at the beginning of the message, personalising it so that the user would feel it was more directed towards them.

Technical design

The app was designed in a four-week period by the researchers. In order to avoid dependence on a single mobile platform and operating system, the system was designed as a web-application. The prototype was developed by using an open-source framework called Appery.io[2] that offers a cloud-based rapid development environment that integrates backend services and API plugins.

A database was used to ensure that the actions from the users were logged by the system. The database contained content extracted from Quit Victoria's database and also data from logging usage of Quitty.

[2] http://appery.io/about-us/

USER STUDY

The prototype was deployed in a study with 11 participating smokers and ex-smokers. The objective of the study was to explore how the participants would interact with the probe and what types of content and recommenders they preferred. Furthermore, we were exploring if any of the app's content and recommenders would persuade the participants to reflect on or even change their current behaviour.

We also conducted a pilot study with a Ph.D. student from the university to ensure overall quality and to gain an insight on the finding we would potentially gather.

Participants

The participating smokers and ex-smokers were recruited through the Melbourne Universities student and staff portal. We also made use of people at the Department of Computing and Information systems as advertisement to people in their social network by mentioning the project at seminars and on Facebook. Furthermore, we advertised the study through posters around the university.

Each of the participants had to meet a basic set of criteria in order to be included in the study. They either had to be currently or previously smoking. The participants were required to have either a smartphone or a computer. The participants were also required to have a mobile phone, which was able to receive SMS-messages for the notifications about new content in the Quitty application.

All of the participants were asked to use the Quitty application at least once a day to view the daily added content. The estimated daily usage of the application was approximately 5-10 minutes. The participants were also asked to check their mobile phones for incoming SMS-messages, which notified of new content added. They participants were allowed to use the Quitty application freely at their own leisure.

The study had 11 participants who were smokers or ex-smokers. 8 of the participants were male and 3 of them females. The age range of the participants were from 23 to 47 with an average age of 34. All of the participants had tried to quit smoking before, 3 were currently trying to stay quit, 2 were thinking about quitting and 6 were preparing to quit. The nicotine dependency of the participants, as based on the Fagerström test [6] showed that 4 participants scored 0 (no dependence), 2 participants scored 1-2 (very low dependence), 2 participants scored 3 (low to moderate dependence), 2 participants scored 4 (moderate dependence) and 1 scored 5+ (high dependency).

METHOD AND DATA COLLECTION

In the initial part of the study, each participant was given access to an online survey in order to gather information about them. The first part of the survey asked demographical questions such as gender, age, occupation, marital status and if they had children. The second part asked information about the participants' smoking habits. Here we made use of a shortened version of the Fagerström test to measure the participants' nicotine dependence. We were also interested in knowing which smoking stage the participants considered themselves of being at, how long they had been smoking, in which situations they were motivated to smoke, when they were most likely to smoke and their reasons for quitting. The third part of the asked questions about their quitting attempts, which included the number of times they have tried, how long their longest quitting attempt lasted and what tools they have used to help them in their quitting attempt. We were also interested in knowing if they had used a quitting app or website before. The last question in the survey considered the time of the day where the participants were not able to check their phones for SMS-messages. The reason for this was to find a good timeframe for the push messages in order to give the participants the information at the right time without interfering with their daily routines.

The study was conducted during spring 2013 in Australia over a period of seven weeks. Each participant was asked to use the application once a day and received a reminding SMS-message. The participants had their own personal login which was based on the three last digits of their phone number. All participants would receive the same content but randomly labelled as recommended by either a community or an expert. The participants were not aware of this randomization of recommendations during the study. They were all asked to give feedback of the content through ratings and comments.

During the study period, Quitty was monitored remotely. If a technical issue should occur during the trial, the researchers would be aware of it so it could be solved as quickly as possible. The participants could also contact the researchers directly through email, if they found problems when interacting with the system. Every time the participants logged into the system their input was saved in a database to monitor user behaviour.

After the three-week deployment with the user, a semi-structured interview was conducted with each of the participants. In this method we used an interview guide with topics that we wanted covered. If the interviewee made an interesting point during the sessions, the interviewer could always chose to pursue this further [9].

