Boundaries and facilitating factors of the inhibitory spill-over effect

Master Thesis

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Abstract

This thesis contributes to the existing literature on self-control by investigating the inhibitory spill-over effect. This effect predicts that engaging in one intentional act of inhibition control, makes the execution of additional, simultaneous acts of self-control easier. In addition to that, potential boundaries of the effect as well as facilitating conditions were analysed by introducing an appetizing stimulus and examining whether differences in the inhibitory spill-over between participants were depending on trait self-control measured by participants' score on a self-control index. The data for this analysis was obtained through a field experiment conducted in Austria, the design of which was based on previous research on self-control. The results of this study do not indicate a significant effect of the deliberate act of self-control on other self-control tasks and therefore no further evidence of the inhibitory spill-over effect is found. Moreover, the addition of a tempting stimulus does not cause a significant change in individuals' self-control. Also, there are no significant differences in the sensitivity to the spill-over between people of high-self-control and low self-control.

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1. Introduction

Every day, people face numerous choices between giving in to short term pleasures or pursuing their long-term goals such as immediately spending or saving money for future purposes (Baumeister, Vohs & Tice, 2007; Tuk, Trampe & Warlop, 2011). Self-control is the ability to ignore impulses to pursue immediate gratification and therefore facilitates behaviour in line with one's principles and long-term plans (Baumeister et al., 2007; Tuk, Zhang & Sweldens, 2015).

There are different theories about the determinants of successful self-control in the prevailing literature. For instance, links between individuals' levels of executive functions, which are cognitive processes that are necessary for cognitive control over behaviour, and self-control ability have been established (Hofmann, Schmeichel & Baddeley, 2012; Schmeichel, Volokhov & Demaree, 2008). A collection of research describes how the suppression of unrelated impulses such as the consumption of unhealthy food or display of impulsive emotions originates from the same regions in the brain. In other words, this would imply the existence of a general neural system for self-control (Berkman, Burklund & Lieberman, 2009; Muraven & Baumeister, 2000; Tuk et al., 2015; Tuk et al., 2011).

There are two streams of literature discussing the implications of such a general system of self-control for self-control performance. The first and most prevalent theory analyses self-control performance in sequential tasks that require self-control. The typical finding is a decrease in self-control performance in the later tasks. This decline in self-control ability is a state called ego depletion (Baumeister, 2014; Inzlicht & Schmeichel, 2012) and has been found to be highly relevant in the determination of prosocial behaviour in the context of social preferences (Achtziger, Alós-Ferrer & Wagner, 2018; Achtziger, Alós-Ferrer & Wagner, 2016; Halali, Bereby-Meyer & Ockenfels, 2013). Within this framework, there are two main models that state the following as reasons for ego depletion. Firstly, the 'strength model' or 'resource model' of self-control describes a general resource for self-control within individuals which is consumed by different acts of self-discipline and therefore deteriorates with an increase in usage. This theory claims that individuals are unable to exert self-control when the resource for self-control is used up (Baumeister & Heatherton, 1996; Muraven & Baumeister, 2000; Baumeister et al., 2007). However, other researchers raise doubt about the consistency of this theory. For instance, it was illustrated that this state of being unable to exercise self-discipline can easily be overcome with motivation brought about by incentives as well as induced beliefs about 'unlimited willpower', which if an actual resource was completely diminished, would not be possible (Job, Dweck & Walton, 2010). Also, the missing proof of the manifestation of this resource lead to the development of a second model (Inzlicht & Schmeichel, 2012).

This model, which is called process model explains how individuals strive for balance between 'exploration and exploitation' of impulses also referred to as 'have to' and 'want to' tasks. To achieve this balance, their priorities continuously shift between these two types of behaviour. The first type, the 'want to' tasks allow people to act more impulsively and focus on immediate gratification. On the other

hand, the 'have to' tasks entail behaviour which is characterized by the inhibition of impulses for immediate gratification and a focus on longer term goals such as completing tasks for one's employer (Inzlicht, Schmeichel, & Macrae, 2014; Inzlicht & Schmeichel, 2012; Tuk et al., 2015). In their line of research, Tuk et al. (2015) state that the successful execution of such a 'have to' task requires individuals to be capable of ignoring not only one but a number of different impulses at the same time. As an example, they describe the completion of an assignment at work. To do so, individuals cannot allow themselves to get distracted by a number of different, more pleasurable activities such as engaging with co-workers, emotions or thoughts regarding one's private life. The research of Tuk et al. (2011) and Tuk et al. (2015) provides evidence for individuals' capability to inhibit multiple impulses at the same time. The authors also illustrate how inhibiting one impulse deliberately, can facilitate the inhibition of additional impulses that might interfere with individuals' focus. For instance, when participants in one of their studies had to control their bladder during the experiment, they performed better in terms of their self-control performance in other, contemporaneous tasks. One example of such a task are intertemporal choice questions, in which participants of the study have to state their preferences between a smaller sooner reward and a larger reward for which they had to wait longer (Tuk et al., 2011).

