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Successful quitters have learning goals
exploring the relationship between the effectiveness of smoking cessation apps and goal types of the user

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Summary
Smoking is the largest preventable cause of death worldwide. The context of cigarettes smoking greatly changed over time. During the beginning of the twentieth century, smoking was mainly adopted by elite groups. The smoking epidemic reached its peak in the 1950’s when the adverse health effects of smoking started to become clear. This led to governments interventions in the form of awareness campaigns, tax raises and restrictions. Over the last sixty years these interventions were accompanied with a significant decline in smoking rates. However, the decline in smoking rates has not been equal for all socioeconomic groups. Smoking rates in lower socioeconomic groups have not declined as much as in the higher socioeconomic groups. This is one of the reasons for an inequality in health in developed countries.

Persuasive technology could play an important role in making health promoting resources available for all groups of society. Technologies like smoking cessation app have a high potential to delay or even prevent the onset of many chronic diseases. However, the effectiveness of technologies like smoking cessation apps is currently quite low. A crucial challenge is that human behavior takes a long time to change. Maintenance of behavior change can take years and requires different support from technology than behavior change itself. However, more than 80 percent of users quit using smoking cessation apps after four weeks.

Existing theories about adoption, like the technology acceptance model, fail to explain many users quit shortly after adopting persuasive technologies that help them achieve a healthier lifestyle. We argue that long term adoption of a persuasive technology and therefore the achievement of long term success by the user is largely dependent on the motivational characteristics of the user. In the current study we investigate the relationship between achievement goals of the user and (long term) effectiveness of smoking cessation apps.

Earlier research by experts in the field of achievement motivation shows that the motivational pattern that people display depends on the type of achievement goal that people set for themselves. They distinguish three types of goals: learning goals, performance-approach goals and performance-avoidance goals. The adoption of learning goals, which are goals aimed at improving abilities, is linked to high intrinsic motivation and high persistence when facing obstacles or failure. The adoption of performance-approach goals, which are goals aimed at displaying abilities, leads to high performance when the individual has confidence in his abilities. However, after experiencing failure, performance-approach goals can undermine intrinsic motivation in individuals and lead them to give up. Performance-avoidance goals, which are aimed at avoiding confrontation with inabilities, are detrimental to both intrinsic motivation and performance.

Achievement goals also have some important social relevance. One of the factors that contribute to health inequality is lower internal locus of control in individuals with lower socioeconomic status. Locus of control has a positive relationship with the adoption of learning goals and an inverse relationship with the adoption of performance goals. This suggests that learning goals could possibly contribute to closing the health gap between different socioeconomic groups.

Presently, the effects of achievement goals have primarily been studied in the context of education, sports and the workplace. We argue, based on motivation achievement theory (Dweck, 1986), that the
effectiveness of persuasive technology during longer term usage (in which people encounter barriers) will be strongest for participants with learning goals. We investigated the following research question:

What is the relationship between user’s achievement motivation and the effectiveness of persuasive technology (aimed at smoking cessation) for attaining (long term) behaviour change?

To study this question, we conducted an online survey among 32 men and 68 women. All participants were (during participation) attempting to quit smoking or had attempted to quit smoking using a smoking cessation app. Participants reported on their smoking behavior, their achievement goals and their personal circumstances. Short and long term success rates were based on the reported smoking behavior. Scores on learning goals, performance-approach goals and performance-avoidance goals were based on participants answers to the achievement goal questions.

**Results**

The results from the current study suggest that the existing theories of achievement goals can be generalized to other contexts, in this case the context of smoking cessation and persuasive technology. Supporting our hypothesis, results showed that participants who scored higher on the learning goal measure also reported to have a higher success rate, as indicated by a partial correlation \( r = .17 \). Also supporting our hypothesis, results also showed that participants who scored higher on performance-avoidance goals reported to have a lower success rate \( r = -.18 \). Furthermore, results of the current study show that participants who scored higher on performance avoidance goals reported less often to be smoke free for a long period of time, as indicated by a partial correlation \( r = -.18 \).

However, the present study also provided some results that did not support our hypotheses. We found no evidence that the adoption of learning goals is related to the period of time that participants reported to be smoke free. This is likely due to three limitations of the current study, which are important to take into account in future research. Firstly, we argue that our sample of participants is not a good representation of the average individual who tries to quit smoking using a smoking cessation app. The participants in our sample were more than twice as successful as participants in earlier research on the effectiveness of smoking cessation apps. Secondly, the participants in our study scored extremely high on learning goals. Thirdly, an explanation for the weak correlations that we found might be that the current study did not take into account the different stages of behavior change.

With the current research we have made the first step in investigating the relationship between achievement goals and long term success of persuasive technologies. Furthermore, our findings could be relevant for the design of smoking cessation apps and preventive health engineering in general. This could contribute to the development of technologies that help people achieve better health. Furthermore, the findings in the present study could be relevant for solving the problem of health inequality. Policymaking could play an important role in stimulating the research and development of preventive health engineering. For policymakers, we recommend the stimulation of further research and innovation on the topic of achievement goals and preventive health engineering.

Concluding, the current research made the first step towards investigating the relationship between achievement goals and the long term effectiveness of persuasive technology for health promotion. The results suggest that the existing theories of achievement motivation could be generalized to other area’s. In particular we have found evidence that that (long term) effectiveness of persuasive technology is
higher for people with the right achievement goals: adhering to a learning goal is beneficial for long term effectiveness of persuasive technology.
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1. Introduction

1.1. General introduction

Smoking is the largest preventable cause of death worldwide (Samet, 2013). The major health risks related to cigarette smoking are well documented. For example, long term studies have shown that smoking cigarettes significantly increases the chance for getting lung cancer and cardiovascular disease (Freund, Belanger, D'Agostino, & Kannel, 1993). For example, an estimated 30 percent of all cancers in the United States in 1992 were caused by smoking cigarettes (Newcomb & Carbone, 1992). Many smokers realize the health risks associated with smoking and take action by attempting to quit the habit. Research by (Hymowitz, Cummings, Hyland, Lynn, Pechacek, & Hartwell, 1997) showed that 67 percent of smokers reported that they attempted to quit over a five year period. Most of them (91 percent) mentioned health concerns as one of the reasons to quit. However, most quit attempts are not successful. This is illustrated by the fact that majority of people who try to quit smoking relapse within only two days (Hughes, 2003).

In order to help people to stop smoking a wide range of methods are available. Individuals who try to quit using professional help, have a higher chance to quit smoking than those who try to quit by themselves (Viswesvaran & Schmidt, 1992). A meta-analysis by Viswesvaran and Schmidt (1992) shows that certain methods (instructional and conditioning based methods) tend to be more successful, with a net quit rates (quit rate minus the average quit rate of self-quitters) of 23 and 22 percent respectively. Other methods (for example drug based and medically sponsored methods) are less successful with net quit rates of 11 and 5 percent.

A recently developed method to help individuals quit smoking is smoking cessation applications that can be installed on smart phones. These apps help people through objectives such as tracking, informing and distraction of smoking individuals (Valdevieso-Lopéz, et al., 2013). This potentially enables users to make use of formal intervention methods anywhere at any time. The potential benefit of these apps is that many different smoking cessation methods can be combined into one program, while at the same time reaching a large number of people.

Smoking cessation applications are a form of persuasive technology (PT). These are technologies that can change individual’s attitudes and behaviors, without the use of coercion or deception (Fogg, 2003). Persuasive technology that helps people to quit smoking is part of preventive health engineering, which is one of the most promising areas of persuasive technology. These technologies that support a healthy lifestyle could contribute to delaying or preventing a wide range of medical problems, improving quality of life (IJsselsteijn, Kort, Midden, Eggen, & Hoven, 2006).

Although preventive health engineering is a very promising area for PT, the effectiveness of these technologies is currently quite low. Research by Abroms, Westmaas, Bontemps-Jones, Ramani, & Mellerson (2013) showed that most smoking cessation apps are not based on scientifically proven methods. For example, only 4.1 percent of 252 apps tested recommended the use of approved medication (Abroms et al. 2013). However, even applications that are based on scientific research perform poorly. A longitudinal study by Ubhi, Michie, Kotz, Wong, & West (2015) investigated the effectiveness of a smoking cessation app that was based on theories of behavior change and smoking cessation. The study revealed that four weeks after adoption only 18 percent of users were successful.
A crucial challenge for preventive health engineering mentioned by IJsselsteijn et al. (2006) is that human behavior generally takes a long time to change. An effective PT for smoking cessation will help the user from the moment of adopting the technology until the moment that complete behavior change is achieved. This can take five years to accomplish (Prochaska & Velicer, 1997). However, for smoking cessation apps, no studies were found that evaluate their long-term effectiveness. Earlier research that investigates the long term effects of PT in general does exist (e.g., Fritz, Huang, Murphy, & Zimmerman, 2014), although the amount of research is limited. In the current study, we investigate whether the motivation of the PT user is linked with achieving long-term success. In particular, we will study the effects of different types of goals that have been constructed by experts on achievement motivation.

