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Long-term vs. short-term lotteries to promote physical activity

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1 Abstract

Providing long-term lottery incentives next to short term lottery incentives have proven to be helpful in creating habit formation and improve goal attainment when it comes to physical activity. This follow-up study examined the effectiveness of long-term lottery rewards next to short-term lottery rewards in a real world setting. Furthermore, the influence of socio-economic status (SES) on the effectiveness of lottery rewards was investigated. This was done in cooperation with health insurer Menzis, who carried out an experiment where users of the health-app SamenGezond have to complete weekly goals to stimulate physical activity and be able to partake in the lotteries. Users were randomly assigned to either the monthly lottery group (short-term) or monthly + quarterly lottery group (long-term). The amount of completed weekly goals was taken as the dependent variable and the effects were analysed using a generalized linear model (GLM) with Poisson distribution. Results show that lower-SES groups are more sensitive to long-term lottery incentives than only short-term incentives. This effect was not found for other SES groups. Therefore providing a long-term lottery reward next to a short-term lottery reward can help in decreasing health-inequalities. Lastly, no significant effects were found for email-prompts and the interaction with self-control.

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3 Introduction

3.1 Motivation

3.1.1 Relevance

The amount of people worldwide who are overweight is rapidly increasing and the Netherlands is not an exception. According to research from the 'Centraal Bureau voor de Statistiek' (CBS) (2021; 2022a) the amount of overweight and obese people in the Netherlands increased from 35% in 1980 to 50% in 2021. Of this 50%, 36% is overweight and 14% is obese. Also, older people tend to be more overweight than younger people and lower educated people tend to be more overweight than higher educated people (Centraal Bureau voor de Statistiek, 2021, 2022a). The Dutch institute for public health and environment (RIVM) predicts that the amount of overweight adults will increase from 49% (6.6 million people) in 2015 to 62% (9.1 million people) in 2040 (RIVM, 2018).

Being overweight imposes serious health risks on a person. Namely, it increases chances of diabetes, cardiovascular diseases and many forms of cancer (Ginter & Simko, 2014) and thus increases healthcare and other societal costs. Nielen et al. (2020) estimate that the amount of people with diabetes type 2 will increase from 1.14 million people in 2025 to 1.33 million people in 2040 based on current trends whilst even neglecting future changes in risk factors, like obesity. Since diabetes has, after coronary heart diseases and strokes, the greatest diseases burden, so this is a serious issue (Nielen et al., 2020). Hecker et al. (2022) calculated the mean costs for people with obesity and overweight. They found that overweight costs are around 79 billion euros per year in the Netherlands (Hecker et al., 2022).

The increase in people who are overweight has multiple causes. First of all, it has become much easier to buy and eat unhealthy foods (Cohen & Babey, 2012). Secondly people exercise less than they are supposed to, especially during the pandemic. In 2021 only 47% of the Dutch population exercised enough, which was less than in 2020 and 2019 but the same as 2017 and 2018 (Centraal Bureau voor de Statistiek, 2022b). According to the Gezondsheidsraad (2017) adults should get at least two and half hours of moderate-intensity exercise a week and children one hour on a daily basis. Next to those two and half hours they should also do muscle and bone strengthening

exercises. Research has shown that this significantly lowers the risks of diabetes, cardiovascular diseases, forms of cancer and even depressive symptoms (Gezondheidsraad, 2017). Even exercising for only 11 minutes a day, or 75 minutes a week, can prevent one in ten deaths (Garcia et al., 2023). Thus, it is important to stimulate people to exercise more and decrease related health risks of physical inactivity.

Especially lower socio-economic status (SES) is associated with increased prevalence of overweight in both the developed and developing world (Cerin & Leslie, 2008; Kavanagh et al., 2005; Taylor et al., 2006). Mierau (2021) states that although obesity has increased among all education classes in the Netherlands, the increase is the biggest in the lowest educated class and their levels were already higher (Mierau, 2021). Next to that, Gidlow et al. (2006) conducted a systematic review of the relationship between socio-economic position (SEP) and physical activity and found that people in a higher SEP have higher levels of physical activity than people in a lower SEP (Gidlow et al., 2006). This causes increasing health inequalities between different socio-economic groups. In the Netherlands, CBS (2022) found that people in the highest socio-economic group live approximately 9 years longer in total and almost 25 years longer in good health compared to people in the lowest socio-economic group (Centraal Bureau voor de Statistiek, 2022c). Higher health inequalities means that there will be more demand for healthcare and other sectors which are dependent on government funds. Research has also shown that more (health) inequalities can lead to less social cohesion which can cause friction in a society (EU, 2023). It is therefore important to come up with policies and interventions which are aimed at reducing these health inequalities.

3.1.2 Goal and research question

Menzis, a health insurer in the Netherlands, has a division called SamenGezond and they created the eponymous app which aims to promote physical activity among its users. Currently, they have implemented an additional long-term lottery reward system (additional quarterly lottery) next to their existing monthly lottery. They want to know if this enhances physical activity of the people using the SamenGezond app. They especially want to promote physical activity in lower SES groups, in order to reduce health inequalities.

Research suggests that financial- and lottery incentives can help in promoting physical activity. However, most of this research has been conducted in the setting of a field study (Patel et al., 2016, 2018; Van Der Swaluw et al., 2018; Volpp et al., 2008). Working with Menzis, and to be more specific, with SamenGezond allows for an unobtrosive real-world setting to test if a long-term lottery incentive, next to a short-term lottery incentive, increases physical activity more among people using the app. Advantages of this are first of all a larger sample size. Where previously named studies had between 57 and 279 observations, SamenGezond has more than 30.000 users in their database. The results of this study would therefore yield more generalizable results. Secondly, participants are not aware of the fact that they are partaking in an experiment thus eliminating the experimenter bias. Next to that, this thesis deviates from previous research as this was conducted using regret lotteries. This study deviates from that in the sense that users of the app only partake in the lottery if they at least completed one weekly goal during that month (or quarter) so the component of loss aversion is lost out. The main research question therefore is:

'Does providing a long term lottery reward in addition to a short-term lottery reward increase the physical activity of SamenGezond users?'

Research by Royer et al. (2015) and Van der Swaluw et al. (2018) have shown promising results in an experimental setting on goal attainment and habit formation. Both studies examined the differences between short-term and long-term lottery incentives and found that long-term lotteries can be helpful. (Royer et al., 2015; van der Swaluw et al., 2018). If these results also hold in a real world application then that would mean that quite some future healthcare can be avoided at a relatively low cost.

Additionally, since SamenGezond especially wants to promote physical activity in lower SES groups the following sub question will also be studied:

'How does SES of SamenGezond users influence the effectiveness of lottery-rewards?'

How SES influences the effectiveness of financial incentives has been investigated but mostly in experimental settings and specifically how the effect of lottery rewards is influenced by SES is not yet extensively studied. Since health inequalities can lead to serious issues, as described earlier, it will be interesting to see if a long-term lottery reward next to a short-term lottery

reward can help in decreasing health inequalities. Similar to the main research question, the real world application of this study has the advantage of testing the effectiveness of financial incentives between SES groups on a large scale.

3.2 Structure and results

In order to answer the main research question and belonging sub-question, first of all a theoretical background is provided in the next section (4). This section dives deeper into the underlying mechanisms and theories on physical activity in combination with lottery incentives. This section also provides hypotheses based on earlier research. This thesis than goes on (section 5) by elaborating further on the chosen method for testing these hypotheses. For this study an experiment was carried out by SamenGezond. They assigned 50% of their users to a monthly lottery alone (short-term group) and 50% of their users to a quarterly + monthly lottery (long-term group) to see if the long-term group obtained more weekly goals than the short-term group. To test this for significance a generalized linear model (GLM) with Poisson distribution was used. The results of this are presented in the section 6. Regarding the main research question, no statistical difference in completed weekly goals was observed between the short-term group and the long-term group. As regards the sub-question, lower SES groups are more sensitive to lottery incentives than high SES groups. Lower SES individuals complete significantly more weekly goals when they are in the long-term group than when they were to be in the short-term group, especially compared to high SES individuals. The last section (7) of thesis elaborates further on the results of this thesis by discussing the implications, strengths and limitations. It also provides suggestions for further research and it ends with a conclusion.

4 Theoretical background

4.1 Behavioural economics in healthcare and health behaviour

4.1.1 Self-control

The paper 'Prospect theory: an analysis of decision under risk' by Kahneman and Tversky (1979) was one of the first papers to suggest that classic economic principles such as 'perfect rationality' were violated and that this could lead to non-optimal results in decision making (Kahneman & Tversky, 1979). Another important contribution from psychology to economics is that people have limited self-control which also leads to non-optimal results in decision making (Ainslie, 1975). People discount costs and benefits differently over time and the degree of delayed discounting is not stable over time which is also known as hyperbolic discounting. Usually, people dislike waiting in the present more than they expect to dislike waiting in the future (Laibson, 1997; Mazur, 1987; Soman et al., 2005). O'donoghue and Rabin (1999) make a distinction between sophisticates and naifs when it comes to self-control problems. Sophisticates foresee their self-control problems and take measures to protect their long-term goals whilst naifs also have self-control problems but are convinced that they will stick to their long-term goals (O'Donoghue & Rabin, 1999). Incorporating self-control issues into behavioural economic models can help understand human behaviour better. For example, it can help understand why humans make (un)healthy choices and what policy makers can do to 'steer' people towards more healthy behaviour and make better choices.