The purpose for this interview was to discuss the different types of content and recommendations that they had received each day: what types of content the participants liked and did not like, what their thoughts of the recommendations were and whether it had an impact on their thoughts of the content? Another purpose was to discuss the usage of the application and also the push messages.

The first couple of questions were about reflections on the use of the app as a supporting tool for quitting smoking which were followed by questions about the different kinds of content and recommenders and how they were interpreted and used throughout the study. We were particularly interested in whether the source of recommendations had an influence on their rating decisions and the reasons behind their decisions. We were also interested in the participant's reflections on their

smoking habits and whether they changed during the study.

Based on their interactions with the system and comments made during the three-weeks study, we also asked which effect the content had on them when it came to motivation and inspiration and how useful they found the content. Furthermore, we wanted to know if the participants used the application as a substitute for smoking.

Each of the participants was presented with the table of content and recommenders and how they interacted with the system.

All the interviews had an approximate duration of 45 minutes and were all recorded and transcribed.

DATA ANALYSIS

For the data analysis a selection of coding techniques were applied from Grounded theory to analyse the data [11] [24].

During the analysis, we used Open Coding to mark significant and important points made by the participants. Each of the interviews were coded by two members of the project team in order to get different perspectives and to make sure that all the important aspects would be covered. It was randomised which interview each member was given, to make sure that they were not coded by the same people.

By using Affinity Diagrams [23], 40 different phenomena were categorised. Most of these were divided among 8 main themes – the rest were considered of minor or of no relevance.

FINDINGS

Our findings were derived from the 10 interviews with the participants and their interaction with the Quitty application (1 participant dropped out during the study).

Mobile usage of the Quitty application

The study shows that 9 out of 10 participants used their mobile phone as their platform to access Quitty. The participants made a total of 98 logins during the three weeks of deployment with an average of personal logins at 0.47 per day. In the study period we logged a total of 792 browsing interactions, the highest number for a single participant being 192 entries and the lowest being 16 entries. During the study, the participants indicated that a mobile device was preferred within a smoking cessation context. One of the reasons being that it can be easily accessed everywhere when you are having a craving for a cigarette: *"I prefer it on the phone. It is like maybe if you are in a bar and you like, you can actually ask, what do I do if I actually see someone smoking and I am in craving."* Another participant addressed quitting smoking as being a very private thing, which means that using a mobile device offers a possibility to look at the phone secretly: *"If you associate with smokers they will go "Oh come on, what are you doing, you are not going to do something as stupid as quitting! […] Qutting smoking is a private thing […] And having an app on your phone means you can kind of look at it, secretly."*

The participants used the Quitty app in different locations and situations. This includes being at work, at home, when socializing etc. As instructed, the participants used the application throughout the entire period. However, we discovered major differences in how often they used the system. For example, a participant logged in to the system two or three times per week, while another participant only used the system twice.

Incoming messages

Once a day the participants received a SMS-message from the Quitty team reminding them to check the app, read and rate the content. These messages were sent at different times each day and about half of the messages were personalized to include the participants' name. 8 out 10 expressed that they liked the text messages. Only 2 did not like them because they found them annoying, especially when receiving the texts at inappropriate times. However, 9 out of 10 participants found the messages usable and it made them use the application more. *"These were good reminders. So If I did not check it that day so it was like 'oh yeah that's what I have to do'. Because you do forget especially if you are busy or you are tired."*

One of the participants mentioned that he found the text messages even more motivating and encouraging when he discovered, by coincidence, that the messages were from a real person and were not computer-generated: *"They were good […] It was nice that it was an actual person sending the message. I only realized when I wrote back to it and someone responded. After that, knowing that there were someone there, I found the messages encouraging and positive and friendly and that was my main motivation for checking the app, was getting that text message."* This indicates that using real person to write the messages to user can have a bigger impact.