Intertemporal choice questions are a popular measure of self-control, as self-control is the main determinant of individuals' preferences in this matter. In this context, a lack of self-control can be explained with the 'present bias', which describes how people give a higher weight to positive outcomes that are in the near future and therefore prefer rewards sooner rather than later (Thaler & Shefrin, 1981; O'Donoghue & Rabin, 1999). Such preferences for immediate rewards as these can have harmful consequences for individuals and their welfare. In fact, many issues characterizing today's society such as high levels of personal debt due to a lack of savings and insurance, drug abuse or obesity have their roots in a lack of self-control (Baumeister & Heatherton, 1996; Inzlicht & Schmeichel, 2012; Tangney, Baumeister & Boone, 2004). Gathergood (2012) analyses the role of self-control problems as a determinant of excessive personal debt and finds it to be even more important than 'financial illiteracy' of individuals. In addition to the accumulation of excessive debt, his results show how people with low self-discipline are more prone to impulsive purchases, as well as the adoption of financial products that provide them with funds quickly but are often costly to repay. These problems highlight the importance of the issue of a lack of self-control for society (Thaler & Shefrin, 1981; O'Donoghue & Rabin, 1999). Despite the growing use of pre-commitment devices such as insurance and savings plans with the aim to aid individuals with their self-control problems (Thaler & Shefrin, 1981), people still seem to struggle which among other things is shown by high debt levels (Gathergood, 2012). The existence of a positive spill-over effect of inhibitory impulses as described before could support people in successfully creating conditions that facilitate self-control behaviour (Tuk et al., 2011), which can help them to make better decisions and increase their own overall welfare, when faced with choices regarding the conflict between instantaneous satisfaction and the pursuit of long-term goals (De Ridder, Lensvelt-Mulders, Finkenauer, Stok & Baumeister, 2012) such as savings or consumption (Thaler & Shefrin, 1981;

O'Donoghue & Rabin, 1999). In addition to areas regarding finance, in their analysis, Tangney et al. (2004) demonstrate how advanced self-control strength is an important factor in determining individuals' overall success in life. Hence, the understanding of the determinants of this trait is of high importance for individuals.

Despite the practical implications of comprehending the concept of self-control further, in the existing literature, there is no consensus on the underlying processes that determine self-control strength. An extensive amount of research has been devoted to the resource model. Still, this model does not prove to be consistent under the conditions explained above. Comparatively few studies have explored alternative explanations such as the inhibitory spill-over effect. In the context of their meta-analysis of this effect in the course of nine studies, Tuk, et al. (2015) encourage further research to investigate the inhibitory spill-over and conditions that might affect its strength. This thesis aims to further contribute to the understanding of the underlying processes determining successful self-control by further examining the existence and robustness of the inhibitory spill-over effect and therefore contribute to filling the gaps of existing theories. Consequently, the following research questions were formulated:

"How does simultaneous execution of self-control affect self-control performance?"

"How do external factors affect the strength of the inhibitory spill-over effect?"

To further investigate these research questions, first, in Section 2 a literature review regarding different conditions affecting self-control strength is presented. Moreover, in this section, the hypotheses which are based on the findings in the literature, are described. To test the hypotheses, an experiment was conducted. A further description of the experiment and the methodology and data of this research is provided in Section 3 and 4. Section 5 will discuss the results obtained. Finally, there will be a discussion including limitations as well as concluding remarks about the results obtained in this thesis and recommendations for further research.

2. Literature Review

According to Baumeister and Heatherton (1996), successful self-control depends on three factors. A person's goals, his or her ability to monitor behaviour and whether it is in line with one's goals and the power to disregard responses to tempting stimuli that are in conflict with one's long-term plans (Baumeister & Heatherton, 1996; Gailliot et al., 2007). This thesis will focus on factors determining the third point, individuals' ability to ignore tempting, distracting impulses. Therefore, in the course of this thesis the terms inhibition control and self-control will be used interchangeably.