4.1.2 Nudging

One way that behavioural economists use to steer people in the 'right' direction is by implementing nudges. In their book 'Nudge', Thaler and Sunstein (2008, p.6) describe a nudge as the following: 'A nudge, as we will use this term, is any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives' (Thaler & Sunstein, 2008, p.6). It is a cheap and effective way of altering people's behaviour. Rice (2013), describes in his overview how behavioural economics and nudges can be applied to for example the enrollment in health insurance, reduction in

tobacco use and combating obesity (Rice, 2013). One of the most famous examples of this in healthcare is how the status quo bias influences organ donation. Johnson & Goldstein (2003) found that countries with an opt-out system had significantly more registered organ donors than countries with an opt-in system (Johnson & Goldstein, 2003). So just by simply introducing an opt-out system you can get much more registered organ donors compared to an opt-in system but people are still free to choose whether or not they want to be an organ donor. Another famous nudge in altering health behaviour is the placement of (un)healthy foods in supermarkets. Ejlerskov et al. (2018) found in their experiment that supermarkets with a policy to not sell unhealthy foods at the checkout had a reduction of 15% of sold unhealthy foods (Ejlerskov et al., 2018). Similarly, Cohen & Babey (2012) found that placement causes people to make different choices than they would actually like, indicating that people have self-control problems (Cohen & Babey, 2012). Thus, by placing more healthy foods at better places you can steer people into making more healthy choices. Lastly, Thaler and Benartzi (2004) found that self-control problems and bounded rationality could lead to pension saving problems. They designed a commitment contract allocating a proportion of their future salary for retirement savings and found that savings increased from 3.5 percent to 13.6 percent. This simple nudge suggests that behavioural economics can be used to design effective programs for important economic decisions (Thaler & Benartzi, 2004). Engaging with the SamenGezond application can be seen as a form of a commitment contract. The next section will dive deeper into financial incentives, commitment contracts and lottery incentives and how these can be applied to enhance physical activity.

4.1.3 Financial incentives

Another way in which behavioural economics contributes to steering people in the right direction and overcome self-control issues is by giving monetary incentives. Multiple meta-studies have shown that financial incentives can help in increasing physical activity, smoking cessation or increase attendance for vaccination and screening (Giles et al., 2014; Mitchell et al., 2013). Financial incentives regarding health behaviours usually come in the form of commitment contracts. Royer, Stehr and Sydnor (2015) for example found that a commitment device can increase gym visits with 25% when participants put their own in money and this is forfeited if they do not visit the gym at least once every two weeks (Royer et al., 2015). The framing of incentives

is important, namely, the prospect theory namely states that people put twice as much weight on losses as they do on gains (Kahneman & Tversky, 1979; Ruggeri et al., 2020). Patel et al. (2016) also found this to be true in their experiment to enhance physical activity among overweight and obese adults, only the 'loss' incentive group performed better than the control group (Patel et al., 2016). Thus, participating in commitment devices, when designed correctly, have proven to be effective in overcoming self-control issues and increase physical activity (Halpern et al., 2012; Mitchell et al., 2020).

4.2 Prior research on lottery rewards and physical activity

Participation in lottery plays is very common, but this is at odds with standard economic principles like rationality and risk aversion (McCaffery, 1994). However, it can be explained by Kahneman and Tversky's prospect theory (1979) where they state that people overestimate small probabilities (Kahneman & Tversky, 1979). Next to that, Loewenstein et al. (2001) state that people are attracted to lotteries because emotional reactions diverge from cognitive assessment of risks (Loewenstein et al., 2001). Based on this, numerous RCT's have been conducted to find out if lottery incentives and commitment lotteries can promote healthy behaviour. Commitment lotteries are a form of a commitment contract. Commitment lotteries usually give people a chance at winning a certain prize but they can only claim their prize when they obtain their goal, these are known as regret lotteries. This can be applied to increasing physical activity, weight loss or smoking cessation for example. For example, Volpp et al. (2008) found in their weight-loss experiment that people in either a deposit contract or a lottery-based reward system lost significantly more weight than the control group (Volpp et al., 2008). Adding to that, as mentioned before, Patel et al. (2016) ran a randomized control trial (RCT) where they framed financial gains in either a gain, loss or lottery incentive to increase physical activity. What they found was that only the loss-incentive group exercised significantly more than the control group (Patel et al., 2016). This again shows the importance of framing incentives. Further research regarding lottery-incentives by Patel et al. (2018) focused on the question whether combined lotteries are more effective than single tiered lotteries in increasing physical activity. Again a RCT was run with 3 different lottery arms, a high frequency/small reward arm, jackpot incentive and a combined

incentive. They found that all arms increased physical activity in the beginning but that the combined arm was more sustainable, where the jackpot incentive had declined rates of physical activity towards the end (Patel et al., 2018). Lastly, van der Swaluw et al. (2018) found in their experiment that having a long-term lottery reward next to a short-term lottery reward can help avert the decline in goal-attainment when it comes to promoting physical activity (van der Swaluw et al., 2018). Thus, having a long-term lottery reward next to a short-term incentive can help form habits, something that is also found by Royer, Stehr and Sydnor (2015) (Royer et al., 2015). The field studies conducted earlier by van der Swaluw et al. (2018) and Royer et al. (2015) provide convincing results that long-term lotteries next to short-term lotteries can help in enhancing physical activity. Therefore this thesis will test the following first sub-hypothesis:

Hypothesis 1a: Participants in the monthly + quarterly draw obtain more weekly goals than people in the monthly draw alone.

Herein 'draw' refers to the lottery as this is preferred by SamenGezond. Working with SamenGezond allows to test this hypothesis in an unobtrusive real world setting as opposed to the work of for example Patel et al. (2018) or van der Swaluw et al. (2018) (Patel et al., 2018; van der Swaluw et al., 2018). Advantages of this are first of all a larger sample size. Where previously named studies had between 57 and 279 observations, SamenGezond has more than 30.000 users in their database. Secondly, participants are not aware of the fact that they are partaking in an experiment thus eliminating the experimenter bias. Next to that, this thesis deviates from previous research as this was conducted using regret lotteries. This study deviates from that in the sense that users of the app only partake in the lottery if they at least completed one weekly goal during that month (or quarter) so the component of loss aversion is lost out. The results of this thesis therefore contribute to the existing knowledge of lottery rewards without regret aversion by showing a more representative reflection of the real world.

4.3 SES, health and financial incentives

4.3.1 Health inequalities

Socioeconomic status (SES) is a combination of economic and social status and is positively related to health, thus higher SES individuals are usually more healthy than lower SES individuals (Baker, 2014). In 1991 already, Dahlgren and Whitehead (1991) came up with a model with factors that determine health but still health inequalities exist (Dahlgren & Whitehead, 2021). It is clearly visible in figure 4.1 that a lot of factors that make up SES are important for determining health.

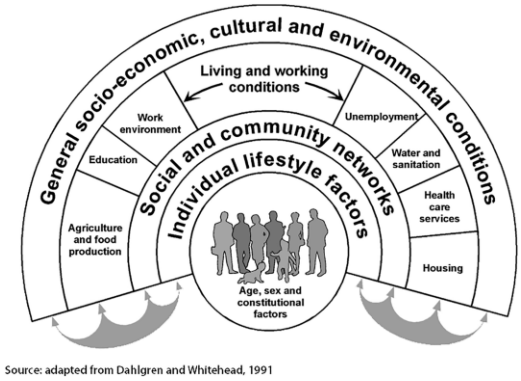

FIGURE 4.1: THE DAHLGREN AND WHITEHEAD MODEL OF HEALTH DETERMINANTS.

Ever since, multiple studies have shown that a lower SES is associated with increased prevalence of overweight in both the developed and developing world and lower levels of physical activity (Cerin & Leslie, 2008; Gidlow et al., 2006; Kavanagh et al., 2005; Taylor et al., 2006). All this contributes to growing health inequalities which can be seen as unjust. It is therefore important to come up with policies which eliminate these inequalities rather than just control for SES to explain differences in health between groups (Adler et al., 1994; Arcaya et al., 2015).

4.3.2 SES and financial incentives

The fact that lower SES groups behave less healthy can partly be explained by the fact that they have lower levels of self-control (Beenackers et al., 2018). Another study by Sheehy-Skeffington (2020) proposes that people in lower SES groups present cues of resource scarcity, environmental instability and low subjective social status which trigger a shift more towards the present. This means they focus more on immediate needs and therefore have less self-control (Sheehy-

Skeffington, 2020). For this reason, they might benefit more from financial incentives than higher SES groups, since financial incentives can shift someone's attention more towards the present in a positive way. Quite some research has been conducted on this topic but the results were ambiguous. Gaalema et al. (2019) found that incentivizing lower SES individuals improves cardiac rehabilitation (CR) participation but this was not compared to higher SES groups (Gaalema et al., 2019). Pisinger et al. (2022) found in their smoking cessation experiment that although all SES groups benefit from financial incentives, people in a higher SES group benefit from them more than people in a lower SES group (Pisinger et al., 2022). A study from Dolan & Rudisill (2014), which looked at chlamydia testing rates, states that SES does not influence the sensitivity towards financial incentives (Dolan & Rudisill, 2014). On the other hand, Mantzari et al. (2015) and Oliver & Brown (2012) suggest that personal financial incentives can stimulate people from lower SES groups to live more healthy and therefore decrease health inequalities (Mantzari et al., 2015; Oliver & Brown, 2012). Complementary to this, a study by Campos-Mercade et al. (2021) showed that monetary incentives for COVID-19 vaccinations work better for lower SES groups than higher SES groups (Campos-Mercade et al., 2021). So as said before the results are contradictory, however there is more evidence pointing towards the fact that lower SES groups are more sensitive towards financial incentives than high SES groups. This therefore leads to the second sub-hypothesis:

Hypothesis 1b: Compared to the participants with a high SES, participants with a low SES in the monthly + quarterly draw obtain more weekly goals than participants with a low SES in the monthly draw alone.