The participants often logged into the app after receiving the text message, because it reminded them that the application exist and what they are trying to accomplish. *"No, generally if I would receive a text message and I was having a cigarette or I just had a cigarette it would make me feel a little bit guilty."*

Some of the participants also mentioned that it was a good thing that the messages did not arrive at the same time each day, e.g. one of the participants mentions creating strategies to avoid them, when knowing the exact time it arrives each day. *"I have already developed a strategy for it, but I still haven't quiet gotten myself to take it off. But getting those messages it wasn't at a set time, there was no "Oh that message is going to come, if I put my phone away I won't see it" it would come through and I would go "Oh I got a new message! Uh it's from the app! Cool", "oh I just had a cigarette I feel kind of bad, I will quickly stub it out, then I will go look at the app, just in case the app will know!"*

It was addressed during the interviews that it is important that the messages should be interesting and maybe funny in order to keep the participant engaged. *"Because then it will keep me interested in the application and in what it actually are going to say next."* The text messages should

not be repetitive, because that will lead the user to start ignoring them. It is therefore important to be creative and inventive when writing these messages in order to keep the user engaged. A participant mentioned that a way to do this could be to include a teaser of the content in the message.

Another important aspect, that almost all of the participants mentioned, was that it would be useful if the messages included a link to the app, which would make it easier and quicker to access. By including a link, it would potentially have made them use the app more, according to the participants.

Design of the application

The participants indicated that they liked the clean and simple design of the app. One participant said that he liked that the app was optimised for different resolutions and devices. Overall, the participants thought that the app was reasonably useful with its content and functionality.

Content

During the study it was discovered that the participants in general were more fond of content that had a gain framed message rather than a loss framed message. An example of this would be a message saying, how much their lungs will improve by quitting rather than having a message telling them how much their lungs would deteriorate from continued smoking. *"I think it was a week or something, the effects on the body and I thought that was a very good way to kind of 'wow I didn't realize it was only that long before you see positive effects' you know and things like that, rather than ones that were you know […] talking about damage."* According to the participants, they would be more likely to ignore the "negative" content, as they felt they had seen enough of this already and thereby have become immune to this type of content. A few participants mentioned that they would rather receive negative or edgy content or a mixture of both negative and positive content in order to help them quit smoking.

Six of the participants expressed that the application did not provide them with enough information. Both in terms of the amount of content released each day, but also because of the lack of in-depth content.

The study indicated that the users were most fond of receiving tips (6 out of 10), while stories and motivators were equally split across the rest. An interesting aspect of this is, if a participant was more fond of tips, he/she would most likely also have an interest in the motivators and a lesser interest in the stories. Vice versa, if a participant was more fond of stories, he/she would not necessarily find tips and motivators as useful. Although, in general the participants thought that the content types supported each other well. This was also indicated by the ratings given in the app where each of the content types had an almost equal score. Furthermore, the study implies a confusion of the content types, tips and motivators, which were difficult to differentiate from each other, due to the similar structure.

Fake/Genuine content

5 of the participants stressed the importance of genuine and realistic content. 3 of the participants thought that the content seemed fake, where it seemed like it was made up, which is both due to the impersonal nature and structure of some of the stories. *"Some of the stories I found to be, almost to the degree that they read as if they were just made up. 'Today I am going to quit, I've decided I am going to quit today'."* This is interesting as all the content supplied in the app are from the Quit Victoria website and not made up for the purpose of this study. Another participant pointed out that when a story does not cover how hard it is to stop smoking, it does not seem real.

Condescending content

4 of the participants found some of the content in the app condescending. This occurred when content being comprised of knowledge that they already knew; in this instance, they felt patronised as this information was not new to them. *"…and that was as well condescending that I felt like. Yeah, you know having tried it or like, you know 'Good little smokie you get a sweetie'."*

Tips

The tips were described by the participants as practical, concise and simple. A typical tip is easy to implement, but it may not work for everyone. *"Probably a tip might not work for everybody. When it comes to tips and it comes to quitting smoking I think really basic things are quite good, […] you don't necessarily think 'If I really want a cigarette, If I just takes some deep breaths and just wait that minute, that might help', you don't necessarily actively think that."* Even if a tip does not work for the user or it is a tip that they are already aware of, it still helps reinforcing their behaviour. *"To change your routine, go for a walk, take your mind off it, do something else. Most of the time you have a cigarette because you're bored as well. So, it's kind of reinforcing behaviours that you already know you should be doing, but to actually see it written there as well it also reiterates it."* One of the participants indicated that a tip should not only be focusing on the quitting aspects, but also try to come with ways to get healthy again. *"Yeah and it would also be good if like receiving tips, not just about like smoking, not smoking cigarettes, but also to receive like some sort of tips about actually getting yourself healthy again. Because that is one of the main things that drives you to stop smoking cigarettes, is to get healthy."*