One example of inhibition control can be the inhibition of an impulsive emotion in a situation where the opposite could hurt one in the long run. Other examples would be for dieters to neglect the temptation to consume unhealthy food despite cravings, or the ability in general to wait for later, higher rewards instead of engaging in immediate consumption in choices referred to as intertemporal choices (Baumeister & Heatherton, 1996; Thaler & Shefrin, 1981). Whether or not someone is able to exert such behaviour can affect personal health, savings and debt levels and is therefore an important factor determining individuals' welfare and life accomplishments (Tangney et al., 2004; Thaler & Shefrin, 1981) and is of high importance for society (Baumeister & Heatherton, 1996). Hence, it is crucial to comprehend the dynamics contributing to individuals' self-control performance (Baumeister & Heatherton, 1996). Thus, this thesis will focus on the underlying processes determining successful inhibition of temptations. This section will provide an overview of the existing literature on self-control and its dynamics with a focus on a setting in which individuals complete multiple self-control tasks in a short time frame. This is a situation which corresponds closely to the circumstances human-beings find themselves in every-day life and can therefore be considered to be of high relevance (Tuk et al., 2015). Thus, the relevant findings of the two key streams of literature on self-control discussing the consequences of the exercise of consecutive and contemporaneous acts of self-control respectively will be reviewed. The exercise of multiple self-control acts at the same time is said to cause a phenomenon called the inhibitory spill-over effect which is the main focus of this research. Hence, this effect and different factors that are discussed in the current literature which might affect the strength or robustness of it will also be presented and their connection to the effect will be analysed. On the basis of this discussion, the hypotheses which will be tested in the course of this thesis will be formulated.

2.1 Self-control as a universal ability

In the prevailing literature, the existence of specific areas in the brain dedicated to the execution of all acts of self-control is considered. This implies that the same regions in the brain are involved in all actions requiring the suppression of impulses ranging from ignoring distractions while studying, to the inhibition of unwanted emotions (Berkman et al., 2009; Lieberman, 2003). A number of studies provide evidence for this theory. Observing the neurological activity during self-control behaviour, the activation of the right inferior frontal cortex, the anterior cingulate cortex and the dorsolateral prefrontal cortex was repeatedly observed while participants were realizing the need for as well as exercising self-

control (Mitchell et al., 2007; Berkman et al., 2009). The observations concerning the repeated activation of these particular areas represent primary evidence for a general neural system for inhibition control. Further support for this theory is provided by research on participants suffering from brain damage due to the abuse of drugs such as methamphetamine. These individuals developed deficiencies in seemingly unrelated behaviours such over-displaying impulsive emotional behaviour (Payer et al. 2008) and a decreased performance on the Stroop task[1] (Salo et al., 2002). These defects imply a role of the damaged areas in inhibition control (Payer et al., 2008; Salo et al., 2002). The findings about the existence of a general neural system of self-control can have various implications for self-control strength concerning its training and failure and provide the basis for most of the theories below (Tuk et al., 2011)

2.2 Ego depletion

The idea of a general neural system for all kinds of self-control lead to the development of two main theories. The first one states that multiple consecutive acts of self-control, will cause individuals to react more impulsively with every additional act of self-control. This decrease in self-control ability is called ego depletion (Baumeister & Heatherthon, 1996; Inzlicht & Schmeichel, 2012). This is a state of mind highly relevant in human behaviour in the field of social preferences (Achtziger et al., 2018). This connection and the two central models analysing ego depletion will be discussed in this subsection.

2.2.1 Resource model

The first and most prominent model in the literature to explore the dynamics behind self-control and ego depletion is the 'resource model' or 'strength model' (Inzlicht & Schmeichel, 2012; Tuk et al., 2015). This theory examines the effect of exercising multiple actions that require self-control on an individual's self-control ability. According to this model, all activities requiring self-control use a central resource to do so. Hence, if one engages in more than one self-control task, self-control performance will decrease with every additional act of self-control. (Baumeister & Heatherton, 1996; Baumeister et al., 2007). For this effect to occur, the acts of self-control do not have to be related or similar to have this effect. For instance, a study showed that participants who had to withstand the temptation of cookies, left another subsequent effortful task earlier than those who did not. Moreover, in another study, participants who had to inhibit their emotions during an emotional movie, showed worse results in a following Stroop test (Muraven, Tice & Baumeister, 1998; Baumeister, Bratslavsky, Muraven, & Tice, 1998). Even though most of the experiments focus on the consequences of sequential