In the next sections of the introduction we will frame our study within existing research. Firstly, we provide some background information around the problem of cigarette smoking. We will provide a basic historical, social and political context of cigarette smoking. Secondly, we present some background on persuasive technology and why such technology can contribute to solving the issue of cigarette smoking. Thirdly, we address the challenges surrounding smoking cessation using a persuasive technology. Fourthly, we propose how principles from achievement motivation could make these technologies more effective in the long term. Finally, we conclude our introduction by introducing our research aim and hypotheses.

1.2. Cigarette smoking

Cigarette smoking has a long history in which its context highly changed over time. In many countries around the globe, the use of tobacco has gone through different trends. In earlier studies, cigarette smoking is described as an epidemic (Lopez, Collishaw & Piha, 1994; Pampel, 2002). In the Netherlands, this epidemic reached its peak during the 1950’s, when about 90 percent of adult men smoked (Gadourek, 1963). Since then, the number of smokers has decreased immensely. However, cigarette smoking remains the biggest preventable cause of death in the western world (van der Velde, 2016).

During the beginning of the epidemic, in the beginning of the twentieth century, smoking was an activity mainly adopted by the socioeconomic elite. Smoking was most prevalent among highly educated people, for example among medical doctors (Lopez et al., 1994). A typical advertisement for smoking during the 1930’s contained slogans like “Chief Whip, the best cigarette four your health!” (Monden, 2002).

From the 1950’s the first reports about adverse health effects of smoking were published. In the long term, this led to anti-smoking campaigns that are highly contrasted against the smoking advertisements during the first half of the twentieth century. Nowadays a pack of cigarettes contains a discouraging text such as “smoking kills” or even visualizations of the adverse health effects of smoking. From 1963, the government launched education campaigns on schools about the dangers of smoking. Nevertheless the transition to the “anti-smoking” society of today was a slow one. It was not until 1990, when the first smoke-free law was introduced in the Netherlands. This law restricted smoking in healthcare facilities, schools, social service facilities, government agencies and indoor sports facilities. However, compliance with this law was low and violations were hardly addressed (Peelen, et al., 2016). Later, in 2004, the smoke-free legislation in workplaces was introduced along with a tax increase on tobacco products. In 2008 the smoke free law was extended for the hospitality industry along with a mass media campaign and another tax increase (Peelen, et al., 2016). These laws are associated with a significant decline in smoking rates (Nagelhout, Willemsen, Putte, Crone, & Vries, 2009).
Although smoking rates have declined rapidly, not all layers of society are affected equally. Among lower socioeconomic groups there is a slower decline in the percentage of smokers (Stronks, Mheen, Looman, & Mackenbach, 1997). While during the peak of the smoking epidemic all layers of society were affected equally, we now see a higher prevalence of cigarette smoking in lower socioeconomic groups. This is a major cause of health inequality in developed countries, where illness and mortality in general have an inverse relationship with socioeconomic status (Bruggink, 2013; Pampel, 2002).

Earlier literature mentions multiple reasons for this health inequality between different socioeconomic groups. Pampel (2002) and Stronks, Mheen, Looman, and Mackenbach (1997) mention that the inability of lower socioeconomic groups to access material resources are related to the inequality in health. Examples of such material resources are quality food, housing, consumer products, educational resources and healthcare. According to Monden (2002), the differences in health can also be attributed to differences in knowledge about healthy lifestyle. For example, a British study showed that women with low education were less convinced about the adverse health effects of smoking during pregnancy for their child than highly educated women (Monden, 2002). Furthermore, Stronks, Mheen, Looman, & Mackenbach (1997) argue that people with higher education are more capable of changing their behavior using their knowledge about health. A factor that plays a big role in this is locus of control, which a measure for whether an individual believes that they have control over their health and events in their life in general.

The social aspect of preventive health engineering is largely out of scope in the current study. However, we do argue that persuasive technology can play a role in making health promoting resources easily accessible for all layers of society. The lower socioeconomic classes are probably the ones who stand to benefit the most from low-cost, easy to access solutions that help them achieve healthier lifestyles. An example of such a persuasive technology is the smoking-cessation app for the smartphone, which is a cheap (often free of cost) application with the intention to persuade individuals to quit smoking. In the next section, we describe the basics of how persuasive technology works.
1.3. Persuasive technology

In his influential book on persuasive technology, Fogg (2003) explains the working mechanisms of computers as persuasive technology by proposing the *functional triad*. Basically this means that computers can be take three basic roles: as tools, as media, or as a social actor. Figure 1 shows examples of applications for each basic role.

![Figure 1: An overview of the functional triad taken from Fogg's book (Fogg, 2003)](image)

In smoking cessation apps, the three basic roles of computers as persuasive technology are combined into one technology. As a tool for example, a smoking cessation app can help individuals to track statistics how many cigarettes they have smoked. The application then takes its role as a medium by immediately presenting the financial and health related consequences on the screen. This motivates individuals by allowing them to easily explore the cause-and-effect relationships related to cigarette smoking. As a social actor, the application then provides support by helping individuals to set a target and rewarding them with positive feedback or game-like rewards when individuals reduce the amount of cigarettes smoked.

1.4. Challenges

An important challenge for smoking cessation apps is long-term support. It can take more than five years to reach a point of complete behaviour change (Prochaska & Velicer, 1997). Long term users (more than three months of use) of PT who try to maintain healthy behavior have different needs from new adopters who aim at behavior change (Fritz et al., 2014). The reason for this is that behavior change, such as smoking cessation, is not just a single “observable event”. There is much more going on at a level that is not directly observable. In their study on behavior change, Prochaska and DiClemente (1983) show that behavior change is a gradual process which can take years to complete. This is especially true for overcoming addictive behaviour such as smoking cigarettes. They distinguish six stages that individuals go through before fully overcoming addiction. These stages are pre-contemplation, contemplation, action, maintenance and termination. Within these stages, small changes in attitude or behaviour can be achieved within short term. However,
The long term nature of behavior change has major implications for the design of persuasive technologies. The fact that behavior change takes a long time to change means that persuasive technologies should not aim to be successful after one single act. According to Oinas-Kukkonen and Harjumaa (2008), persuasion should be seen as a longer term process instead.

To our knowledge, there is little research available that studies the long term effects of persuasive technology on influencing people’s lifestyle. One study that does consider long term effects is the study by Fritz et al. (2014) on persuasive technology for fitness purposes. Fritz et al. studied the long term effects of wearable devices for tracking fitness- and health-related activities. In this study they follow and interview a group of people who used devices like the Nike Fuelband and the FitBit. These devices are similar to smoking cessation apps in the sense that they motivate individuals to set a personal goal and monitor their progress.

With their study, Fritz et al. (2014) provided insight in the benefits and habits surrounding long term use of persuasive technologies that motivate healthy behaviour. Based on interviews with long term users of PT Fritz et al. (2014) conclude that long term users (who had been using the technology for at least three months) have different needs than those who are in the early stages of using the device. This difference in needs is related to the difference between behavior change in the early stages of use and behavior maintenance for long term users. For example, individuals who recently quit smoking might need different support than individuals who are planning to quit. By meeting these long-term needs, persuasive technologies will be more effective at helping people to maintain their behavior change.

A study on smoking cessation apps by (Ubhi, Michie, Kotz, Wong, & West, 2015) showed that 81 percent of users stopped using the app in question after four weeks. The high number of dropouts is an important issue that should be addressed, given the fact that behaviour change is a process that takes longer than four weeks. However, to our knowledge the existing long term research on PT does not provide information on why individuals continue to use these technologies and what makes these individuals successful in the long term. The group of individuals that Fritz et al. (2014) studied succeeded to maintain their behavior change using the technology. However, continued use of a persuasive technology to maintain behavior is not evident for all users. While some persuasive technologies have proven to be effective to achieve lifestyle goals, some people tend to give up using the technology in an early stage (Fritz et al., 2014). While their study provides some insight in the long term needs of PT users, this study only focused on those people who have successfully incorporated it into their daily practices. Thereby the study does not teach us much about why other individuals did not adopt the technology in the long run.