For a tip to be considered useful and good, the study shows that it should be easy to implement. This means that it has to be realistic and achievable for the user, which also involves instruction and examples. *"Actually tips would also be about how realistic I found them. Like how I could actually implement them realistically. Those would be my three things, you know if I can relate with it, is it easy to implement or not, if you are starting off, it should be very… You know like someone who is a heavy smoker he wants to quit either he's got to be really mentally prepared for it or you actually need to like, get him ready, you have to get him psyched and mentally ready to bring really, really small changes into his smoking habits."* This statement

also indicates that if a user can relate to a tip and actively apply it in their life, it is more likely to be considered a good tip. Another aspect that would make a good tip is to make use of content that is original. *"I think a good tip would be something people are unlikely to have thought of. I don't know how possible that would be, but yeah something that people haven't really thought about would be a great tip. "*

In contrast to the good tips, a bad tip is when you do not supply the user with much detail on how to actively apply the tip. It is thereby important to come with possible ways and examples on how to implement it. Some of the participants stated that when a tip was psychological, such as "Think of yourself as a non-smoker and the benefits you would gain", was not a helpful tip, which indicates that a tip should be practical. If a tip is not relevant to the user, it is also considered bad. Relevance are when the participant can apply a tip or it focusses on their quitting stage. *"You know and I mean once you go and do it, you do feel better, but you know, that fairly common tip 'Just go for a walk or something' initially when you quit smoking, that's the last thing you feel like doing, because you don't feel right. Tips like that it's like "no! I am not going to go and do any exercise, this is hard!"*

Stories

The stories were described as being content telling personal experiences, which gives an opportunity to relate to the people who wrote the story. *"So you know, I can't relate to this, but, I'm listening to someone, whose not trying to scare me into something, 'I'm not trying to do this', just telling me her experience, and sharing that with me, and encouraging me to go on my own journey. So, I respond to that positively."* Stories also offer hope to people who are trying to quit smoking. A participant explained that even a small hope, that it will get better, can have a huge impact on the reader. *"I think for me personally if I had read stories about, you know, 'I quit smoking after 20 years and it was horrific and I hated it and I thought I could never live without cigarettes, but eventually it got better and I thought about like every day' a story like that I would have gone 'Yeah, I guess there is some sort of hope.'"* Stories did also differ from the other content types by offering emotion, rather than being factual, according to the participants.

The study indicates that, for a story to be considered useful, it has to grab the reader's attention and offer something different. Many of the participants talked about stories missing the middle part, which should elaborate the struggle of quitting, the reason being that this makes it easier to relate to the person in the story and create a feeling of reality. *"Look there's always the stories about, across the board, there is always stories about people who smoked for 20-30 years and "then I decided I had enough" and that is all well and good and okay that's how the story panned out and you have got to that end point now and after 30 years you have quit. Did you feel really horrible in the middle? Was it really bad? Now you have reached that endpoint. Stories like that I just found no resonance at all."* The participant described the "struggle" as being inspirational, which increases the usefulness and quality of the story.

A story was considered bad if it was not relatable to the participants. Elements that make it relatable includes, but not limited to: demographics, experiences and quitting stage. *"I think to me, the bad stories were, a lot of them were then, things I really couldn't relate to like quitting for my children or quitting because you got really sick…".* This is closely related to stories not being realistic, which is important for a story to be considered useful. *"Just sort of, not like 'I could and it was so easy, I can't believe I didn't do it sooner', because it is not realistic to me. I have tried to quit a lot of times and that is not easy at all."*

Motivators

The motivators were considered as being factual content that could add both new information and things that the participants were already aware of. *"A good motivator is things like knowing that, things I already know that I sort of needs to be reminded of, if I quit smoking I could exercise more easily and I wouldn't get puffed walking on the street or whatever."* The participants were fond of these insight which made them reflect on themselves. A participant stated that motivators help on a subconscious level. The study indicates throughout the surveys and interviews that the biggest motivator within smoking cessation involves money and the earnings from quitting.