[1]The Stroop task is a test designed to assess individuals' levels of executive functioning such as individuals' ability to successfully inhibit impulsive reactions to stimuli and focus attention on long-term goals. During this task, individuals face names of colors displayed in another color than the name. To successfully complete the task, individuals then have to suppress their initial impulse to read the name of the color and state this as an answer but answer the color the word is written in instead, which represents a much more effortful task and required executive functions (Egner & Hirsch, 2005; Stroop, 1935).

actions of self-control, the prediction of this model for simultaneous acts of self-control is the same, as they also require the use of the same resource, which is the cause for ego depletion where participants fail to regulate their reactions to temptations (Baumeister & Heatherton, 1996).

The main support for this idea of self-control being a central resource is coming from Gailliot et al. (2007) who frame glucose levels as the underlying resource of self-control performance. The authors show how after acts requiring self-control, human-beings exhibit low levels of glucose in their blood. Still, the finding that inhibiting impulses substantially declines blood glucose levels could not be reproduced, which casts some doubt on glucose representing the central resource of self-control (Inzlicht & Schmeichel, 2012).

In addition to this, other findings cast doubt on the strength model. These findings show how ego depletion can be overcome and therefore would not be possible, if self-control was an actual resource which could become fully depleted (Inzlicht et al., 2014). One of the factors able to counteract ego depletion is motivation. Enhancing people's motivation for the task by changing their beliefs about their own capabilities of self-control towards being limitless or inducing self-affirmation results in participants being less susceptible to ego depletion (Job et al., 2010). Masicampo, Martin and Anderson (2014) investigate the role of incentives as measures against ego depletion and find that the introduction of an incentive for the exercise of self-control behaviour itself has counteracting effects on ego depletion. Moreover, participants who received an incentive in the form of a pleasurable activity in-between tasks such as smoking a cigarette for smokers or the viewing of a funny video were less affected by ego depletion. Furthermore, changing people's perception about self-control tasks away from an effortful towards a more automated task can have the same effect as the examples above (Laran & Janiszewski, 2010; Masicampo, Martin & Anderson, 2014).

2.2.2 Process model

Besides the attempt of Gailliot et al. (2007) to confirm the existence of an actual resource of self-control, there is no further evidence of its existence. The assumption is based mainly on the observation of ego depletion in consecutive self-control tasks. Due to the missing proof and the findings on how to overcome a state in which the central resource for self-control is said to be fully depleted, another model advanced. Instead of a limited resource this model describes motivation, attention and a trade-off between two conflicting goals – the desire for 'exploration' and 'exploitation' of impulses - as the drivers of depletion (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014). Human-beings seek to reach a balance between the two goals which can either be obtained through behaviour that allows an immediate reward and is therefore driven by intrinsic motivation also referred to as 'want to' tasks or behaviour that is driven by an external incentive once completed called 'have to'-task (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014).

This need for balance causes a trade-off between exercising each of these behaviours. The process model discusses the fundamental processes that cause a shift of preferences between either of these behaviours that is also viewed as the reason for occasional self-control problems. As such the authors explain how individuals continuously compare the benefits of both acting on or inhibiting the tempting impulse. They view this trade-off as a decision between engaging in an activity that requires cognitive effort or allowing the cognitive control system to relax. Research has shown how the act of cognitive control has a negative utility for human-beings. Hence, a compensation is needed to maintain it and prevent a shift towards mental relaxation. (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014).

Contrary to the resource model, which states that at a certain point individuals are unable to exert self-control, this model assumes that they are unwilling to do so (Inzlicht & Schmeichel, 2012). What drives individuals to this state are two main, interdependent processes. First, it is a shift in the focus of their motivation for inhibition control tasks meaning that after exercising self-control for a while, rewarding stimuli become more salient while 'have to' tasks decrease in salience (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014). Also, the role of motivation is highlighted by the fact that when individuals are motivated, the usually exhibit no or little depletion effects (Vohs, Baumeister & Schmeichel, 2012). The other determining process is a shift in attention. As mentioned in the introduction, the monitoring of goals, current behaviour and detection of whether there is a conflict between the two is a central part of self-control (Baumeister & Heatherton, 1996). Individuals who previously exerted self-control show less brain activity in the areas responsible for this conflict monitoring which suggests that when presented with two options, no conflict and therefore no need for self-control is detected because of a lack of attention. In addition, to decreased attention towards whether or not self-discipline is necessary, attention in general shifts towards rewarding stimuli after effortful activities that require regulation of impulses (Inzlicht et al., 2014; Inzlicht & Schmeichel, 2012). For instance, in a study by Schmeichel, Harmon-Jones and Harmon-Jones (2010), participants who previously took part in a writing task in which they were not allowed to use words containing certain letters, perceived dollar signs, a sign connected to reward much more than those who did not (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014).