By testing this hypothesis this thesis will contribute to existing knowledge on how SES influences the effectiveness of financial incentives. This is especially interesting because of the ambiguous results. Also how SES influences the effectiveness of short- and long-term lotteries specifically has not been studied extensively yet. This thesis will therefore contribute to this gap in the literature. Again, the real-world setting will provide answers that are a better representation of the real world.

4.4 Self-control, physical activity and financial incentives

Self-control in economic theory has been described as the conflict between the farsighted planner and the myopic doer (Thaler & Shefrin, 1981). Behavioral economic models explain this by stating that people systemically overweight the present, also known as present bias. People discount costs and benefits differently over time and the degree of delayed discounting is not stable over time which is also known as hyperbolic discounting. Usually, people dislike waiting in the present more than they expect to dislike waiting in the future (Laibson, 1997; Mazur, 1987; Soman et al., 2005; van der Swaluw, 2018). Therefore, people with higher levels of self-control usually exercise more and this is also found by multiple studies. Research has shown that higher levels of self-control lead to more physical activity but that this relationship can also be bi-directional, thus consistently exercising leads to higher self-control (Boat & Cooper, 2019; Kinnunen et al., 2012). In overcoming self-control issues, Duckworth, Milkman and Laibson (2018) have distinguished four domains with different mechanisms to help overcome them. They distinguish between self-deployed and other deployed strategies and between situational and cognitive interventions. Commitment devices, like commitment lotteries, are labelled as self-deployed and situational (Duckworth et al., 2018). There is a lot of research that proves that people with low levels of self-control can benefit from commitment devices (Brocas et al., 2004). Commitment devices can especially be beneficial for the earlier defined sophisticates (Bryan et al., 2010). Commitment contracts have not only proven to be effective for increasing physical activity but have also proven to increase savings, quitting smoking or increase the purchases of healthy foods (Ashraf et al., 2006; Giné et al., 2010; Schwartz et al., 2014). Knowing that commitment devices such as commitment lotteries can help people with low self-control to stick to their goals, this thesis will test the following, third, sub-hypothesis:

hypothesis 1c: Participants with low levels of self-control in the monthly + quarterly draw obtain more weekly goals than participants with low levels of self-control in the monthly draw alone.

'Low' in this case, will be defined as lower than the average. Testing this hypothesis will further contribute to the existing knowledge on self-control and sensitivity towards financial incentives

and physical activity. This thesis wil also explore the interaction effect between SES and self-control.

4.5 The effect of communication

Mobile health (mHealth) apps, like the SamenGezond app, are increasingly used for promoting lifestyle behavior changes however the effectiveness of these apps is limited by low participant engagement. Nonetheless, Agachi et al. (2022) found proof (specifically for SamenGezond) that people with lower SES are more likely to adopt mobile app programs than high SES groups, whereas higher SES groups are more likely to adopt website based programs (Agachi, Bijmolt, Mierau, et al., 2022). Adding to that, there has been some research which suggests that email prompts and push-notifications can increase the engagement with the SamenGezond app and mobile apps in general (Agachi, Bijmolt, van Ittersum, et al., 2022; Neff & Fry, 2009a). Furthermore, other research on this topic confirms that prompts can enhance the engagement and thus are effective but caution is required because of small sample sizes (Alkhaldi et al., 2016; Schneider et al., 2012). These are very interesting results because it would mean that the effectiveness of the app can be enhanced against very little costs. The results from Agachi et al. (2022) indicate that email prompts do increase the engagement with the SamenGezond app, however this research was conducted when they were still working with a points-based reward system (Agachi, Bijmolt, van Ittersum, et al., 2022). This thesis will investigate if these results also hold for a lottery-based reward system and because SamenGezond has a large database this thesis will also test if this positive effect is also found for larger sample sizes. This leads to the following hypothesis:

Hypothesis 2: Participants in the monthly + quarterly draw who received an email prompt obtain more weekly goals than participants in the monthly + quarterly draw who did not receive an email prompt.

4.6 Behavior change models

For some background information on the mechanisms involved in behaviour change the behaviour change wheel and the integrated change model (I-change model) were analysed. In collaboration with SamenGezond the above mentioned variables of interest were chosen to analyse, based on these two models. The models will briefly be discussed below and finally will be followed by the conceptual model of this thesis.

4.6.1 Behavior change wheel

The behaviour change wheel, see figure 4.2, by Michie, van Stralen and West (2011) is based on nineteen different frameworks to explain behaviour change. The inner layer shows the sources of behaviour, involving three essential conditions: capability, opportunity and motivation. Around this are nine intervention functions aimed at addressing deficits in one or more conditions. The outer layer shows seven categories of policy that could enable those interventions to occur. The model has been found reliable in coming up with effective strategies for reduction in tobacco consumption as well as for reducing obesity. According to the model, motivation problems can be overcome by incentivisation (Michie et al., 2011). This thesis will also investigate if long term incentives (next to short-term incentives) can increase physical activity.

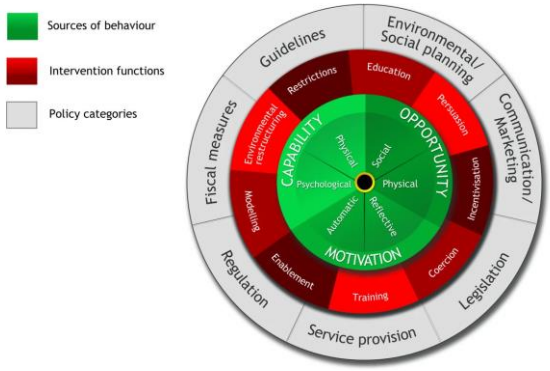

FIGURE 4.2: THE BEHAVIOUR CHANGE WHEEL.

4.6.2 The I-change model

Another model which looks at explaining health behaviour is the integrated change model (I-change model) by de Vries (2017). It combines 5 existing change models and is an extension of

the ASE-model. The model shows all factors that contribute to the decision to go exercise for example, see figure 4.3 (De Vries, 2017). This thesis will investigate whether commitment lotteries can help in for example taking away barrier and how SES influences behaviour

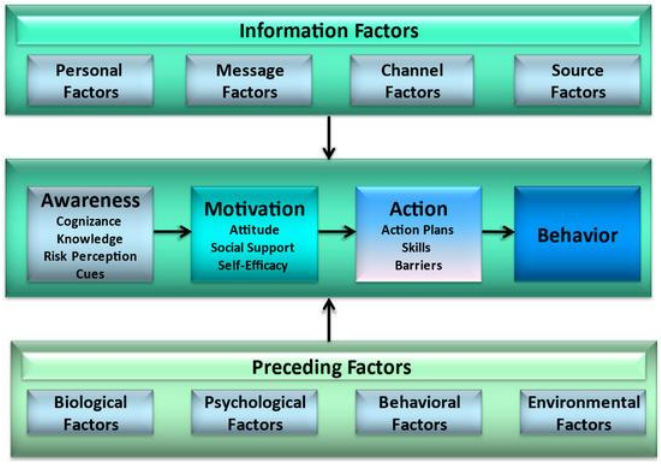

FIGURE 4.3: THE I-CHANGE MODEL

4.6.3 Conceptual model

Based on the previously mentioned hypothesis and above named models the conceptual model looks as follows:

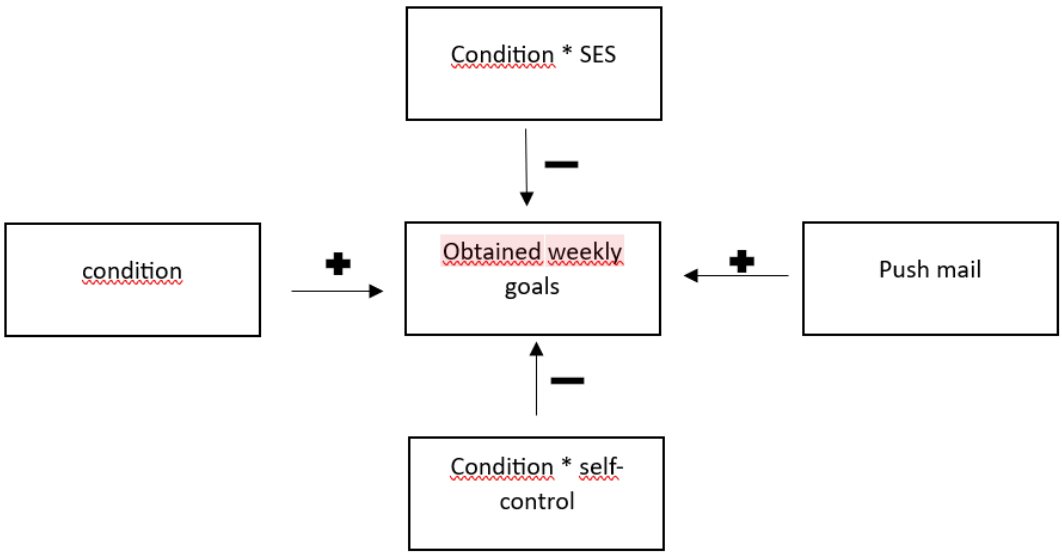

FIGURE 4.4: CONCEPTUAL MODEL.