Most of the participants stated that for a motivator to be motivating, it has to be positive. This means that the motivators' focus should be on the gains of quitting. *"The good ones I found in that were positive saying like 'after a week..' or whatever you know "these are the health benefits' you know, the positive effects that you can get rather than the necessarily shock tactics."* The participants also indicated that these positive motivators help to give more confidence because they usually focusses on the achievements they have reached. Like the tips and stories, a motivator also has to be relatable in order to be considered useful.

A motivator is perceived as bad when the focus and phrasing is negative, the reason being that these motivators are not considered motivating. Some of the participants indicated that if a motivator was long-term focused, they had difficulty in relating. *"15 years seems like a very long time, you know and to think like, it's like in 15 years I will be 50 or something. It's too far away, it's not like… it's kind of discouraging to think that I have done that much damage and that is going to take that long to get any kind of benefit."* A motivator then has to be short-term focused, so that the participant can see the immediate effects of quitting smoking.

Recommenders

In the app, the participants received content recommenders by either an expert or popularity within a smoking cessation community. When asked if the participants noticed these recommenders only 4 out of 10 said that they did. The rest of the participants either misunderstood this concept or overlooked this.

During the interviews, the concept of having a recommender was discussed, where 5 of the participants preferred having community based recommenders. *"Where I found it, like, easier if something that was a community kind of driven, that I knew was correct information, I found more accessible, because it was from people going through the same struggle."* This indicates that the users find it more useful to receive content recommendations from people in the same situation, which may not be the case with an expert. *"I don't know if being expert requires having experience of reality addiction but it doesn't necessarily imply that they have been though it. Maybe they know the facts and figures, but they haven't lived it. Experts do not know how it is."* 2 of the participants preferred an expert recommender and the last 3 wanted both or either. However, it was discussed that these recommenders could compliment each other. 1 participant stated that he had high expectations when something was labelled as being recommended by an expert.

A few participants mentioned that it was important to know the source of the content, the reason being that it helps the user to trust the content more.

Relatability and tailoring

The study showed that relatability is an important factor in order to determine the usefulness of the content. All the participants mentioned that they liked content that were relatable. If the participants could not relate to a type of content in any way, it was disliked and not found relevant. Even though that all of the participants agreed on the importance of relatability, they did not agree on what it should be based on. 5 out of 10 participants expressed that they could only relate to content that focused on people with the same demographics and quitting stage as themselves. If the age gap was too big or the content was describing a different quitting stage, they found the content irrelevant. *"There is no bad stories. Relevant stories. To someone's personality. You know what I mean. I don't care about 18 years old kids. I don't care about this mother who has two kids and harming her to give up smoking. It's not my life it is your life honey."* 4 out of 10 participants said that the demographics were not the key factor to determine relatability. Instead the relatability was determined based on the content itself, how genuine it was and how well it engaged and involved the participants. *"Whilst a lot of them didn't relate to me directly in anyway, because I don't have children or I don't have this… it felt genuine enough that I could access it. It felt that there was enough in it that I felt I could make an emotional connection, it wasn't preachy, it wasn't this… it was just an experience that someone was sharing."*

9 out of 10 participants mentioned tailored information as something they would like to see more of. The two main aspects that should determine the tailoring was demographics and quitting stage. 6 out of 10 mentioned the quitting stage as having a significant influence on their perception of the content. *"Some of them I found frustrating to read, because, hearing other people having succeeded, when you are still struggling is difficult."* 2 of out 10 thought that the demographics was important while the rest did not mention it or did not find it important in relation to relevance or value of the content in relation to tailoring.

Social interaction

9 out of 10 participants showed interest in having some sort of social functionality in the application. Some wanted the ability to write to the authors of the content, in order to ask questions about the content. Others wanted to be able to contact a smoking cessation expert to get personal advice or ask simple questions. One participant mentioned that this functionality would give him a bigger motivation to use the app as a substitute for having a cigarette. Most of the participant mentioned the importance of being a part of a community while trying to stay quit. This could both be as an online community or someone to arrange social activities with. 5 of the participants stated an interest in sharing their own experiences with other people online.