When it comes to short term adoption of information technologies (such as smoking cessation apps), there are many different theories and models. Experts from the fields of information systems, psychology and sociology have worked on the subject, creating a vast amount of literature. Based on the number of citations, the most widely used model is the “technology acceptance model”. According to this model, whether an individual has the intention to adopt an information technology depends on two factors: perceived usefulness and perceived ease of use of the technology (Davis, 1986). Later on this model has been expanded to include social influence processes (Venkatesh & Davis, 2000) and integrated with other models (Venkatesh, Morris, Davis, & Davis, 2003).

We argue that the technology acceptance model is not useful for determining why people stay motivated to use persuasive technologies in the long run. First of all, it only explains about 40 percent of variance in
adoption (Legris, Ingham, & Collerette, 2003). Apparently the model misses out on important factors that determine whether a technology is adopted or not. Secondly, the technology acceptance model is used to explain whether or not individuals have the intention to use a technology. This is useful to determine why people would initially adopt a technology or not. However, we argue that studying initial adoption is not sufficient in order to explain why people would continue using a technology in the long run. We argue that long term adoption of a persuasive technology and therefore the achievement of long term success by the user is largely dependent on the motivation of the user. To investigate this statement we looked at theories of achievement motivation. In the next section we explain the basics of achievement motivation and it is relevant for long term success in the use of persuasive technology.

1.5. Achievement goals
Long term success of persuasive technologies might depend on many different factors. In general, achieving long term success is largely dependent on motivation (Dweck, 1986). Since no adequate research is available on what keeps people motivated to use a persuasive technology, we take a look at what keeps people motivated in general.

Adaptive motivational patterns
In order to achieve long term success, adaptive motivational patterns play an important role (Dweck, 1986). Adaptive motivational patterns are defined by Dweck (1986) as behaviours that facilitate “establishment, maintenance and attainment of personally valued achievement goals”. Simply put this means that successful individuals set a goal that is in their personal interest, that they stay persistent in striving for the goal until it is eventually met. Such a pattern is characterized by high persistence in the face of obstacles and by challenge seeking behaviour. To the contrary, maladaptive (“helpless”) patterns are characterized by low persistence when facing obstacles and by challenge avoidance.

Earlier research by experts in the field of achievement motivation shows that the motivational pattern that people display depends on the type of achievement goal that people set for themselves. However not all studies agree on how these goal types should be classified and what the effects of the different goal types are. We discuss two different frameworks of achievement goal classification.

The first framework by Dweck (1986) distinguishes between two types of achievement goals: learning goals and performance goals. Learning goals are those goals that are aimed at improving one’s abilities in order to prepare an individual to perform better. An example of a learning goal is to find an effective strategy that could help to quit smoking. Achieving this goal would prepare individuals to quit smoking by improving the abilities needed to quit. The second type of goals, performance goals are aimed at displaying current abilities. An example of a performance goal would be to quit smoking by the first of January. Achieving this goal relies on current abilities of individuals to quit smoking.

Heyman and Dweck (1992) state that the adoption of learning goals leads to better motivational patterns than the adoption of performance goals when facing obstacles or when new challenges arise. This statement is supported by empirical studies done by Diener and Dweck (1978), (1980). In these studies, children had to perform a concept formation task. The children completed a number of tasks successfully before attempting to do a task that was too difficult. After each task, the children were asked to explain what they were thinking when working on the task. During the easy task, all children displayed the same level of performance and the same kind of strategies. However, after failing on the more difficult task the
children displayed distinct levels of adaptation. One group of children responded in a helpless way, viewing the unsuccessful task as personal failure. On the other hand, the rest of the children showed a mastery response, indicating that they viewed the task as a setback that offered opportunity for learning. These different responses are attributed to the goal type that the children adopted. Those children in the learning goal group showed better motivational responses (adaptive motivational patterns) than those in the performance goal group.

Furthermore, the Elliot and Dweck (1988) found evidence that learning goals can be manipulated by repeating the above study with a slight modification. This time, the type of goal was manipulated by giving children different task descriptions. For one group of children the task description highlighted that the performance would be graded, stimulating performance goals. The other group received a task description that highlighted the development of skills, promoting learning goals. The results were as predicted: Those children who adopted learning goals through the manipulation showed better motivational responses (adaptive motivational patterns) than those who were manipulated to adopt performance goals.

The second framework by Elliot and Harackiewicz (1996) distinguishes three types of goals: learning goals, performance-approach goals and performance-avoidance goals. They claim that individuals either orient themselves around increasing or showing their competence or around avoiding display of incompetence. These two orientations, which are aimed at attaining success and avoiding failure, are described as approach and avoidance orientations of achievement motivation. Learning goals are by definition approach type of goals, since these are always aimed at increasing competence. However, performance goals can be aimed in two orientations. In the first orientation, the performance approach goal strives to display competence. For example by showing that someone can quit smoking within a week. In the second orientation, the performance avoidance goal strives to avoid incompetence. For example “not failing to quit smoking within a week”.

According to Elliot and Harackiewicz (1996), the adoption of approach oriented goals leads to better motivational patterns than the adoption of avoidance oriented goals. They state that approach oriented goals trigger behavior that is centered on positive outcomes. This improves task engagement and leads to a mastery response (adaptive motivational patterns). Furthermore they state that avoidance goals on the other hand lead to behavior that entails lower task engagement and a helpless response (maladaptive patterns). These statements find support in an experiment where students were to solve “nina puzzles” (Elliot & Harackiewicz, 1996). These are puzzles in which the solver has to find hidden words. The students were divided over three groups and each group received different task descriptions in order to stimulate the formation of different goal types. Those students in the learning goal and performance-approach goal groups had significantly higher indicators of intrinsic motivation than those students in the performance-avoidance goal group.

The approach-avoidance framework of achievement goals finds additional support in two meta-analyses by Elliot (1994), (1995). In this analysis it is concluded that 90% of the experiments contained data that supported the approach-avoidance method. Therefore Elliot and Harackiewics (1996) state that the approach-avoidance dichotomy is a better predictor of intrinsic motivation than the learning-performance method.
Which type of goal is better?

Although earlier research is clear about the negative effects of performance-avoidance goals, some studies seem to contradict each other when it comes to which goal type is best. For example, studies by Dweck (1986) show a clear benefit of learning goals over performance goals, while Elliot and Harackiewicz (1996) and Elliot and Church (1997) show that performance goals can be beneficial as well. This raises the question of which goal type leads to better performance. According to Cury, Elliot, Sarrazin, Da Fonseca, & Rufo (2002), it depends on the situation which goal leads to better results.

Cury et al. (2002) claim that in some situations learning goals can have benefits over and performance approach goals. After facing failure, performance approach goals are more likely than mastery goals to decrease intrinsic motivation. A possible explanation for this this would be that performance approach goals are more likely to change into a performance avoidance goal when the initial goal is not met. Changing from a learning goal to a performance approach goal is less likely, since failure does not necessarily undermine learning goals. An example applied to smoking cessation would be an individual who experiences a relapse after successfully quitting at a set date (performance approach goal). In a next attempt this person might shift his focus on avoiding another relapse, instead of focusing on maintaining not smoking. If this person would have set a learning goal (for example finding strategies to stay smoke free), the shift to a performance avoidance goal might be less likely. This is because a relapse does not undermine his initial goal of finding a strategy to stay smoke free.

On the other hand, performance-approach goals can lead to high performance and adaptive motivational patterns when individuals experience success. A study on psychology students showed that those students who set performance-approach goals actually scored higher marks than those who set learning goals (Elliot & Church, 1997). This suggests that learning goals are not always as effective as performance-approach goals when it comes to high performance, even though learning

Social relevance of achievement goals for preventive health engineering

One of the factors that play a role in the socio-economic differences in smoking and health in general is internal locus of control. Internal locus of control is related to the adoption of learning goals and refers to the believe of individuals that they have control over the events in their lives. Individuals with higher internal locus of control have the believe that they can influence their own health by doing health promoting activities or by avoiding activities that might damage their health. Earlier research shows that internal locus of control has a negative correlation with cigarette smoking and that internal locus of control is more common in higher socio-economic groups. Current smokers have more externally oriented locus of control, meaning that they have the believe that they do not have control over their own health.