Condition here indicates whether someone is in the quarterly + monthly draw or not. Condition, in this case being in the long-term group (versus being in the short-term group) is positively related to the amount of obtained weekly goals. The interaction between condition and SES is negative related to the amount of the weekly goals because it is expected that individuals in the low SES group are more sensitive to the long-term lottery than high the SES individuals. Similarly, individuals with a low self-control are expected to be more sensitive to the long-term lottery as well, hence the negative relation to the amount of completed weekly goals. Lastly, the push-mail is expected to have a positive impact on the amount of weekly goals obtained.

5 Methodology

5.1 Study design

5.1.1 Setting: SamenGezond

This thesis follows up on earlier research conducted by SamenGezond. SamenGezond is a subdivision of health insurer Menzis in the Netherlands that created an eponymous app to promote physical activity and encourage weight loss. Users of the SamenGezond app receive weekly goals based on their current exercise pattern. Weekly goals start on Monday and end on Sunday. All participants get the target to achieve at least 2000 steps for five out of the seven days and exercise for at least 40 minutes to a maximum of 200 minutes, depending on how much they already exercise. If participants do not specify their current exercise pattern upfront SamenGezond assumes they do not exercise a lot so they get a low first minutes target. Every week a participant completes a weekly goal two or more times in a row the amount of minutes they need to exercise the next week increases with 7 to 23 minutes. If someone largely exceeds his or her goal this is 17 to 23 minutes, else it is 7 to 13 minutes. How much the goal goes up is random between these ranges and goes to a maximum of 200 minutes a week. Participants can either go for a walk, a run or go biking to achieve the amount of minutes of exercise needed to complete their weekly goal. The amount of steps and minutes of exercise are tracked by the SamenGezond app. A weekly goal thus exists of achieving at least 2000 steps a day for 5 days per week and exercise for 40 to 200 minutes and is only seen as completed when both parts are achieved. Since 2017 they have incentivized their users in various ways to stimulate their them to achieve their goals. The current interventions are a short- and long term lottery reward system and are described further on, under ‘interventions’.

5.1.2 Eligibility

The SamenGezond app is free to download for everyone living in the Netherlands. The only condition is that users have to be 18 years or older, due to nature of the lottery rewards and legislation. Users do not have to be clients of Menzis in order to download the app and participate

in the lotteries. Participants are free to decide when to use the app or to quit using the app if they want to.

5.1.3 Interventions and randomization

The trial consisted of two intervention arms and has no control arm. SamenGezond already used of monthly draws to promote physical activity among its users. From the start of 2023 they ran an experiment where half of the users got an additional long-term incentive in the form of a quarterly lottery next to the monthly lottery. The other half of the people were still in the monthly lottery group only. The experiment ran for 12 weeks in total, from the second week of 2023 up to and including the 13th week of 2023. The users were randomly assigned to either the monthly + quarterly lottery group (from here on long-term group) or the monthly lottery group (from here on short-term group).

For the long-term group, every week someone completes a weekly goal they got one ticket which was valid for both the monthly and the quarterly draw. Since the experiment started in the second week of January 4 tickets per month could be obtained and 12 in total for the quarterly lottery. Tickets earned in January were not valid for the draw of February and vice versa but were valid for the quarterly draw which occurred in April. The more weekly goals a participant obtained the higher the chances of winning at either one of the draws. The short-term group could only earn tickets for the monthly draws. Tickets earned in the previous month were forfeited in the next month.

Participants in both groups knew the prizes they could win but not the chances of winning. The chances of winning a prize in either one of the draws depends on the amount weekly goals obtained by all users. The prizes and the validity of the tickets per draw can be found in appendix 1.

5.1.4 Outcomes

The primary outcome is the amount of obtained weekly goals at the end of the intervention period (week 13 of 2023). A weekly goal was only obtained if someone reached all of their targets for a certain week. Secondary outcomes of interest are SES and self-control, how these are obtained can be found in the next section ‘data’.

5.2 Data

5.2.1 Dataset 1: all user data

This thesis will use 2 datasets to test the hypothesis. Dataset 1 contains information on the amount of weekly goals obtained from the 2nd to 13th week of 2023 by all SamenGezond users. This was merged with an existing SamenGezond database which includes information on participants' gender, age and postal code + house number. The information about participants' postal code + house number was merged with existing data about participants' social economic score (SES). The existing database on SES scores is based on the MOA Normvraagstelling 2020. Lastly, half of the participants in the long-term group received a push mail in week 7. This email contained information about the amount of completed weekly goals so far and motivation to keep going in order to have more chance of winning prizes at the end of the quarter. This data was also merged with the data on completed weekly goals to create dataset 1. Dataset 1 contains 8966 observations, the filtering of the data can be found in Appendix 2.

5.2.2 Dataset 2: active user/survey data

Dataset 2 is based on additional survey data and consists of only active users. For hypothesis 1c, self-control needed to be measured. In order to do this, a survey was sent out to users of the SamenGezond app. In order to increase the response rate the survey was only sent to active users of the app. Active users were defined as people who had at least completed one weekly goal in 2023, note that this also includes people who achieved a weekly goal in the first week of 2023 but this week is not part of the experiment. Next to being active it is considered important that people in the long-term group are aware of the fact that they can win a big prize at the end of the quarter, therefore this group should at least have opened the information mail about the quarterly lottery, if they did not, they also did not receive the questionnaire. This requirement of course does not hold for the short-term group since they did not receive the information mail to begin with. SamenGezond did not want to bother all of their active users with the survey. Therefore the survey was randomly sent to 2500 participants in the long-term group and 2500 in the short-term group who met the selection criteria using. The survey was sent using Typeform, and 3 HEMA gift vouchers worth 10 euro's each were distributed among the respondents. To measure self-control

an adjusted version of the brief self-control scale by Tangney et al. (2004) was used as this is considered to be a reliable measure for self-reported self-control (Duckworth & Kern, 2011; Tangney et al., 2004). Adjustments were made so that the survey could be related to exercising. To test if the scale was still reliable a reliability test was conducted regarding the questions about self-control. The results of this test can be found in the next chapter 'Results'. Information on gender, age and postal code + house number was composed by a combination of survey responses and the existing SamenGezond database. Although not all questions from the survey were used for the analysis, the full questionnaire can be found in appendix 4. The data from the questionnaire was then merged with the data on the amount of completed weekly goals and SES to create dataset 2. Dataset 2 contains 2209 observations, the filtering of the data can be found in appendix 3.

5.3 Analysis

5.3.1 Assumptions

To test the hypothesis mentioned in chapter 5 two models were built pertaining to dataset 1 (model 1) which entails 8966 observations and dataset 2 (model 2) which entails 2209 observations. R (version 4.1.3) was used to fit a generalized linear model (GLM) for both datasets. A GLM was used because the dependent variable runs between 0 and 12 and is skewed in both datasets. The data from dataset 1 is heavily positively skewed whilst the data from dataset 2 is negatively skewed (see figure A5.1 and A5.3 appendix 5). This opposition in skewness is caused by activity level of the participants included in the datasets: dataset 2 was filtered by people who completed at least 1 weekly goal, and thus are more active, whilst the data from dataset 1 also comprises inactive people who have not completed a single weekly goal. Therefore model 1 can be seen as a model including 'all users' and model 2 as a model including only 'active users'. Because of this skewness a GLM model with Poisson distribution was used to analyse the results. Tests on the assumptions of the models can be found in appendix 5.

5.3.2 Model 1

Model 1 focuses on merely on hypothesis 2:

Hypothesis 2: Participants in the monthly + quarterly draw who received an email prompt obtain more weekly goals than participants in the monthly + quarterly draw who did not receive an email prompt.

The reason that model 1 only looked at hypothesis 2 is the fact that model 1 includes the data of a lot of people who do not even use the app, and they could therefore not even be aware of the fact that they can win a big prize at the end of the quarter. This could potentially cause an underestimation of the main effect and the interaction term of SES and condition. That is why model 1 was not suitable for analysing hypothesis 1a and 1b and since it does not have the information on self-control, also 1c. The reason that model 1 was suitable for the second hypothesis however is the fact that you especially want to trigger inactive users of the app by sending an email prompt. Since most profit can be made with inactive people, these are people that might benefit the most from this email prompt. Therefore, model 1 was best suited for testing hypothesis 2 only. This model took the amount of weekly goals as the dependent variable. The dependent variable was taken as a function the push-condition. Next to that it also controlled for age and gender. This model only looked at people who received an email prompt. Since only people in the long-term group received an email prompt this model has a total of 4373 useful observations out of 8966 who were originally in the dataset. Regarding hypothesis 2, the direct relationship between the dependent variable and the push variable was analysed to draw conclusions on hypothesis 2, the formula looks as follows:

$$\text{obtained weekly goals} = \beta 0 + \beta 1 \times \text{pushmail} + \beta 2 \times \text{age} + \beta 3 \times \text{gender}$$

5.3.3 Model 2

Model 2 focuses on hypothesis 1a, 1b and 1c:

Hypothesis 1a: Participants in the monthly + quarterly draw obtain more weekly goals than people in the monthly draw alone.