Tracking and feedback

Another topic that immerged throughout the interviews was tracking and feedback. 6 out of 10 participants mentioned that they wanted a type of tracking within the app in order to measure progress of their quitting attempt. *".. I don't necessarily count the days, but then I can perhaps with a tracker go "Oh it's been nine days and twelve hours! This is great! I feel better now, it felt like it was only two days!" I think that would probably be the only thing that I feel would improve it, just something like a tracker to monitor your own progress."*

By being able to self-monitor their progress, the participants wanted it to be combined with positive feedback, which could be a type of achievement or badges based on the users' activities and actions. *"Things that would be encouraging would be sort of again a tracking kind of stuff like motivation of, congratulations you have gone a day or week or months. Sort of focusing on the positive."* This form of rewarding could help motivate in order to stay smoke free.

DISCUSSION

Our aim was to study different content types within a smoking cessation context to get a better understanding of the potential use of these. We found that the content types where somewhat useful in helping people to quit smoking. The study also shows that quitting is a very personal area, in which each individual has their own needs.

During our analysis, 8 interesting themes emerged. Even though these themes were elicited from empirical data about smokers, we suggest that they may also be relevant for designing persuasive mobile technology in other domains.

The 8 themes are as follows and will be discussed: Relatability and tailoring, reminding messages, gain and loss framed content, genuine/fake, the content types, sources of recommendation, tracking and social.

Relatability and tailoring

One of the big discoveries from the study is the phenomena of relatable content. The study indicates that when the

users received a piece of content that they cannot relate to or make us of, it is considered less useful. This is closely related to that of tailoring where participants mentioned that tailoring could be based on their demographics and quitting stage. However, it is important that this process is made simple in order to achieve the wanted result. A participant stated the following: *"I think users wouldn't really want to be having to input a lot of stuff each time. If there was just a simple slider though of showing where someone thought they were at that might change every day, that might give the app an idea of which tips and motivators to show them."* This support earlier studies in this and other domains, such as Dijkstra [2] and Paay et al. [18] This further supports the theory of credibility by Fogg. According to Fogg it is especially important within a HCI contexts, when systems, such as the Quitty app, has to instruct or advice a user (Fogg, et al., 2002). This can lead to an increased power of persuasion, which can be achieved by contextualized information that fits the user's quitting stage, such that they only received content that are relevant to their situation.

Reminding messages

During the study we discovered that the text messages where considered an important and useful functionality within a smoking cessation context. The participants perceived these as a positive reminder. The study indicates that the messages are a useful tool to get users to perform a specific task, even when they think that it can sometimes be annoying. Both the data logging and the interviews points out that it made the participants use the app more. The usage of these text messages also supports Fogg's theory about triggering the user to do a specific behavior (Fogg, et al., 2002).

Gain and loss framed content

In general the study indicates that the users are more fond of receiving content focussing on the gains of quitting smoking (e.g. the improvement of general health) rather than content focussing on the negative aspects of smoking (e.g. risk of diseases). This does not mean that loss framed messaging are not helpful in order to stay quit or obtain a realisation of quitting. The study shows that even though the participants dislike loss-framed content more, they still paid attention to these in the Quitty application. This can indicate that these type of content have an impact, despite the users opinion. Secondly, even though that the gain-framed messages were liked more, it does not mean that it is the right type of content to show the smokers in order to get them to stop smoking. It may be the case that different type of messaging can be applied at different stages throughout the quitting process to achieve maximum impact. This is supported by Professor Ron Borland from Quit Victoria who states that negative or shock-inducing types of content may be a useful tool in order to get the user to realise that they should quit – such as the images and messages currently displayed on cigarette packets in Australia, while positive content has the best impact on smokers who have already decided to quit. [Borland, personal communication]

Genuine/fake

An interesting finding throughout the study was the topic of fake content. This was particular interesting, due to the origin of the content was from real people who had, or are currently trying to quit. The study implies that for a piece of content to seem real, it has to describe the struggle of a smoking cessation and what can be achieved by quitting. Furthermore, if the message is not seen as achievable by the participant, it may seem unrealistic and fake. It is therefore important to describe the process of quitting and what the user can expect from quitting.

The content types

The study made use of three different content types: tips, motivators and stories, which had different impacts on the users. The study implies that the majority of the participants were most fond of the tips, due to the reason that they were practical and easy to implement in their attempt to quit smoking. However, the numbers show a small difference between the motivating effect of the different content types, which could imply that they support each other well.