Research by Akin (2010) examined the relationship between achievement goals and locus of control, an important variable in the socio-economic differences in smoking rates. In his study, Akin (2010), found that locus of control has a direct relationship with achievement goals for a group of university students. He found that students with high external locus of control were more likely to adopt performance-approach and performance-avoidance goals. Which means that students who have the believe that events in their life are caused by uncontrollable factors. On the other hand, he found that students with high internal locus of control were more likely to adopt learning goals. Meaning that students who believe that they have control over the events in their life.
These findings suggest that learning goals could possibly contribute to closing the gap in smoking rates between different socioeconomic groups.

**Summary of achievement goal theory**

According to the previous studies that we reviewed, these goals have different effects on motivation. We have distinguished three types of goals. Firstly, learning goals are linked to high intrinsic motivation and adaptive motivational patterns, which is characterized by high persistence when facing obstacles or failure. Secondly, the performance-avoidance goal has a detrimental effect on motivational patterns and performance. Lastly, the performance-approach goal can result in either negative or positive effects on motivational behavior. After an individual experiences success, performance-approach goals have a positive effect on motivational behavior and on performance. However, after experiencing failure performance-approach goals can undermine intrinsic motivation in individuals and lead them to give up. The effects of different kinds of goals on intrinsic motivation and on persistence in the face of obstacles is demonstrated in many previous studies.

Most research on achievement goals was primarily in the field of education (Elliot A., 1994) (Elliot & Church, 1997) (Diener & Dweck, 1978) (Dweck, 1986). The generalizability of the effects of achievement goals has also been shown in the context of the workplace (Orehek & Yperen, 2013) (Lange, Yperen, Heijden, & Bal, 2010) and sports (Roberts, Treasure, & Kavussanu, 1996) (Duda, Fox, Biddle, & Armstrong, 1992). For example (Orehek & Yperen, 2013) showed that also in the workplace, approach oriented goals lead to better performance. However, whether the adoption of different achievement goals is related to the (long term) success of persuasive technology for health prevention has not yet been demonstrated. This will be the focus of the current study. In the next section we will elaborate on this and present the research question for this study.

**1.6. Research aim**

By reviewing the leading literature on the subjects of persuasive technology, achievement motivation and human behavior change, we have set the first steps to investigate a possible link between achievement motivation and smoking cessation success. The literature on persuasive technology and human behavior change shows that changing human behavior is a long term process. During this process individuals run into challenges or may face failure which might cause them to become demoralised and give up. Theories on achievement motivation show that these challenges can be overcome if individuals show adaptive motivational patterns. These motivational patterns are linked to setting learning goals and goals that are approach oriented. This suggests that there might be a link between the type of goal that individuals set and the long term success they experience when using a persuasive technology, especially if there is a high chance of facing challenging situations while using such a technology.

In the current study, we make the next step to investigating the connection between goal types and the success that people experience using a smoking cessation app. We investigate whether there is a correlation between the type of achievement goals that people tend to set and their long term success in using a persuasive technology that helps people to stop smoking. This directs us to the following research question:

*What is the relationship between user’s achievement motivation and the effectiveness of persuasive technology (aimed at smoking cessation) for attaining (long term) behaviour change?*
To investigate the relationship between people’s achievement motivation and smoking cessation success we conducted an online survey. In this survey (see Appendix A to D for the survey) participants reported their smoking cessation success, the kind of achievement motivation they have and the demographic context in which they are situated. Analyzing the relationships between participants’ smoking cessation success and their achievement motivation allows us to answer the research question. In this correlational study, we expect to find that:

**Hypothesis 1a**
We expect that individuals who score higher on learning goals and performance-approach goals will also have a higher success rate in smoking cessation (as reported by themselves).

**Hypothesis 1b:**
We expect that individuals who score higher on performance-avoidance goals will have a lower success rate in smoking cessation (as reported by themselves).

We expect to find this based on earlier research where approach oriented goals led to higher task performance than avoidance oriented goals. Studies by Elliot and Harackiewics (1996) and Elliot & Church (1997) have shown that the adoption of performance-avoidance goals is detrimental to intrinsic motivation and task performance when compared to the adoption of performance-approach goals and learning goals. Therefore we expect that people who score higher on performance avoidance goals to have a smaller chance to quit smoking than those people who score higher on performance approach goals and learning goals.

Furthermore, we expect:

**Hypothesis 2a:**
We expect that individuals who score higher on learning goals to be smoke free for a longer period of time (as reported by themselves).

**Hypothesis 2b:**
We expect that individuals who score higher on performance-approach and performance-avoidance goals to be smoke free for a shorter period of time (as reported by themselves).

We expect to find this because we argue that learning goals have a positive effect on overcoming challenges. Smoking cessation is shown to be highly challenging: depending on which method is used only 5 to 30 percent of smoking cessation attempts are successful after 6 months (Freund, Belanger, D'Agostino, & Kannel, 1993). Studies by Dweck (1986) and Elliet & Dweck (1988) have shown that learning goals have a positive impact on maintaining motivation in challenging situations. People who adopt learning goals have higher intrinsic motivation than those people who adopt performance goals. Furthermore, these previous studies have shown that the adoption of learning goals is linked with high persistence when facing challenges. When facing failure, people who adopt learning goals are more likely to search for new strategies that will reach them to their goals. The adoption of performance goals on the other hand increases the chance that people give up after experiencing failure. The adoption of performance-avoidance goals even leads to lower intrinsic motivation and task enjoyment (Dweck, 1986). Because of the high amount of potential challenges and the low success rates related to smoking
cessation, we expect that those people who score high on learning goals to stay more persistent in the long term than those people who score higher on performance goals.
2. Method

2.1. Participants
An a priori power analysis using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) indicated that we needed to have 82 subjects to have 80% power for detecting a medium sized correlation with a two-tailed significance level of .05.

32 men and 68 women participated in this study, and all of these were English speakers (native or as a second language). All participants were (during participation) attempting to quit smoking or had attempted to quit smoking. Moreover, the participants used a smoking cessation app to help them quit smoking. We made sure of this by asking potential participants if they had ever used a smoking cessation app before recruiting them.

On average, the participants were very successful in their attempt to quit smoking. The majority of participants (75%) indicated that they had successfully quit smoking using a smoking cessation app. How long participants had not smoked varied from less than a week to three months or more. A high percentage of the participants was highly educated, with 69 out of 100 participants indicating that they had studied at university or college.

2.2. Procedure
Participant were recruited through two different channels. Firstly, participants were recruited on the social media page (Facebook) of Smoke Free. This social media page hosts a community of app users where they can find support to quit smoking using the Smoke Free application. On this page, a link to the survey was posted regularly for a total duration of two months, together with a short description of what the survey is about. Secondly, a group of participants were recruited in person. The recruitment was done at shopping malls and train stations, or by personally contacting acquaintances. Potential participants were asked whether they had ever used a smoking cessation app. If they ever used such an app, they were presented the link to the survey and asked to participate.

Participants who followed the link to the survey were presented with a short introduction on the first page (see Appendix A). In the introduction it was stated once more what the target audience was, how long the questionnaire would take and that the answers are kept anonymous. Before starting the survey, the participants were required to log in with their e-mail address in order to make sure that they only filled out the survey once.

Subsequently, participants were asked which smoking cessation app they used. Just in case that a participant had not used an app to quit smoking, we included the option to indicate this before taking the survey. On the next three pages of the survey, the participants completed questionnaires about their smoking behavior (see Appendix B), their achievement goals (see Appendix C) and on their demographic context (see Appendix D). After finishing the questionnaire, participants were thanked for their cooperation and debriefed. In total, participants should be able to complete the survey in six minutes. No monetary reward was offered for completing the survey.
2.3. Materials

2.3.1. Measures
To assess participants’ achievement goals, demographics and smoking behavior we developed an online survey using Google Forms. The survey is divided in three questionnaires. Each questionnaire contained a list of questions that fall in within the same category. The first questionnaire (see Appendix B) contains questions on smoking behavior, which are used to measure participants’ success and persistence. The second questionnaire (see Appendix C) contains questions on achievement goals. The answers to these questions used to construct measures for each type of achievement goal. The last questionnaire (see appendix D) contains relevant demographic questions. The answers to the demographic questions are used as control variables and to validate findings from earlier research. In this section, we explain the items of each questionnaire in more detail.