Hypothesis 1b: Compared to the participants with a high SES, participants with a low SES in the monthly + quarterly draw obtain more weekly goals than participants with a low SES in the monthly draw alone.

hypothesis 1c: Participants with low levels of self-control in the monthly + quarterly draw obtain more weekly goals than participants with low levels of self-control in the monthly draw alone.

The reason that model 2 looked at hypothesis 1a, 1b and 1c is because of the fact that model 1 includes inactive users whilst model 2 only incorporates active users of the SamenGezond app. Active users were partially defined as people who completed at least one weekly goal in 2023 (this requirement holds for both the long- and short-term group) and partially as people who have opened the information mail about the quarterly lottery (this requirement only holds for the long-term group). Therefore to measure the effect of the long-term lottery reward this group is more suitable. The dependent variable was taken as function of condition, SES, the interaction effect condition and SES, self-control and the interaction effect between condition and self-control and was also taken into account. Model 2 looked at the direct relationship between the dependent variable and condition and the interaction effect between condition and SES on the dependent variable to test hypothesis 1a and 1b. To test hypothesis 1c the interaction effect of condition and self-control on the amount of weekly goals completed was analysed. The direct influence of SES and self-control together with their interaction term on the dependent variable was also taken into account out of interest but are not used to draw conclusions on one of the hypotheses. To this model age and gender were added as control variables as well.

$$\text{obtained weekly goals} = \beta 0+\beta 1\times \text{Condition}+\beta 2\times \text{Condition}+\beta 3\times \text{ Selfcontrol } + \\ +\beta 4\times \text{Condition}\times \text{SES}+\beta 4\times \text{Condition } \times \text{Selfcontrol}+\beta 5\times \text{SES}\times \text{Selfcontrol}+ \beta 5\times \text{age}+\beta 6\times \text{gender}$$

All outcomes were analysed using an alpha of 0.05. Tests on the assumptions can be found in appendix 5 whilst the models can be found in appendix 6.

6 Results

6.1 Descriptive results

This study looked at the hypotheses from two models. Model 1 is based on dataset 1 which includes a total of 8966 observations and looked at hypothesis 2 whilst model 2 is based on dataset 2 which includes a total of 2209 observations and looked at hypothesis 1a, 1b and 1c. See appendix 2 and 3 to find out how the data was filtered. Table 6.1 shows the descriptive results from both datasets of all characteristics. All observations from the second dataset are also represented in the first dataset. Because dataset 2 only has active users, the amount of obtained weekly goals was on average 2.55 higher than in dataset 1. Next to that the adjusted version of the brief self-control scale by Tangney et al. (2004) was tested for reliability using Cronbach's alpha. The results of this test was a score of 0.74 which is higher than the cut-off of 0.7 (Tavakol & Dennick, 2011) therefore the conclusion is that the measure can be considered as reliable.

TABLE 6.1. DESCRIPTIVE RESULTS

Characteristic	Dataset 1: All users (N = 8966)	Dataset 2: Active users (N = 2209)
Age, mean (SD)	55.0 (13.7)	56.8 (12.8)
Gender, observations (%)		
- Male (0)	2741 (30.6)	790 (35.8)
- Female (1)	6215 (69.3)	1419 (64.2)
- 'I'd rather not say' (2)	10 (0.1)	
Condition, observations (%)		
- Short-term group (0)	4442 (49.5)	1056 (47.8)
- Long-term group (1)	4524 (50.5)	1153 (52.2)
SES group, observations (%)		
- Low (0)	2862 (31.9)	808 (36.6)
- High (1)	6104 (68.1)	1401 (63.4)
Condition:SES, observations (%)		
- Short:low (0:0)	1421 (15.8)	381 (17.2)
- Short:high (0:1)	3021 (33.7)	675 (30.6)
- Long:low (1:0)	1441 (16.1)	427 (19.3)
- Long:high (1:1)	3083 (34.4)	726 (32.9)
Self-control, mean (SD)		3.71 (0.63)
Pushmail, observations (%)	(N = 4373)	
- Control (0)	2203 (50.4)	
- Test (1)	2170 (49.6)	
Completed weekly goals, mean (SD)	6.12 (4.67)	8.67 (3.59)

Table 6.1: Characteristics of the samples.

6.2 Differences between the datasets

Table 6.2 provides an overview of the average amount of completed weekly goals per dataset

TABLE 6.2. AVERAGES OF COMPLETED WEEKLY GOALS PER GROUP

Group	Dataset 1: All users (N = 8966)	Dataset 2: Active users (N = 2209)
Condition, mean (SD)		
- Short-term (0)	6.08 (4.68)	8.40 (3.67)
- Long-term (1)	6.14 (4.66)	8.92 (3.49)
SES group, mean (SD)		
- Low (0)	6.15 (4.66)	9.01 (3.51)
- High (1)	6.09 (4.68)	8.48 (3.62)
Condition:SES, mean (SD)		
- Short:low (0:0)	6.09 (4.68)	8.44 (3.70)
- Short:high (0:1)	6.08 (4.68)	8.38 (3.66)
- Long:low (1:0)	6.20 (4.64)	9.52 (3.26)
- Long:high (1:1)	6.11 (4.67)	8.57 (3.57)
Pushmail, mean (SD)		
- Control (0)	6.33 (4.60)	
- Test (1)	6.32 (4.63)	
- NA	5.90 (4.72)	

Table 6.2: average and standard deviation of completed weekly goals per group, where short:low is short-term group and low SES; short:high is short-term group and high SES; long:low is long-term group and low SES; long:high is long-term group and high SES.

As shown in table 6.2, it is visible that on average people in the long-term group completed more weekly goals than the people in the short-term group in both datasets. Similarly, people in the lower socioeconomic classes obtained more weekly goals than people in the higher economic classes on average, this holds in both the long-term and short-term group and in both datasets as well. However, this table also shows that people in the long-term group who received a push mail in week 7 did not obtain more weekly goals on average than people who did not receive a push mail. Figure 6.1 graphically shows the differences between the two datasets and the different groups. From this figure it is clearly visible that the active users overall obtained more weekly goals and that the differences between the groups is bigger than the differences are between the groups with all users.

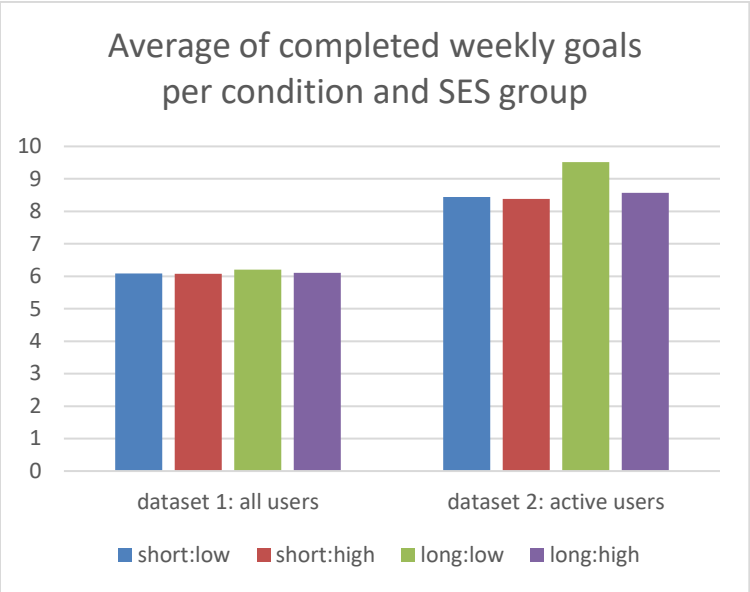

FIGURE 6.1: THE AVERAGE OF COMPLETED WEEKLY GOALS PER DATASET PER CONDITION AND SES GROUP

6.3 Hypothesis 1

Table 6.3 beneath gives an overview all the coefficients and whether or not they are significant for model 2. The coefficient of condition will be looked at to test the first hypothesis (1a): '*Participants in the monthly + quarterly draw obtain more weekly goals than people in the monthly draw alone.'* The model does find a slightly positive effect (coefficient of 0.070) for condition on the amount of weekly goals of obtained however this result is not significant. Therefore, hypothesis 1a is rejected.

Moving on to hypothesis 1b: '*Compared to the participants with a high SES, participants with a low SES in the monthly + quarterly draw obtain more weekly goals than participants with a low SES in the monthly draw alone.*' To test hypothesis 1b, the interaction coefficient of condition:SES was analysed. The model found a coefficient of -0.068 which is significant at a 95% confidence interval. This coefficient indicates that the effect of the treatment depends on the level of SES of the participant. Individuals with a lower SES are more sensitive to the condition, compared to individuals with a high SES, and therefore obtain significantly more weekly goals if they were in the long-term group than if they were to be on the short-term group. Figure 6.2 graphically shows the difference in sensitiveness towards the condition between the two SES groups and can be found below. Looking at figure 6.2 it is clearly noticeable that low SES individuals react much

stronger on the condition than high SES individuals. Low SES individuals who were in the long-term group obtained significantly more weekly than low SES individuals who were in the short-term group, therefore, hypothesis 1b is accepted.