Overall, the process model describes individuals' need for balance between two contradicting goals which leads to a continuous shift in motivation and attention and therefore the occurrence of ego depletion.

2.2.3 Social preferences and ego depletion

Human behaviour is often portrayed as an interaction between impulsive and controlled processes (Alós-Ferrer & Strack, 2014). In a state of ego depletion, human-beings are expected to resort to more automated behaviour (Achtziger et al., 2018). This is especially relevant in the field of social preferences, where researchers are interested in proving whether individuals are altruistic in nature, meaning that they are willing to sacrifice part of their personal wealth or pay-off to help others or if this behaviour is more 'controlled' and requires them to exert cognitive effort. To evoke impulsive behaviour among individuals in such a context, inducing ego depletion among participants is the central element in their studies. In fact, ego depletion was found to be a crucial determinant in individuals' behaviour regarding altruistic behaviour. In most of the studies regarding this topic, ultimatum as well as dictator games[2] serve as measures to elicit social preferences (Achtziger et al., 2018; Achtziger et al., 2016; Halali et al., 2013).

Achtziger et al. (2016) and Halali et al. (2013) find that in a state of ego-depletion, people tend to offer more money to their partners in ultimatum games. To observe whether this is due to an increase in social preferences, the authors also conduct dictator games and find opposite behaviour. Individuals who complete prior tasks targeting their self-control tend to share less money. Also, Xu, Bègue and Bushman (2012) find this behaviour in dictator games. In addition to that, they tested whether subjects were willing to donate a share of the money they decided to keep to charity. Results of the study of Xu et al. (2012) showed how depleted individuals' charitable giving was much lower than those of non-depleted individuals. Due to the patterns observed in dictator games, both Achtziger et al. (2016) and Halali et al. (2013) state that the reason for the behaviour found in ultimatum games is 'fear of rejection'. This means that in a state of ego depletion individuals strongly desire to maximize their own pay-off and they want to eliminate possible risks that might keep them from doing so. One of these risks could be the reaction of their partner in case of an unfair allocation. Therefore, according to Achtziger et al. (2016) and Halali et al. (2013), individuals tend to increase the share of money they offer to their partners.

Still, the direction of the effect of ego depletion on behaviour in ultimatum games is inconsistent across studies. Contrary to the studies discussed before, Achtziger et al. (2018) find that instead of more individuals who previously had to exert self-control give away less money than those who did not in ultimatum games. In an attempt to explain these results, the authors compare this study with their previous one of 2016. According to the Achtziger et al. (2018), one potential explanation for these contradicting results, lies in the difference between samples of the studies. While their study in 2018 took place in Germany, their study in 2016 took place in Spain, a country which suffered more

[2]In these games subjects are paired and one of the individuals has to decide how to split an amount of money between him or herself and the other individual. While in the dictator game, the other individual has to accept this choice, in the ultimatum game he or she can reject the proposal of how to split the money. In the case of rejection, neither of the participants receives a pay-off (Bolton, Katok & Zwick, 1998; Nowak, Page & Sigmund, 2000).

extensively from the economic crisis. According to Achtziger et al. (2018), the different economic situations in the two countries are what might have caused the differences in impulsive behaviour, which highlights the importance of context when determining what the intuitive reaction is for individuals. However, the authors highlight that even though their research provides results of different directions, the studies show that a lack of self-control can significantly alter individuals' behaviour in the context of social preferences and is therefore of high importance in this field (Achtziger et al., 2018).

2.3 The inhibitory spill-over effect

Another, more recent stream of literature exploring the implications of the findings of Berkman et al. (2009) about a central neural system of self-control predicts that multiple acts of self-control will increase self-control ability (Tuk et al. 2011; Tuk et al., 2015).