The way these content types were perceived, matched the results from previous studies in order to make a behavior change within health care. We cannot say that these help users to successfully quit, based on a three-week study, but the study shows a potential of using these, which may lead to a change in behavior.

Sources of recommendation

In the design of the study we labelled the content as being recommended by either an expert or a community to see if this had an impact on how it was perceived. The study indicates that these recommenders do not affect their opinion. The post-interviews revealed that most participant either did not notice the different recommenders or did not understand these, due to e.g. the design of the app. When asked what which recommender they were most fond of, community came out as the most preferred, because it originates from people in the same situation. Experts was perceived as being people who are not in the same situation. Furthermore, the title of being an expert creates a higher expectation, the reason being that they would only recommend high-quality content. This supports concept of social proof as an effective persuasive principle [1]. However, the opinions of the recommenders indicated that content from either recommender has a value to the user depending on different contexts.

Tracking

A closely related topic to the tailored information, was the idea of tracking. The participants suggested that an application that measured their achievements would keep them engaged with the application. The reason for this was, according to the participants, that it would keep them motivated with a visualisation of what they have achieved, which supports the principle of self-monitoring by Fogg [5].

Social

The social aspect of quitting was a topic that was considered important by the participants, the reason being

that it can be helpful and motivating to communicate with people in the same situation. This helps users feel that they are not alone and may offer hope to successfully quit smoking. The participants also stated that they wanted to be able to submit content about their own tips and experiences while trying to quit. Previous study by Ploderer et al. [17] shows that even though the users says they would like to contribute with personal content, research indicates that this may not be the case when given the opportunity. Participants from this study implied that quitting is a personal thing and that when quitting, you often tend to isolate yourself.

LIMITATIONS

An important consideration regarding this study and the findings is the ecological validity. The participants' motivation of quitting, may have been the vouchers, which was promised for participating in the study or the actual fact that they are participating in a study. A participant interestingly mentioned this issue during one of the interviews: *"When you have the app and it is in the market or whatever, people that use it is actually people who want to quit. Here like for instance you have a consentive that it is 40$ and it is like an experiment. It is not like I wanted to quit and I didn't even thought of that before you told me this experiment. So maybe you have to think of that. The people that are going to use this system is different than we are."* This is also known as the Hawthorne effect where when participants knows that they are being studied might in worst case scenario distort the results of the study [23].

CONCLUSION

This paper has explored how to design a mobile technology in order to persuade the user. We have described and discussed the design, implementation and deployment of a technology probe in the form of a mobile application. The study elicited several themes that supports new insight into the context of smoking cessation. The study implies that the participants found the tool reasonably useful with different preferences on the content types. The results indicates that to increase the power of persuasion for these content types, they have to be tailored to the user's situation, which then makes the content more relatable. The SMS-messages that were sent out in order to get the participants to return to the app, turned out to be useful and considered to be a positive reminder. The study outlines different ways to strengthen this persuasive technique, based on the participants' opinions.

FUTURE WORK

This study suggests the importance of tailored content within a smoking cessation context. This was not covered in the Quitty app. This could lead to a future study of the phenomena in order to get an understanding on how to tailor information within a smoking cessation context and what impact it would have on the user.

Another area that could be studied further, is the SMS-messages that were send out to the users. Throughout the study we discovered the positive aspects of push messaging, which resulted in the app being used more. The study implies different ways to increase the power to persuade, which could be interesting to explore further.

A third theme that emerged throughout the study was the social aspect of quitting. Many of the users implied that they wished to interact with other people in the same situation or have the possibility to ask an expert for advice, which could be studied further. Furthermore, the idea of contributing with personal content could be interesting to study, to see if the users would actively do this and how to make them do so.

ACKNOWLEDGEMENTS

The authors of the paper would like to thank the 11 participants for their time and interest during the study. We would also like to thank the participant who helped us with the pilot test and the members from the staff at the University of Melbourne who participated in the expert evaluation.

Furthermore, we would like to thank Dr Bernd Ploderer, Dr Wally Smith, Dr Greg Wadley and Dr Jon Pearce from the University of Melbourne, Professor Ron Borland and Luke Akin from Quit Victoria and Dr Jeni Paay from Aalborg University for their helpful support and feedback during the study.

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