Smoking behavior questionnaire
To assess participants’ smoking behavior while using the Smoke Free app we included a questionnaire on smoking behavior in the survey. This questionnaire contains a list of seven items that are inspired by previous studies (Freund, Belanger, D’Agostino, & Kannel, 1993), (Hughes, 2003), (Hymowitz, Cummings, Hyland, Lynn, Pechacek, & Hartwell, 1997) on smoking cessation. Because there is no clear consensus in earlier studies on how smoking cessation is measured we chose to use a combination of questions to construct a reliable measure for smoking cessation success.

This part of the survey contains seven smoking behavior items that are intended to measure success and persistence of the participants. A factor analysis and analysis of Cronbach’s alpha rendered two measures for smoking cessation performance.

The first measure of performance is the sum of people’s answers to four survey questions that indicate the success rate that participants experienced. The measure was shown to have high internal consistency (alpha = 0.84) and is based on the following four questions.

1. How many relapses did the participant experience while using the app?
2. Did the participant smoke since the intended quit day?
3. Does the participant smoke less than before adoption of the app?
4. Did the participant successfully quit smoking using the app?
These questions are coded as presented in table 1.

<table>
<thead>
<tr>
<th>Score</th>
<th>Number of relapses while using app</th>
<th>Smoked after intended quit day</th>
<th>Smokes less than before using app</th>
<th>Successfully quit smoking using app</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Three or more</td>
<td>Regularly</td>
<td>As much or more</td>
<td>No</td>
</tr>
<tr>
<td>1</td>
<td>Two relapses</td>
<td>Occasionally</td>
<td>Slightly less</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>One relapse</td>
<td>Once or twice</td>
<td>Significantly less</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>No relapses</td>
<td>Never</td>
<td>Quit altogether</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 1: coding for the items for success rate

As indicated earlier, the group of participants was highly successful, with 75% of participants indicating that they had successfully quit smoking using the app.

The second measure of performance indicates for how long participants have been smoke free. Participants indicated whether they had been smoke free for less than one week, for a week to a month, for one month to three months or for over three months. How long participants have been smoke free will be used to measure long term performance in order to test our second hypothesis. The measure is coded as presented in table 2:

<table>
<thead>
<tr>
<th>Score</th>
<th>Time since last cigarette</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Less than one week</td>
</tr>
<tr>
<td>2</td>
<td>One week to one month</td>
</tr>
<tr>
<td>3</td>
<td>One month to three months</td>
</tr>
<tr>
<td>4</td>
<td>More than three months</td>
</tr>
</tbody>
</table>

Table 2: coding for the amount of time that participants have been smoke free at the time of the survey

Achievement goal questionnaire

To measure participants’ adoption of learning, performance-approach and performance-avoidance goals when trying to quit smoking, we used an adaptation of the achievement goal questionnaire developed by Elliot and Church (1997). The original achievement goal questionnaire was used to assess the types of achievement goals that university students adopted for psychology class and contained six question per goal type. The learning goal items measured the motivation to learn as much as possible in the class, while the performance goal items measured the motivation to perform well in the class compared to other students.

This classroom context is highly different from the smoking cessation context in the current study for two reasons. Firstly, the social aspect of a classroom is absent because we are studying people who are individually trying to quit smoking using an persuasive technology. Nevertheless, we argue that participants can still be motivated to perform well, also compared to other people who try to quit smoking. Secondly, the subject at hand is different. Instead of learning about psychology, participants in the current study have the possibility to learn about smoking cessation. For these reasons, we rephrased the items developed by Elliot and Church (1997) in order to fit the context of smoking cessation, while at the same time maintaining the original meaning regarding achievement goals. As in the original questionnaire, our questionnaire contained six items assessing each goal type (so 18 items total).
Participants were asked to indicate the extent to which they believe each item applies to them on a scale of 1 (applies not at all to me) to 5 (applies very well to me). Appendix C contains a list of the achievement goal items that we used.

A factor analysis confirmed that the items could be divided into three independent groups. Some items from the achievement goal questionnaire did not load high on either of the three factors and were dropped. We dropped one learning goal item, one performance-approach item and four performance-avoidance items. Subsequent calculations of Cronbach’s alpha showed that the adaptation of the achievement goal questionnaire rendered three internally consistent measures. The three measures are described below.

Firstly, a learning goal measure was calculated by averaging the scores on five learning goal questions which was highly reliable (alpha = 0.94). These indicate whether the participants reported that the following statements apply to them on a five point scale:

1. "I want to learn as much as possible about quitting smoking"
2. "It is important to me to understand how to quit smoking as deeply as possible"
3. "I hope to gain more knowledge on how to quit smoking from the app"
4. "I want to completely master the strategies that are suggested in the app"
5. "In the app, I like to be provided with new matter, even if it is difficult to apply"

Secondly, a performance-approach goal measure was calculated by averaging the scores on five performance-approach goal items, which proved to be highly reliable (alpha = 0.91). These items indicate whether the participants reported that the following statements apply to them on a five point scale:

1. "It is important to me to do better than other people who try to stop smoking"
2. "My goal with this app is to quit smoking quicker than others who try to quit"
3. "I am motivated to demonstrate my ability to quit smoking relative to other people"
4. "I am motivated by the thought of outperforming other people who try to quit smoking"
5. "It is important to me to do well compared to other people who try to quit smoking"

Thirdly, a performance-avoidance goal measure was calculated by averaging the scores on two performance-avoidance goal items, which proved to be reliable (alpha = 0.84). These items indicate whether the participants reported that the following statements apply to them on a five point scale:

1. "I often think to myself, what if I fail to quit smoking?"
2. "I worry about the possibility to relapse"

Since the achievement goal items were rephrased versions of the original items constructed by Elliot and Church (1997), the components look slightly different from the original ones. Nevertheless, the factor analysis and tests for internal consistency provided us with three clear components with moderate to high internal consistency.

Demographics
Research by Hymowitz, Cummings, Hyland, Lynn, Pechacek, and Hartwell (1997) showed that several demographic measures are closely related to the success rate of smoking cessation. Participants answered 11 questions on the demographic circumstances that might impact their smoking behavior. These demographic items will be used for control variables as well as for validating our measures by comparing results to earlier studies. Important demographic variables include the participant’s age, whether or not they have other smokers living in their household, the participant’s desire to quit smoking and whether or not they have invested money to buy the smoking cessation app. The full list of items can be found in Appendix D.

2.3.2. Smoking cessation app
All participants used a smoking cessation app in their attempt to quit smoking. The majority (89 out of 100) of participants used the Smoke Free application to help them quit smoking. The main features of the app are the dashboard, the diary and the progress screen.

On the dashboard, the user has a quick overview of their savings, how long they have been smoke free, the amount of cigarettes not smoked, how many hours of their lives they have regained and the amount of cravings they have resisted. Furthermore, on the dashboard users can enter when they have a craving to smoke. The application will then give useful information on how to beat these cravings. In the smoking diary, the user can make entries on their smoking behavior. Users can enter whether they have smoked since their last diary entry, how much money they have spent on nicotine replacement and how strong their desire to smoke was. On the progress screen, users view an overview of their smoking cessation progress thus far. This screen includes game like rewards in the form of badges that users can earn when they make progress.

2.4. Descriptive statistics
Table 3 presents the means, standard deviations, observed ranges, possible ranges and reliabilities for our main measures of interest. On average, participants were highly successful in their quest to quit smoking using the app. Three quarters of participants indicated to be nonsmoking at the time they completed the survey. Furthermore, on average the participants were very learning goal oriented with a mean average learning goal score of 3.92 on a scale from 1 to 5.