2.3.1 General overview

According to the process model, in some cases exerting willpower for a substantial time can put a person into a specific mindset which can lead to a positive spill-over of this inhibitory activity to other, unrelated behaviour and therefore increasing self-control performance in that activity (Inzlicht & Schmeichel, 2012). The findings of Dewitte, Bruyneel and Geyskens (2000) bolstered this theory by demonstrating how and when individuals engage in similar consecutive acts of self-control, their inhibition control increases.

Recent literature is studying this effect in a different setting, between simultaneous tasks. Verbruggen, Adams and Chambers (2012) tested this effect in the context of gambling and show that participants who deliberately inhibit motor responses, take less risks in gambling, which the authors associate with increased self-control. Berkman et al. (2009) investigate this effect from a neurological perspective. Prior to their work, the neural activity related to self-control was only investigated separately for different kinds of self-control behaviour. However, most of these studies mention the activation of areas such as the right inferior frontal cortex and the anterior cingulate cortex in connection with self-control. This lead the authors to test whether a wilful recruitment of one of these areas can lead to unintentional inhibition of impulses in other areas. In their study, Berkman et al. (2009) illustrate how the wilful inhibition in a motor task can at the same time lead to inhibited emotional responses to triggering cues such as faces displaying negative emotions. The emotional response was measured by looking at the activity of the amygdala, which while motor responses were inhibited was much lower than during a state of no inhibition of motor responses as well as the baseline condition (Berkman et al., 2009).

Further investigating this effect, Tuk et al. (2011) test its implications on a behavioural level. As a proxy for the intentional inhibition of impulses the authors exposed participants in their studies to varying amount of bladder pressure. Being in this state is said to trigger the anterior cingulate cortex, which Berkman et al. (2009) mention as a part of the general inhibition system (Tuk et al., 2011). The

authors tested the effect of varying bladder pressure on participants' performance in a Stroop task as well as intertemporal choice making, both measures of self-control performance. They find evidence of an inhibitory spill-over between tasks. To further prove that the suppression of bladder pressure was the decisive factor, they exposed participants to different levels. Results reveal a positive relationship between self-control ability and increased bladder pressure. Participants were able to wait for their reward much more often in a state requiring high bladder control. Also, external stimuli relating to bladder pressure had a positive effect on the self-control measure, suggesting that this effect is not solely limited to the actual physical sensation (Tuk et al., 2011). Another study that investigated the effect of bladder pressure on the inhibition of impulses was conducted by Fenn, Blandón-Gitlin, Coons, Pineda, and Echon (2015). The authors find that inducing this state within participants enables them to lie in a more convincing way, meaning they inhibit indicators that they were currently deceiving the other person better than the control group. In other words, the level of inhibition control increased among the participants in the treatment group (Fenn et al., 2015).

The two previously described papers focus on a greatly automated act of intentional impulse regulation. Thus, Tuk et al. (2015) investigate whether this effect exists among more demanding tasks. In their meta-analysis of 18 studies, nine of which focus on sequential tasks while the other nine focus on simultaneous tasks, they find that deliberately regulating impulses in one area, increases inhibitory activity in other areas in the simultaneous tasks. The results of the sequential self-control behaviour studies provide evidence for ego depletion. Therefore, the authors emphasize on the importance of task timing. More than 1,000 participants coming from all over the world participated in their studies which were conducted both offline and online. To test for the inhibitory spill-over, different proxies for both the wilful and the incidental act of self-control are used. For instance, the authors employ 'attention control', 'thought control', 'cognitive impulse control', 'consumption control' and 'emotion control' to represent different wilful acts of inhibition control and to recruit the inhibition system. Intertemporal choices, the desire to and actual consumption of unhealthy snacks as well as performance on tasks such as a Stroop tasks are used as measures of incidental self-control performance in their research. For instance, in one study they show how resisting the impulse to show emotions during a very emotional short movie leads to a significantly lower consumption of chips (Tuk et al., 2015).

Aside from 'cognitive impulse control', all studies including different combinations of the variables mentioned before, indicate the existence of an inhibitory spill-over effect and the sizes of the effect do not differ significantly amongst studies**.** According to the authors, the different outcomes of the 'cognitive impulse control' tasks, are due to the fact that these tasks were targeting different parts of individuals' executive functions. While their intention was to create tasks that mainly trigger the inhibition element, these tasks are focused on 'working memory capacity' which when activated has shown to deteriorate self-control performance, also in simultaneous tasks (Tuk et al., 2015).