TABLE 6.3. MODEL 2

Obtained weekly goals	Model 2: Active users (N=2209)
Variable name	Coefficient
Intercept	1.577***
Age	-0.000
Gender (dummy, 0 = male)	-0.110***
Condition (dummy, 0=short)	0.070
SES_num (dummy) (0 = low)	-0.021
Condition:SES_num	-0.068*
Self_control	0.169***
Condition:self_control	0.007
SES_num:self_control	0.002

Table 6.3: The effect of the independent variables on the amount of completed weekly goals. significance levels: '***' = 0, '**' = 0.01, '*' = 0.05

Lastly, looking at hypothesis 1c, '*Participants with low levels of self-control in the monthly + quarterly draw obtain more weekly goals than participants with low levels of self-control in the monthly draw alone.*', no significant coefficient for the interaction between condition and self-control was found. Self-reported self-control on itself is significant, with a coefficient of 0.169, when predicting the amount of weekly goals obtained but condition does significantly stimulate individuals with a lower self-reported self-control to obtain more weekly goals. Therefore hypothesis 1c is rejected. Furthermore, the only significant variable, with a coefficient of -0.110, that stands out is the fact males on average completed more weekly goals than females. A full table with all coefficients, standard errors and P-value's can found in appendix 6.

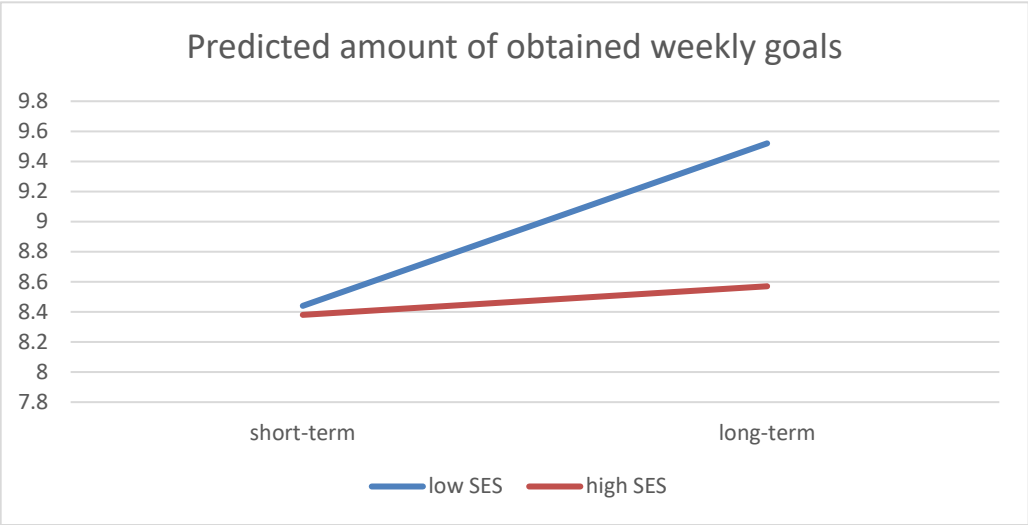

FIGURE 6.2: THE PREDICTED AMOUNT OF WEEKLY GOALS BASED ON CONDITION PER SES GROUP.

6.4 Hypothesis 2

Table 6.4 beneath gives an overview the results of model 1 and whether or not these are significant. This model consists of 4373 observations because only people in both the monthly and quarterly draw received an email prompt in the 7th week of 2023. To test hypothesis 2, '*Participants in the monthly + quarterly draw who received an email prompt obtain more weekly goals than participants in the monthly + quarterly draw who did not receive an email prompt.*', the coefficient of the push variable was analysed. Although slightly positive (0.002), hypothesis 2 is rejected because the coefficient is not significant.

TABLE 6.4. MODEL 1

Obtained weekly goals	Model 1: All users (N=4373)
Variable name	Coefficient
Intercept	1.382***
Age	0.009***
Gender (dummy, 0 = male)	-0.082***
Push_num	0.002

Table 6.4: The effect of the independent variables on the amount of completed weekly goals. significance levels: '***' = 0, '**' = 0.01, '*' = 0.05

7 Discussion and conclusions

7.1 Key findings

The main focus of this thesis was to answers the question whether or not providing a long-term lottery reward in addition to a short term lottery reward increases the physical activity of SamenGezond users. Next to that, in order to reduce health inequalities, SamenGezond especially wants to promote physical activity in lower SES groups. Therefore this thesis looked at an additional sub-question, namely: *'How does SES of SamenGezond users influence the effectiveness of lottery-rewards?'*. Regarding the main question of this thesis, a long-term lottery reward next to a short-term lottery rewards does not lead to significantly more obtained weekly goals. Fortunately, this thesis does find proof for the fact that lower SES groups are more sensitive to a long-term lottery reward next to a short-term lottery rewards compared to high SES groups. Lower SES individuals thus obtained significantly more weekly goals if they were in the long-term group than if they were to be in the short-term group. Thus indicating that lower SES individuals can be stimulated more with a long-term incentive next to a short-term incentive to obtain more weekly goals.

7.1.1 Hypothesis 1

The results on hypothesis 1a (*Participants in the monthly + quarterly draw obtain more weekly goals than people in the monthly draw alone.*) are not consistent with the results from earlier research by van der Swaluw et al. (2018) or Royer et al. (2015) demonstrating that a long-term lottery incentive can help avert the decline in goal attainment and create habits when it comes to promoting physical activity (Royer et al., 2015; van der Swaluw et al., 2018). The effect found was consistent with earlier research since individuals in the long-term group obtained more weekly goals in average than individuals in the short-term group, but this effect is not significant and it could therefore be a coincidence. A reason for this could the fact that my research did not have control group or baseline data to compare the effect of the short- and long-term lottery with whilst earlier research did have a control group. Another reason could be that earlier research worked with regret lotteries and this study did not have a loss aversion component. Since the

framing of incentives has been proven to be important this could be a reason why there were no significant results found. Lastly, long-term lotteries next to short-term lotteries have only proven to be effective for low SES individuals, as shown by the interaction effect between condition and SES in table 6.3. Since there are many more high SES individuals in the sample, namely 1404, than low SES individuals, namely 808, this could be a reason why the main effect cannot be detected. Further research should test if the main effect can be found using equal groups or groups that are more representative for society as a whole.

The results on hypothesis 1b (*Compared to the participants with a high SES, participants with a low SES in the monthly + quarterly draw obtain more weekly goals than participants with a low SES in the monthly draw alone.*) are consistent with the literature of Campos-Mercade (2021), Mantzari et al. (2015) and Oliver & Brown (2012). They stated that lower SES groups are more sensitive towards financial incentives which could lead to less health inequalities and thus obtain more weekly goals than individuals in higher SES groups (Campos-Mercade et al., 2021; Mantzari et al., 2015; Oliver & Brown, 2012). This is an interesting finding and the implications of this will be discussed later on.

The results on hypothesis 1c (*Participants with low levels of self-control in the monthly + quarterly draw obtain more weekly goals than participants with low levels of self-control in the monthly draw alone.*) are also not in line with the literature (Ashraf et al., 2006; Giné et al., 2010; Schwartz et al., 2014). Brocas et al. (2004) also showed that people with low levels of self-control can benefit from commitment devices therefore it was expected that an additional long-term long lottery next to a monthly lottery would increase physical activity among individuals with low levels of self-control (Brocas et al., 2004). Self-control in itself is significant when predicting the amount of weekly goals obtained but the results of the interaction with condition are not significant. Similar to hypothesis 1a, a reason for this could be the absence of a control group or the framing of the incentive.

7.1.2 Hypothesis 2

Hypothesis 2 (*Participants in the monthly + quarterly draw who received an email prompt obtain more weekly goals than participants in the monthly + quarterly draw who did not receive an email prompt.*) also did not yield significant results. This is contradicting previous literature by Agachi et

al. (2022) and Neff & Fry (2009) since they found positive effects of email prompts(Agachi, Bijmolt, van Ittersum, et al., 2022; Neff & Fry, 2009). This is an unfortunate result, else it would have indicated that people can be triggered to exercise more against very little costs. An explanation for this could be that sending out extra emails does not improve engagement because they are already more engaged with the application due to the information mail they got upfront. Further research could therefore focus on the sending out an email prompt to all users to investigate whether engagement increases significantly or not.

7.2 Implications

The key result of this study is that a long-term lottery reward next to a short-term lottery reward significantly increases physical activity in lower SES groups. This is an interesting finding because SamenGezond especially want to promote physical activity among lower SES groups in order to decrease health inequalities. Therefore this study is optimistic about implementing long-term lottery reward next to short-term lottery reward. These results can be used to design the incentive program more effectively and to better differentiate between different SES groups. However, currently it is the case that mainly individuals in a higher SES group make use of the SamenGezond app. In dataset including all users, 2862 individuals are have a low SES and 6104 individuals a high SES. This would imply that SamenGezond should promote their application more amongst lower SES groups in order to reduce the health inequalities between the groups more effectively.

In addition, SamenGezond may still decide to keep the long-term lottery next to their short-term lottery reward system. Although the difference between the short-term and long-term group is not significant, still the long-term group, on average, obtained more weekly goals in all SES groups. Of course this may be a coincidence, since the difference is not significant. However, due to fact that health inequalities are very persistent and exercising for only 11 minutes a day or 75 minutes a week can prevent one in ten deaths every extra minute a user exercises is beneficial, especially for individuals with a lower SES (Garcia et al., 2023).

7.3 Strengths

This study provides new insights on the working of short- and long-term lottery incentives. The major difference with previously conducted research is the real-world application of the incentives outside of a study setting, which also described as a limitation by Patel et al. (2016) (Patel et al., 2016). Particularly the larger samples (8966 observations in dataset 1, 2209 in dataset 2) compared to previous work with no more than 280 observations can be seen as an advantage. Next to that, the real-world setting makes it a bit more generalizable and takes away the experimenter bias. Furthermore, how SES influences the effectiveness of short- and long-term lotteries specifically has not been studied extensively yet. This thesis shows that there is a significant interaction effect between SES and the effectiveness of short- and long-term rewards.