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>Observed range</th>
<th>Possible range</th>
<th>Crohnbach's alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of Cessation Success</td>
<td>9.22</td>
<td>3.70</td>
<td>0.00-12.00</td>
<td>0.00-12.00</td>
<td>0.84</td>
</tr>
<tr>
<td>Performance-approach goal</td>
<td>2.39</td>
<td>1.31</td>
<td>1.00-5.00</td>
<td>1.00-5.00</td>
<td>0.91</td>
</tr>
<tr>
<td>Performance-avoidance goal</td>
<td>3.41</td>
<td>1.38</td>
<td>1.00-5.00</td>
<td>1.00-5.00</td>
<td>0.94</td>
</tr>
<tr>
<td>Learning goal</td>
<td>3.92</td>
<td>1.15</td>
<td>1.40-5.00</td>
<td>1.00-5.00</td>
<td>0.84</td>
</tr>
<tr>
<td>Time not smoked</td>
<td>1.29</td>
<td>1.27</td>
<td>0-3*</td>
<td>0-3</td>
<td>-</td>
</tr>
</tbody>
</table>

* 0 = Less than one week; 1 = One week to one month; 2 = One month to three months; 3 = More than three months
3. Results

3.1. Test of hypotheses

Results of the current study provided partial evidence for hypothesis 1a, which stated that individuals who score higher on learning goals and performance-approach goals will also have a higher success rate in smoking cessation (as reported by themselves). In line with hypothesis 1a, participants who scored higher on the learning goal measure also scored higher on success rate, as indicated by a first order spearman rank correlation which was controlled for the effects of performance-avoidance goals, \( r(97) = .17, p = .092 \). Contrary to hypothesis 1a, we found no meaningful correlation between performance-approach goal scores and success rate. Also contrary to hypothesis 1a, we found no significant zero-order correlations (where we did not control for the effects of avoidance goals), between success rate and learning goals or performance-approach goals.

The results of the current study provided partial evidence for hypothesis 1b, which stated that individuals who score higher on performance-avoidance goals will have a lower success rate in smoking cessation (as reported by themselves). In line with hypothesis 1b, participants who scored higher on performance-avoidance goals scored lower on success rate, as indicated by a first order spearman rank correlation (which was controlled for the effects of learning goals), \( r(97) = -.18, p = .074 \). Contrary to hypothesis 1b, we found no significant zero-order correlations (where we did not control for the effects of performance-approach goals, learning goals or both), between success rate and performance-avoidance goals.

Results of the current study did not provide evidence in support of hypothesis 2a, which stated that individuals who score higher on learning goals to be smoke free for a longer period of time (as reported by themselves). Contrary to hypothesis 2a, we found no meaningful correlation between learning goals scores and the amount of time that participants reported to be smoke free.

The results of the current study provided partial evidence in support of hypothesis 2b, which stated that individuals who score higher on performance-approach and performance-avoidance goals to be smoke free for a shorter period of time (as reported by themselves). In line with hypothesis 2b, participants who scored higher on performance avoidance goals reported less often to be smoke free for a long period of time, as indicated by a partial spearmen rank correlation (which was controlled for the effects of learning goals and performance-approach goals), \( r(96) = -.18, p = .078 \). Contrary to hypothesis 2b, we found no meaningful correlation between performance-approach goals and the amount of time that participants reported to be smoke free.

3.2. Exploratory results

3.2.1. Recruitment strategy and success rate

We found that the participant recruitment strategy had a highly significant relationship with success rate, \( t(98) = -5.21, p < .00001 \), with participants who were recruited through social media pages having higher scores than participants who were recruited in person.

On average, the participants in this study were highly successful with 54 out of 100 participants scoring the maximum of 12 points on our measure for success rate. On average, the participants had a success rate of 9.22 on a scale from 0 to 12. Most of these participants were recruited through the social media page of the Smoke Free app. A small group of participants were recruited by approaching them in person. Table 4
shows the means and standard deviation for smoking cessation success rate for two participant recruitment sources. People who were recruited through social media had a much higher success rate.

<table>
<thead>
<tr>
<th>Cessation Success Rate</th>
<th>Recruitment on social media</th>
<th>Recruitment in person</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>9.85</td>
<td>4.58</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>3.25</td>
<td>3.60</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>89</td>
<td>11</td>
</tr>
</tbody>
</table>

*Table 4: Means and standard deviation for smoking cessation success rate for two participant recruitment sources*

### 3.2.2. Demographic effects

Highly significant zero order correlations were found between our measure for cessation success rate and four items from the demographic questionnaire. Firstly, people who indicated a high desire to quit smoking scored high on success rate, $r(\#) = .54, p < .01$. Secondly, people with a higher income also scored high on success rate, $r(\#) = .35, p < .01$. Thirdly, older participants scored high on success rate as well, $r(\#) = .27, p < .01$. Fourthly, people who smoked more cigarettes prior to their quit attempt had a higher success rate, $r(\#) = .38, p < .01$.

Except for the number of cigarettes smoked per day, these findings are in agreement with earlier research on smoking cessation (Hymowitz, Cummings, Hyland, Lynn, Pechacek, & Hartwell, 1997). In their study, Hymowitz et al. (1997) found a negative correlation between the number of cigarettes smoked per day and success rates in smoking cessation. In the current study we found that participants who smoked more cigarettes before attempting to quit also had higher income, a higher desire to quit smoking and more often used a paid application. This could explain why participants who smoked more were more successful.

Furthermore we found significant differences in success rates for gender and whether participants used a free application or a paid one. Women were more successful than men, $t(97) = -2.93, p < .001$. Furthermore, participants who indicated that they paid for their application were more successful than participants who used a free app, $t(98) = -3.81, p < .001$. 
4. Discussion

4.1. Short Summary
Smoking cigarettes is associated with severe health risks such as lung cancer and cardiovascular disease. Many people are aware of these health risks and try to quit the habit. However, the majority of quit attempts is not successful (Hughes, 2003). Most individuals who try to quit smoking experience difficult situations, relapse or give up entirely.

Smoking cessation application to be used on smartphones are a popular tool for smokers to help them quit smoking. Nevertheless, many people who attempt to quit smoking using such apps still fail. Earlier research showed that only 18 percent of users are still smoke free after four weeks (Ubhi et al., 2015). An important factor in this low success rate is that a large proportion of users quit using smoking cessation apps shortly after adopting them. In the current study we have investigated whether achievement goals can contribute the long success of individuals who use smartphone applications as a tool to quit smoking. We concentrated on the effects of achievement goals during the first three months of use, which is the stage where the majority of users give up using smoking cessation apps.

Earlier research on achievement goals, outside the scope of smoking cessation, has shown that certain types of goals are more beneficial for performance and persistence than other types of goals. Learning goals and performance-approach goals have been shown to lead to higher performance than performance-avoidance goals (Elliot & Church, 1997). Moreover, learning goals have been shown to lead to higher intrinsic motivation, and perseverance in the face of obstacles or failure than performance goals do (Dweck, 1986; Elliot & Dweck, 1988). In the current study, we have investigated the following research question:

*What is the relationship between user’s achievement motivation and the effectiveness of persuasive technology (aimed at smoking cessation) in attaining (long term) behaviour change?*

To investigate this question we conducted an online survey among 68 women and 32 men who had used a smoking cessation app. The participants reported on their smoking behaviour while using the app, their achievement goals and their demographic context.

4.2. Discussion of results
Results of the current study provided partial evidence for hypothesis 1a, which stated that individuals who score higher on learning goals and performance-approach goals will also have a higher success rate in smoking cessation. In line with this hypothesis, participants who scored higher on the learning goal measure also scored higher on success rate ($r = .17$, when controlling for the effects of performance-avoidance goals). Contrary to hypothesis 1a, we found no meaningful correlation between performance-approach goal scores and success rate.

Results of the current study supported hypothesis 1b, which stated that which stated that individuals who score higher on performance-avoidance goals will have a lower success rate in smoking cessation. In line with this hypothesis, participants who scored higher on performance-avoidance goals scored lower on success rate ($r = -.18$, when controlling for the effects of learning goals). Contrary to hypothesis 1b we found no significant zero-order correlation between performance-avoidance goals and success rate.
Just like in earlier research by Elliot and Harackiewicz (1996) and Elliot and Church (1997), higher scores on the performance-avoidance goal scale led to lower success rate (when controlling for the effects of performance-avoidance goals). Furthermore, in line with an earlier study by Dweck (1986), higher scores on the learning goal scale led to higher success rate (when controlling for the effects of performance-avoidance goals). This suggests that the existing theories of achievement motivation could be generalized to other areas, in this case smoking cessation and persuasive technology.

Unlike the research by Elliot and Church (1997), we did not find a positive relationship between performance-approach goals and success rate. One explanation for this inconsistency might be the challenging nature of smoking cessation. Other studies, by Dweck (1986) and Elliot and Dweck (1988), propose that the adoption of performance goals in general can lead to giving up when the individual encounters situations that are too challenging. According to Cury et al. (2002), performance-approach goals might turn into performance-avoidance goals when an individual faces repeated failure or highly challenging situations. However, the current study did not provide detailed insight in the amount of challenging situations and failure that participants experienced. Therefore, additional research is required to support this explanation.