Other studies such as the one conducted by Hinson, Jameson and Whitney (2003) report the same outcome. When participants in their research had to try to remember a complicated number, their

share of impulsive decisions increased (Hinson et al., 2003). Hence, Tuk et al. (2015) emphasize that the inhibitory spill-over only works within the inhibition element of executive functions.

The paper of Tuk et al. (2015) provides further proof that the inhibitory spill-over effect exists for a variety of behaviours. Also, these findings encourage further questioning of the view of self-control as a limited resource, as instead of decreasing self-control ability increased with additional tasks. The evidence on the literature review provided above lead to the first hypothesis that will be investigated in the course of this thesis:

H1: Intentionally exercising self-control in one task will increase inhibition in another unrelated task.

2.3.2 The role the reward system

As recommendations for further research regarding the inhibitory spill-over effect, Tuk et al. (2015) mention a more in-depth investigation of this effect by examining its potential boundaries and facilitating factors.

One prominent way to analyse human behaviour, especially in terms of self-control, is from a 'dual systems' perspective. According to this approach, individuals' decision-making depends on the interaction of two systems (Alós-Ferrer & Strack, 2014). In his line of research, Lieberman (2003) implies the existence of both of these systems based on evidence from data derived from individuals' brain activity. In the existing literature, these systems are referred to as the 'hot' and 'cold' system (Loewenstein & O'Donoghue, 2005), 'reflective' and 'reflexive' (Lieberman, 2003) or 'automated' and 'controlled' (Schneider & Shiffrin, 1977) system. The 'controlled' one of the systems is characterized as disciplined, responsible for rational behaviour and concerned with long-term outcomes of decisions and the other is more of an impulsive, emotional nature whose focus is on present outcomes (Alós-Ferrer & Strack, 2014). In an attempt to explain their interaction, Evans (2006) describes how the region for rewards is always operating and reactive, while its opposite is only activated if an intervention is required. For example, in the case of a reaction of the impulsive system that could impair the achievement of one's long term goals, the system for discipline attempts to take over (Evans, 2006). Eventually the behaviour resulting from this interaction depends on the subjective weight of each system in the decision. This relative weight is subject to the influence and strength of internal as well as external factors (Alós-Ferrer & Strack, 2014). For instance, triggering the reward system through the use of tempting objects changes individuals' focus more towards the present and therefore shifts individuals' overall preferences towards sooner rewards (Inzlicht et al., 2014; Schmeichel & Inzlicht, 2012). In an attempt to provide evidence of the effect of this trigger on decision making, Van den Bergh, De Witte and Warlop (2008) demonstrate how sexual stimuli such as pictures of women in appealing clothes and poses deteriorated men's ability to wait for pay-offs in questions about their intertemporal preferences, a known measure of self-control. Additional support for the role of tempting stimuli and their influence on inhibition control in an unrelated area is found in the work of Li (2007). The author illustrates how exposure to such 'appetitive stimuli' encourages people to think more myopic regarding

intertemporal choice making and prefer impulsive behaviour in 'vice vs virtue situations' (Tuk et al., 2011; Tuk et al., 2015). The author defines such triggers as physiologically and psychologically satisfying such as the smell of cookies brought about by candles as well as pictures of desserts, which were used in her research. Nowadays, people constantly face numerous of tempting impulses contemporaneously (Tuk et al., 2015). Hence, it would be of interest to test whether the inhibitory spill-over effect, meaning an increase in the overall self-discipline in two simultaneous activities can survive in such an environment or whether this constitutes a limit to this effect.

Therefore, this thesis aims to conduct a similar study to the one of Li (2007) in the context of the inhibitory spill-over effect. It intends to test whether the effect found by both Li (2007) and Van den Bergh et al. (2008) persists or if the inhibitory spill-over effect is strong enough to overcome it. Due to its role in the success of self-control (Heatherton, & Wagner, 2011; Hofmann et al., 2012) and the findings of Li (2007) and Van den Bergh et al. (2008) within the framework of intertemporal choice, creating an environment with increased temptation is expected to decrease the magnitude of the inhibitory spill-over, which is reflected in Hypothesis 2.

H2: The introduction of an additional, tempting object requiring self-control will decrease the inhibitory spill-over effect.

2.3.3 The impact of different levels of self-control

Individuals are said to differ in their ability to exercise self-control (Tangney et al., 2004). To measure individual differences and levels in self-control ability in general, Tangney et al. (2004) developed a self-control scale. This scale is designed to test whether individuals' personality entails self-discipline as a general character trait. In addition to their scale Tangney et al. (2004) developed an abbreviated version, the 'Brief Self-Control Scale'. In their research the authors show how high scores on both scales are a predictor for a successful future life. People who obtained such a score were able to get better grades in school, sustain a healthier life-style, found it easier to get along with people and exhibited less antisocial behaviour.