7.4 Limitations and recommendations

This research is first of all limited by the fact that the results still are not fully generalizable. Although the experiment took place in a real world setting, there still is a selection bias in the sample. First off, people need to be willing to install the app themselves and can then decide whether they actively use it or not. Because users are not obliged to fill out details on their gender, age or postal code + housenumber, a lot of data was lost as well. Next to that, regarding dataset 2, only active users received the survey and then needed to be willing to fill in the survey. The difference in averages of completed weekly goals between dataset 1 and 2 (2.55 weekly goals) shows this selection bias pretty well. Future research could focus on more randomly choosing participants to make it more generalizable.

Secondly, this research did not have a control group or baseline data to which the short- and long-term incentive groups could be compared to. Therefore, I was unable to study whether either lottery incentive in this setting worked better in promoting physical activity than no incentive. This could be a reason why there were no significant results for hypothesis 1a, 1c and 2. It would therefore be interesting to repeat this experiment with baseline data or a control group.

Thirdly, this study made use ‘standard’ commitment lotteries as opposed to regret lotteries. Regret lotteries are known to be more powerful since losses hurt more than gains give pleasure

(Mitchell et al., 2020). This could also be one of the reasons why there were no significant results obtained. Future research might therefore focus on how SES influences the effectiveness of regret lotteries since this has not been studied extensively yet.

Finally, this experiment did not take place in a controlled environment allowing for greater external validity and thus generalizability. However, this is at the costs of the internal validity of the experiment. For example, one of the criteria for dataset 2 was the fact that someone opened the email about the quarterly lottery you can never be certain that someone actually read it attentively, hence you can never be sure if someone is aware that he/she can win big prizes at the end of the quarter. Another example is that people can decide to quit the program whenever they want which may confound the results. Future research might look at improving the internal validity of the experiment to see of the same results hold.

7.5 Conclusion

This study follows up on earlier research conducted by SamenGezond and tried to find out if long-term lottery rewards in addition to short-term lottery rewards increased physical activity among SamenGezond users. Additionally, it tried to find out how SES, self-reported self-control and email prompts influence the effectiveness of long-term lottery rewards next to short-term lottery rewards.

To conclude, having an additional long-term lottery next to short-term lottery significantly increases physical activity only for people in a lower SES in the SamenGezond app. Indicating that these people are more sensitive to rewards and thus complete more weekly goals when they are in the long-term group. Although no main effect was found, this is an important and useful finding since SamenGezond specifically want to promote physical activity among lower SES groups to reduce health inequalities. Individuals with lower levels of self-control do not complete significantly more weekly goals when they are long-term group compared to the short-term group. Lastly, sending out an email prompt to motivate the long-term group to obtain more weekly goals does not significantly enhance physical activity.

Nonetheless, this thesis recommends future implementation of long-term lottery incentives next to short-term incentives. Despite the fact that this reward system does not significantly

enhance physical activity it still contributes to more weekly goals obtained on average, and significantly more for individuals with a low SES. Since low SES groups benefit more from this long-term reward system, this could help in decreasing health inequalities. to achieve this, an important recommendation is that SamenGezond promotes their application more among lower SES groups.

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9 Appendix

9.1 Appendix 1: lottery prizes

TABLE A1: PRIZES PER DRAW

Maand	Prizes
January Valid tickets: tickets earned in week 2 to 5	1x jumbo gift voucher worth €445 15x Fresh'n rebel earplugs worth €39,95 100x hema gift voucher worth €10
February Valid tickets: tickets earned in week 6 to 9	1x decathlon gift voucher worth €445 15x Fresh'n rebel speaker worth €39,95 50x hema gift voucher worth €25 30x led bracelet
March Valid tickets: tickets earned in week 10 to 13	1x bol.com gift voucher worth €445 15x kettleball set worth €64,99 100x coolblue gift voucher worth €10
Quarterly lottery Valid tickets: tickets earned in week 2 to 13	1x bol.com gift voucher worth €745 5x coolblue gift voucher worth €445

Table A1: all prizes that you could win by completing weekly goals during the time of the experiment.

9.2 Appendix 2: preparing dataset 1

Firstly the dependent variable, named 'Gehaald2t13', was constructed by aggregating all completed weekly goals from participants. The data is retrieved from the SamenGezond app. The amount of completed weekly goals ranged between 0 and 12 and can take no decimal values, you either complete a weekly goal or not. This data was linked with the long-term and short-term group. The dummy variable 'Condition' was created and coded 0 for the short-term group and 1 for the long-term group. This led to a data frame consisting of 22.714 observations. This data frame was then merged with an existing dataset from SamenGezond containing information on gender, age and postal code + house number. Gender was coded 0 for male, 1 for female and 2 for 'zeg ik liever niet/i'd rather not say'. Age was calculated in R given the date of birth and the date at that time which, was 11-5-2023, and rounded down to the nearest whole number. This data was then merged with data from an existing database on social class. It was merged based on the postal code + house number in order to determine the social class. The social class is determined using the MOA Normvraagstelling 2020, this measure calculates social class based on someone's education and job and is connected to someone's postal code + house number. The

MOA Normvraagstelling distinguishes 5 categories of social class: A, B1, B2, C and D where A is the highest and D the lowest. In order to get large enough groups and detect significant differences these 5 categories were split up in two categories: High and Low. A and B1 were considered high social class and B2, C and D were considered low. A dummy variable named SES_num was created and coded 0 if low and 1 if high. Finally, half of the participants in the long-term group received a push mail in week 7. This email contained information about the amount of completed weekly goals so far and motivation to keep going in order to have more chances of winning prizes at the end of the quarter. This data was merged with the data on the completed weekly goals, condition and SES to create dataset 1. Lastly, any duplicated AccountId's were omitted and age was checked for people younger than 18 (since this is not allowed) and older than 100 (since it does not seem realistic) but no observations were found in that category. After merging all available data on gender, condition, age, SES and checking for duplicates a total of 8966 observations were left. Or in other words, 13.748 observations were lost because of missing information.

9.3 Appendix 3: preparing dataset 2

For preparing dataset 2, most of the steps taken for preparing dataset 1 were copied. This means that the dependent variable (the amount of completed weekly goals) was calculated in the same way and linked with the condition. In total 2405 people filled in the survey which indicates a response rate of 48.1% which was rather high. However, only 1360 people filled in their postal code + house number (correctly) therefore for the missing observations for the postal code + house number was supplemented with the data from the existing database. This data was then matched with the social class data again. Similar to dataset 1 two groups were made for SES, namely high and low, where A and B1 again were considered high and B2, C and D were low. A dummy variable for SES_num was created again and coded in the same way as dataset 1. Regarding self-reported self-control, the brief self-control scale by Tangney et al. (2004) was used at this is considered to be a reliable measure for self-reported self-control (Duckworth & Kern; Tangney et al. 2004). The questions from this scale were rewritten to be more related to exercising and a couple were omitted because they could not be transformed and had nothing to

do with self-control in relation to exercising. In total 9 questions were asked with respect to self-control. Respondents were asked to what extent a statement described him or her and the answers were divided in 5 categories, namely: totaal niet/not at all; enigszins/somewhat; min of meer/more or less; vrij goed/relatively well'; volledig/completely. These answers were then coded as follows: totaal niet/not at all = 1 up and until volledig/completely = 5, see appendix 4 too. Questions 1,4,6 and 8 related to self-control were positively framed and 2,3,5,7 and 9 were negatively framed and therefore reversed. A reliability test was conducted to test if the scale could still be considered reliable. Cronbach's alpha was 0.74 which is higher than the cut-off of 0.7 (Tavakol & Dennick, 2011) therefore the conclusion is that the measure can be considered as reliable. Lastly, age was checked for respondents younger than 18 and older than 100. One person was younger than 18 and one person was (way) older than 100 so these observations were omitted. Also duplicates and were checked and deleted which led to a total of 2209 observation for dataset 2, indicating that a total 196 observations were lost after cleaning the data.