The results of the current study provided partial evidence in support of hypothesis 2b, which stated that individuals who score higher on performance-approach and performance-avoidance goals to be smoke free for a shorter period of time (as reported by themselves). In line with hypothesis 2b, participants who scored higher on performance avoidance goals reported less often to be smoke free for a long period of time, as indicated by a partial spearmen rank correlation ($r = -.18$, when controlling for the effects of learning goals and performance-approach goals). Contrary to hypothesis 2b, we found no meaningful correlation between performance-approach goals and the amount of time that participants reported to be smoke free.

Just like earlier research by Cury et al. (2002), Elliot & Church (1997), Dweck (1986) and Elliot and Dweck (1988), we found that performance-avoidance goals undermine success rate. Again, this is an indication that the achievement goal theory, which has proven itself in the fields of education, sports and the workplace, can be generalized to other fields.

However, our study results in general also provided some results that are inconsistent with our hypotheses or with earlier studies in achievement goal studies. Firstly, we did not find evidence to support hypothesis 2a, which stated that a high score on learning goals would correlate with longer smoke free times. Secondly, unlike earlier studies by Elliot & Harackiewicz (1996) and Elliot & Church (1997), we found no significant zero order correlations (without controlling for other goal types) between achievement goal types and either of our two measures for success. Thirdly, all the correlations that we found in our study are of marginal statistical significance. We suggest three explanations for this inconsistency with earlier studies on achievement goals.

First of all, we argue that our sample of participants is not a good representation of the average individual who tries to quit smoking using a smoking cessation app. In our sample participants scored very high on success rate compared to the average person who tries to quit smoking. At the time of taking the survey, three quarters of participants indicating that they had quit smoking using the app. A big proportion of participants (40 percent) indicated that they had been smoke free for more than one month at the time of taking the survey. In reality, the fraction of people who successfully quit smoking using PT is much
lower. Research by (Ubhi et al., 2015) showed that for a SmokeFree28 the quit rate after 28 days was only 18 percent. Because the participants in our sample were more than twice as successful we argue that our sample is rather poor. A highly successful sample of participants might make it more difficult to observe a significant relationship between smoking cessation success and achievement goal types.

Second of all, the participants in our study scored extremely high on learning goals. Only a small minority (8 percent) scored low (under 2 points on a scale of 1 to 5) on learning goals. The majority (55 percent) scored high (more than 4 points) on learning goals. Because our sample only has a small number of participants that scored low on learning goals, it would be harder to find a significant relationship between learning goals and smoking cessation performance.

Third of all, an explanation for the weak correlations that we found might be that the current study did not take into account the different stages of behavior change. Each stage of smoking cessation might respond differently to achievement goals. As stated in our introduction, smoking cessation is a long term process where people go through six stages: pre-contemplation, contemplation, preparation, action, maintenance and termination (Prochaska & Velicer, 1997). In order to get high success rates, Prochaska and Velicer (1997) believe that health promotion programs should be taken stage by stage and that interventions that are stage-matched. For example, smokers in the later stages need intense, action focused interventions of shorter duration. On the other hand, those people in the early stages might benefit more from frequent contact and less intense interventions (DiClemente, Prochaska, Fairhurst, Velicer, Velasquez, & Rossi, 1991). If interventions from a health promotion program are not stage matched, the program is more likely to fail. For example, people in the pre-contemplation stage are not ready for action intervention and will most likely give up treatment if action oriented processes are applied (Prochaska & Velicer, 1997). For these individuals, directly trying to quit smoking and relapsing can send people back to one of the earlier stages which might demoralize them. This can make individuals give up on changing their unhealthy habits. Perhaps, each stage would respond differently to the adoption of different achievement goals.

We suggest that people in the early stages of smoking cessation might have more benefit from adopting learning goals. Learning about smoking cessation would prepare these people to quit by gathering strategies that they can deploy in difficult situations or after relapsing. In later stages, when fully prepared to quit smoking, individuals might benefit more from performance-approach goals. However, one would need a much larger study in order to test this statement. In the current study, we have made no distinction between the different stages of smoking cessation. Therefore, possible benefits of achievement goals within a stage are harder to discover.

4.3. Scientific implications
The current study renders some important scientific implications.

Firstly, with the current research we have made the first step in investigating the relationship between achievement goals and long term success of persuasive technologies. Most research on persuasive technology mainly looked at short term adoption of persuasive technology. Those studies that investigated success rates of smoking cessation apps did not investigate why some users were more successful than others and why some users stopped using the technology. Furthermore, studies that did consider long term use of persuasive technologies (Fritz et al., 2014) only looked at the small proportion of users who passed the test of time and continued to use the technology in the long run.
Firstly, by recruiting both recent adopters and long term users of smoking cessation apps for our survey, the current study made the first step in investigating why the majority of users fail within the first months of using this technology. A limitation of the current study is that it is cross-sectional, since we did not follow participants for a long period of time. However, by including people with different levels of success, we found indications that achievement goals of the user do impact the user’s long term success in the use of preventive health engineering.

Secondly, the current study provided evidence that the partitioning between learning goals, performance-avoidance goals and performance-approach goals as introduced by Elliot and Church (1997) can be generalized to the field of smoking cessation and persuasive technology. Whereas previous studies on achievement goals focused on the context of education, sports and the workplace, the combination of achievement goals with preventive health engineering is new. Although the findings of the current research are quite limited, the results indicate that further research on the relationship between achievement goals and quality of life could be promising.

Finally, the results of the current study suggest that the negative effects of performance-avoidance goals can also be generalized to the context of persuasive technology aimed at improving lifestyle. We found results that confirmed these effects in the short term and also an indication of generalizability in the medium-long term. This puts new light on the design of persuasive technologies that improve quality of life. Whereas currently there is a lot of research on technology adoption and persuasiveness of these technologies. Little attention is paid to the motivation of the user. With the current research we have an indication that the motivation of the user is an important factor which determines the success that the user will experience with the technology.

4.4. Suggestions for future research

Because of the marginal significance of the correlations we found in the current study we have not enough evidence to draw hard conclusions about the relevance of achievement goals for long term success with persuasive technology. Nevertheless, the current study provided some important insights that can be used in future studies on the subject. We suggest two points of interest that we recommend to take into account in future studies.

Firstly, we point out the influence of recruitment strategies on the success scores of survey participants. Recruiting participants for the current study was a long process because of the highly specific nature of potential participants. Especially recruitment in person (for example in shopping malls and train stations) was a slow and intensive process. Recruitment through social media took less work, even though it took over two months to reach the current number of participants.

The exploratory results from the current study showed that our participant recruitment strategy had a highly significant effect on the success rate, with participants who were recruited through social media pages having higher scores than participants who were recruited in person. This suggests that unsuccessful quitters are unlikely to be recruited through social media. From the current study we can conclude that although specific social media communities are a much easier channel than recruitment in person, the latter most likely will offers a much more diverse group of participants. We suggest to take this into account would be for making a recruitment plan in future studies.
Secondly, we suggest for future research to differentiate for the stage of behavior change that participants are going through, or to follow them for a longer period of time. Although we found some evidence for a possible relationship between achievement goals and smoking cessation success, the correlations that were found in the current study are of borderline significance. Following participants for a longer period of time might expose effects that we missed in a cross sectional study.

### 4.5. Social implications

Although the social perspective of preventive health engineering is largely outside the scope of the current study, we argue that the current study has potential social implications.

With the emergence of preventive health engineering in the form of smartphone apps, individuals who want to improve their quality of life have a brand new tool to deploy. Research on what makes these tools effective can highly contribute to the success of individuals using them. The current study addressed the relationship between achievement goals and the effectiveness of smoking cessation apps. We found indications that there is an inverse relationship between avoidance goals and users’ success. Furthermore, we found an indication that the there is a positive relationship between learning goals and success of the user.

These findings could be relevant for the design of smoking cessation apps and preventive health engineering in general. A possible application of these findings would be to manipulate the adoption of different goal types through persuasive technology. Although in the current study we did not manipulate participants’ goal types, earlier research by Elliot and Dweck (1988) shows that goal type manipulation is an effective tool to influence people’s motivational patterns. By “helping” individuals to set learning goals, they might become more successful at attaining their lifestyle goals. Although this scenario is still speculative, we argue that it is an important topic for future research.

Furthermore, we argue that the current research might also have implication for societies in developed countries. As we mentioned in the introduction, developed countries face a health inequality between different socioeconomic groups. The emergence of inexpensive and easy to access tools to help people achieve better health could potentially contribute to closing this health gap. We argue that achievement goals could play an important role in closing this gap because of the relationship between goal types and locus of control. Earlier research has shown that learning goals have a positive relationship with internal locus of control, which is negatively correlated with smoking. Differences in locus of control have been suggested to contribute to health inequality. The fact that we found indications that achievement goals also have a relationship with the effectiveness of smoking cessation apps suggests that learning goals could possibly contribute to closing the gap in smoking rates between different socioeconomic groups. Again, this scenario is speculative and needs to be subjected to further research.

### 4.6. Relevance for policymaking

We argue that the results of the present study are also relevant for policymaking. In the previous section we suggested two social implications of the current study. Firstly, health app users could benefit from advances in preventive health engineering that result from the implementation of achievement goal
theory. Secondly, we posed that the benefits of adopting learning goals could possibly contribute to closing the health gap between groups of different socioeconomic status. In this section we offer a few recommendations for policymaking in order to keep the developments of preventive health engineering going.

For further development, additional research and innovation in the field of achievement goals and preventive health engineering is needed. Furthermore, new ideas from research should be turned into useful products and services. According to the European Commission (2010), lowering barriers to entry and giving access to finance for R&D are important factors to ensure that innovative ideas make it to the market. Klomp and Roelandt (2004), of the Dutch ministry of economic affairs, offer three suggestions for stimulating innovation. Firstly, they suggest to stimulate innovation by encouraging competition, which is one of the drivers of innovation. Competition could be enhanced by encouraging entrepreneurship, for example by financing startups to lower entry barriers. Secondly, they mention that innovation could also be stimulated directly, by offering fiscal incentives to R&D. Thirdly, they mention that a good knowledge infrastructure is vital to make sure that knowledge from research institutes flows to business. Furthermore, the knowledge flow between universities and business can be improved by stimulating the incentive structure for innovation and research by creating incentives for making science and education more responsive to business and social needs (Klomp & Roelandt, 2004).

However, we argue that the measures above are not sufficient for stimulating real improvements in preventive health engineering. A point of concern is that there is little incentive to make preventive health engineering more effective. The majority of smoking cessation apps are not based on scientifically proven methods (Abroms et al., 2013). Instead, developers will more likely spend their resources on marketing and appeal to the customer. Since innovation is driven by market demand (Mowery & Rosenberg, 1979), we argue that market demand should be stimulated for those applications that have proven to be successful. This requires two steps. Firstly, it requires more insight in what makes preventive health engineering effective. We recommend the development of a high quality benchmark institute that evaluates the effectiveness of technology for improving health. Secondly, we recommend that those technologies that prove to be successful should be provided with public benefits. For example by giving health insurance benefits to individuals who adopt these technologies. This will increase the market demand for effective technologies at the expense of market demand for less effective technologies. With increased market demand, there would be more incentive for business to invest in making technologies for preventive health engineering more effective.

4.7. Conclusion
The current research made a step towards investigating the relationship between achievement goals and the long term effectiveness of persuasive technology for health promotion. Earlier research on achievement goals was mainly applied to other contexts, such as education, sports and the workplace. The fact that we found evidence that achievement goals of the user are related to the effectiveness of smoking cessation apps suggests that achievement goal theory can be generalized to other contexts. Just like earlier research by Cury et al. (2002), Elliot & Church (1997), Dweck (1986) and Elliot and Dweck (1988), we found that performance-avoidance goals undermine success rate. Furthermore, we found that learning goals are positively correlated with success rate. Together, these findings suggest the (long term) effectiveness of persuasive technology is higher for people with the right achievement goals: adhering to a learning goal is beneficial for long term effectiveness of persuasive technology.
5. References

Bibliografie


6. Appendices

6.1 Appendix A – Survey Introduction

What motivates you to quit smoking?

We are conducting research on people's motivation to quit smoking. We'd love to hear from you about what motivated you while quitting to smoke while using the smoking cessation app. This information will be useful to help more people quit smoking in the future. The survey should only take 5 minutes, and your responses are completely anonymous.

You can only take the survey once. Questions marked with an asterisk (*) are required. If you have any questions about the survey, please email us at ...(insert email address.)

We really appreciate your input!

6.2. Appendix B – Smoking behavior items

1. Did you successfully quit smoking using the smoking cessation app?
   (0 = No, 3 = Yes)

2. Do you smoke less than before you adopted the smoking cessation app?
   (0 = At least as much as before, 1 = Slightly less than before, 2 = Significantly less than before, 3 = Not at all anymore)

3. How many times did you attempt to quit smoking using the smoking cessation app?
   (1 = Once, 2 = Two times, 3 = More than two times)

4. How many times did you attempt to quit smoking prior to using the smoking cessation app?
   (0 = No attempts before adopting the app, 1 = One attempt, 2 = More than one attempt)

5. How long have you been smoke free?
   (0 = Less than one week, 1 = One week to one month, 2 = One to three months, 3 = More than three months)

6. Have you ever smoked after your intended quit date while using the smoking cessation app?
   (0 = Regularly, 1 = Occasionally, 2 = Once or twice, 3 = Never)

7. Did you experience a relapse (smoking on at least 2 days in a 2 week period after quitting) while using the smoking cessation app?
   (0 = More than two times, 1 = Twice, 2 = Once, 3 = Never)
6.3. Appendix C – Achievement goal items

For the items below, indicate how well it applies to you on a scale of 1 = “Not at all applies to me”, 2 = “slightly applies to me”, 3 = “Moderately applies to me”, 4 = “very much applies to me” and 5 = “completely applies to me”.

1. It is important to me to do better than other people who try to quit smoking
2. My goal with this app is to quit smoking quicker than others who try to quit
3. I am motivated to demonstrate my ability to quit smoking relative to other people
4. I am motivated by the thought of outperforming other people who try to quit smoking
5. It is important to me to do well compared to other people who try to quit smoking
6. I want to quit smoking to show my ability to my family, my friends or others
7. I want to learn as much as possible about quitting smoking
8. It is important to me to understand how to quit smoking as thoroughly as possible
9. I hope to gain a more knowledge about how to quit smoking from the app
10. In the app, I like to be provided with new matter, even if it is difficult to apply
11. I enjoy the challenge to quit smoking
12. I like that quitting to smoke makes me learn new things
13. I often think to myself, “what if I fail to quit smoking?”
14. I worry about the possibility to relapse
15. My fear of relapsing is often what motivates me
16. I just want to avoid relapsing
17. I’m afraid that if I ask other people for help to quit smoking, they might look down on me
18. I wish that I did not have to quit smoking
6.4 Appendix D – Demographic items that influence smoking behavior

1. How many cigarettes did you smoke per day prior to using the smoke free app?
   (0-4, 5-14, 15-24, over 24)

2. Do you have other smokers living in your household?
   (0 = No, 1 = Yes)

3. At what age did you start smoking?
   (0 = Under 16 years of age, 1 = Between 16-19 Years of age, 2 = Between over 19 years of age)

4. Indicate your desire to quit
   (on a range of 1 “not at all” to 5 “a lot”)

5. What is your gender?
   (0 = Male, 1 = Female)

6. What is your age?
   (0 = under 25 of age, 1 = Between 25 and 34 years of age, 2 = Between 35 and 44 years of age, 3 = between 45 and 54 of age, 4 = over 54 years of age)

7. What is the highest level of education you have completed?
   (0 = Primary School, 1 = Secondary School, 2 = Highschool, 3 = College/University)

8. How would you classify yourself?
   (1 = Arab, 2 = Asian, 3 = Black, 4 = Caucasian, 5 = Hispanic, 6 = Latino, .a = Other)

9. What is your current annual household income in U.S. dollars?
   (0 = Under 10.000 dollars, 1 = Between 10.000 and 25.000 dollars, 2 = Between 25.000 and 40.000 dollars 25K-40K,3 = Over 40.000 dollars)

10. How frequently do you consume alcohol?
    (0 = Less than once per month, 1 = One to three times per month, 2 = 1 to 2 times per week, 3 = Three to four times per week, 4 = Daily)

11. Did you use a free of charge smoking cessation app or a paid version?
    (0 = Free version, 1 = Paid version)

12. How often did you use any kind of nicotine replacement therapy to help quit smoking?
    (0 = Never, 1 = Occasionally, 2 = Regularly, 3 = Daily)