9.4 Appendix 4: questionnaire

TABLE A4.1: QUESTIONNAIRE

Vraag/Question	Answer options	Used for analysis Yes/No	brief self-control scale question:
Ik krijg plezier en voldoening van bewegen	totaal niet (1); enigzins (2); min of meer (3); vrij goed (4); volledig (5)	No	
ik weet verleidingen om niet te gaan bewegen goed te weerstaan	1-5	Yes (self-control 1 (S_1))	I'm good at resisting temptation.
Over het algemeen beschouw ik mezelf als iemand die bereid is risico's te nemen	1-5	No	
Ik vind het moeilijk om mijn slechte beweegpatroon te doorbreken	1-5	Yes (S_2)	I have a hard time breaking bad habits.
Ik ben te lui om regelmatig te bewegen	1-5	Yes (S_3)	I am lazy

Ik weiger dingen te doen die slecht zijn voor mijn gezondheid	1-5	Yes (S_4)	I refuse things that are bad me.
Ik beschouw mezelf als iemand die risico's neemt	1-5	No	
Ik wou dat ik meer discipline had om te bewegen	1-5	Yes (S_5)	I wish I had more self-discipline.
Ik houd mij goed aan mijn voorgenomen beweegschema	1-5	Yes (S_6)	People would say that I have iron self-discipline
Andere leuke dingen zorgen ervoor dat ik niet toekom aan bewegen	1-5	Yes (S_7)	Pleasure and fun sometimes keep me from getting work done.
Ik stel doelen voor mezelf om actief te blijven en ik kan hier effectief naar toewerken	1-5	Yes (S_8)	I am able to work effectively toward long-term goals.
Ik doe liever andere leuke dingen dan bewegen ook al zijn deze slecht voor me	1-5	Yes (S_9)	Sometimes I can not stop myself from doing something, even if I know it's wrong.
Ik beweeg omdat ik het leuk vind	1-5	No	
Een knuppel en een bal kosten in totaal 1,10 euro. de knuppel kost 1,00 meer dan de bal. hoeveel cent kost de bal?	Open	No	
als het 5 machines 5 minuten kost om 5 widgets te maken, hoe lang zou het dan duren om met 100 machines 100 widgets te maken?	Open	No	
Op een meer is er een stukje bedekt met waterlelies. Elke dag verdubbelt het stukje in omvang. Als het 48 dagen duurt voordat het hele meer bedekt is met waterlelies, hoeveel dagen zou het dan duren om de helft van het meer te bedekken?	Open	No	
Wat is je leeftijd	Open	Yes	
Wat is je geslacht?	Man (0); vrouw (1), zeg ik liever niet (2)	Yes	
Wat is je postcode?	Open	Yes	
Wat is je huisnummer	Open	Yes	
Wat is je gewicht?	Open	No	

Wat is je lengte in centimeters?	Open	No	
Tot slot, welk rapportcijfer geef je je gezondheid op dit moment?	Open	No	

Table A3.1: all questions from the survey and whether or not they have used in the analysis and on which questions from the brief self-control scale they were based.

9.5 Appendix 5: analysis

The amount of completed weekly goals was the dependent variable which could range between 0 and 12. It's a binary variable in the sense that you either complete your weekly goal (1) or not (0) so no decimal numbers can be found in this variable. Looking at figure A5.1 learns us that the data from all users of the SamenGezond app (N = 22.714) is not normally distributed but is heavily positively skewed. The simple explanation for this is that there are a lot of inactive users who do not use the app at all and therefore do not complete a single weekly goal.

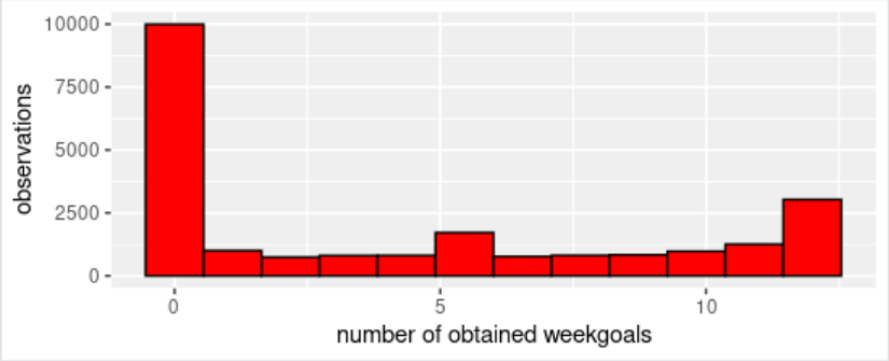

FIGURE A5.1. HISTOGRAM OF THE AMOUNT OF OBTAINED WEEKLY GOALS OF ALL USERS OF THE SAMENGEZOND APP

After merging this data with the existing databases on gender, age, SES and push mail it is clearly visible in figure A5.2 that the data is not as positively skewed anymore as it was before. The reason for this could be that people who are willing to fill in their age, gender and postal code + house number feel more engaged with the app and therefore are more active. However, the data is still not normally distributed but rather skewed on both sides, so a lot of inactive people still do not complete a single weekly goal, but also a lot of active people who complete all weekly goals. Since merging the SamenGezond app data with the additional data on gender, age and SES is important

for analysing the hypotheses this data will be used in the analysis, leaving 8966 observations out of the 22.714 observations there were before.

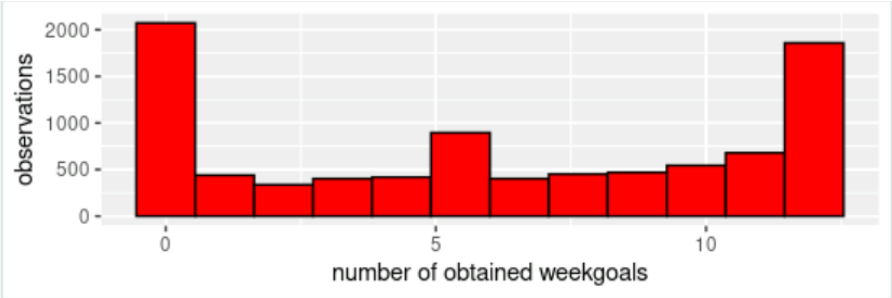

FIGURE A5.2. DISTRIBUTION OF THE AMOUNT OF COMPLETED WEEKLY GOALS FROM DATASET 1

When looking at the data distribution of the dataset 2 in figure A5.3 it is visible that the data is negatively skewed. This is due to the fact that the data from the SamenGezond app here is merged with the survey data. The survey was only sent out to people who opened the information mail about being in the quarterly lottery in order to be sure that they at least knew they could win prizes at the end of the quarter and to people who had completed at least one weekly goal in 2023. This also explains why the data is so heavily left-skewed since only active users received the questionnaire, creating a selection bias of active people who thus complete more weekly goals.

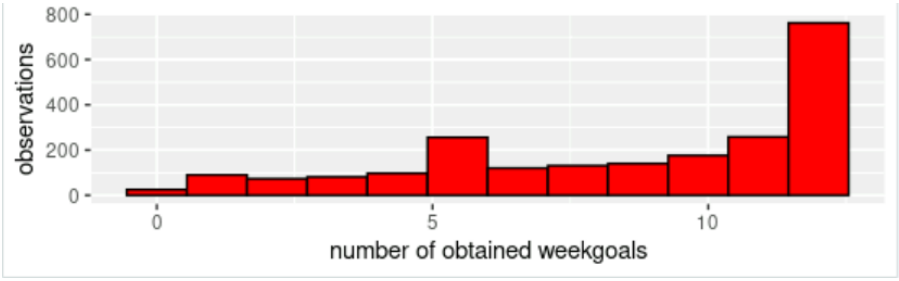

FIGURE A5.3. DISTRIBUTION OF THE AMOUNT OF COMPLETED WEEKLY GOALS FROM DATASET 2

After visually inspecting the data some tests were conducted on the assumptions of a linear model. Model 1 is based on dataset 1. This model takes the amount of weekly goals as the dependent variable. The dependent variable is taken as a function of pushmail. Next to that it also controls for age and gender. Firstly, I ran a Breusch-Pagan test to test for homoscedasticity, the p-value of the test came back as 0.425 which is larger than 0.05 therefore confirming homoscedasticity. A Shapiro-Wilk test on the normality of the dataset came back as P=0.000

indicating that residuals are not normally distributed. This makes sense because there are a lot of binary variables in the regression. Model 2 is based on dataset 2. The dependent variable is again taken as function condition, SES, the interaction effect condition and SES but now self-control and the interaction effect between condition and self-control is also taken into account. Similarly, I ran tests on homoscedasticity again but this time the p-value came as 0.000 therefore rejecting the hypothesis of homoscedasticity and confirming heteroscedasticity. Again the assumption of normality is violated with a p-value of 0.000. These violations can be solved for using a GLM model with Poisson distribution. Thus, After running the tests and visually inspecting the data a GLM model with Poisson distribution fits the data best. When running model 1, the 10 observations where gender is category 2 'zeg ik liever/i'd rather not say' are omitted to draw better conclusions on the effect of gender on the dependent variable. Leaving out these observations does not change the model significantly.

9.6 Appendix 6: results

TABLE A6.1: MODEL 1

Variable Name	Model 1		
	Coeff.	Std. Err.	P(>|z|)
Intercept	1.263	0.024	0.000 ***
Age	0.011	0.000	0.000***
Gender (Dummy) (0 = male, 1 = female)	-0.091	0.009	0.000***
Push_num	0.002	0.012	0.841

Table A6.1: the effect of the pushmail variable on the amount of completed weekly goals. Both models are a GLM with Poisson distribution. Significance levels '***' = 0, '**' = 0.01, '*' = 0.05

TABLE A6.2: MODEL 2

Variable Name	Model 2		
	Coeff.	Std. Err.	P(>|z|)
Intercept	1.577	0.094	0.000***
Condition (Dummy) (0=short-term, 1 = long-term)	0.070	0.091	0.442
SES_num (Dummy) (0 = low, 1 = high)	-0.021	0.094	0.820
Age	-0.000	0.000	0.957
Gender (Dummy) (0 = male, 1 = female)	-0.110	0.015	0.000***
Condition:SES_num	-0.068	0.030	0.022*
Self_control	0.169	0.023	0.000***
Condition:self_control	0.007	0.023	0.766
SES_num:self_control	0.002	0.024	0.921

Table A6.2: the effect of all independent variables on the amount of completed weekly goals. Both models are a GLM with Poisson distribution. Significance levels '***' = 0, '**' = 0.01, '*' = 0.05

For both models first a normal GLM model was run, but visually looking at the data and testing the assumptions learned that a GLM model with Poisson distribution fits better. Both models, with and without Poisson distribution, have been tested on goodness of fit and no significant differences were found.