Furthermore, individual differences in the results of this scale substantially affect people's ability regarding the regulation of impulses so that high levels of self-control are associated with a high ability to override tempting impulses. This pattern was tested in the context of overeating, saving money instead of spending it immediately and drug abuse (Tangney et al., 2004; Romal & Kaplan, 1995). Further proof for the predictive power of the self-control scale concerning impulse control was gathered by Malouf et al. (2014). They conducted a study among prisoners to examine the link between the 'Brief Self-Control Scale' and problematic, impulsive behaviour caused by a failure of self-control. According to their research results, a low score on the 'Brief Self-Control Scale' was able to predict future impulse control problems shown in behaviour such as drug abuse (Malouf et al., 2014).

Given the importance of individual differences in overall self-control ability for successful inhibition of impulses (Tangney et al., 2004), such differences are expected to be relevant determinants of the strength of the inhibitory spill-over effect in that participants of high self-control might be triggered more easily (Tuk et al., 2015). As part of their studies to investigate the inhibitory spill-over effect, Tuk et al. (2011) and Tuk et al. (2015) looked at individual differences in the sensitivity of the behavioural inhibition system also referred to as 'BIS-system' and whether high levels enhance the inhibitory spill-over effect. Participants had to complete questions determining their score on the BIS-scale. Results show a positive relationship between sensitivity of the 'BIS-system' and the inhibitory spill-over effect. Individuals with a sensitive inhibition system indicated by a high score, experienced the inhibitory spill-over even stronger which is demonstrated by increased preferences for later rewards in intertemporal choice questions (Tuk et al., 2011). Nevertheless, Tuk et al. (2015) were unable to replicate these results and therefore call for further investigation into individual characteristics that could affect the inhibitory spill-over effect.

As the responsiveness of the inhibition system is closely related to self-control ability (Shackman, McMenamin, Maxwell, Greischar, & Davidson, 2009), a similar direction of results is anticipated for this thesis, meaning that high scores on the 'Brief-Self-Control Scale' of Tangney et al. (2004) facilitate the inhibitory spill-over effect, which is summarized in Hypothesis 3. The expected effect of high self-control ability in the context of an additional stimulus is described in Hypothesis 4.

H3: Individuals of high self-control ability are expected to experience a higher inhibitory spill-over effect compared to those of lower self-control ability.

H4: The expected decrease in the inhibitory spill-over effect due to the tempting stimulus is smaller for people of high self-control ability.

3. Methodology

3.1 Participants

To address the research question and the underlying hypotheses, an experiment based on the research design of the studies conducted by Tuk et al. (2015) as well as Li (2007) was carried out.

The participants were recruited on the main square of Graz, Austria and invited to conduct the survey in an office nearby. In total, there were three conditions in this experiment, the control group and two treatments. Overall, 124 participants were recruited for the purpose of this thesis and were randomly assigned across the three groups to ensure a randomized as well as an equal allocation of all participants.

3.2 Experiment

As mentioned above, the experiment conducted for this study was based on previous research in the field such as the one of Tuk et al. (2015). The authors carried out a meta-analysis of several studies, in which they utilized different intentional self-control tasks and tested their spill-over effect on a number of activities. Most of the measures used to trigger the inhibitory spill-over effect in the studies of Tuk et al. (2015) had an equal impact on individuals' self-control ability. Therefore, it should not matter which one is adopted for this thesis. For the purpose of this thesis the 'attention control' task, which will be elaborated later in this section (Tuk et al., 2015) was chosen as the trigger of the inhibition system, while intertemporal choice questions were chosen as a measure of the spill-over effect. This particular measure was chosen, as it was also used in the studies regarding the impact of tempting stimuli on inhibition control which were the basis for the design of the second treatment referred to as 'Treatment Cookie'.

In the experiment, all participants were asked to fill out a questionnaire on the experimenter's personal computer consisting of two parts. The first one was measuring their intertemporal pay-off preferences (Tuk et al., 2011; Tuk et al., 2015). A collection of the questions is shown in Table 1. The order of questions was shuffled for every participant using the RAND() formula in Microsoft Excel to rule out order effects (McFarland, 1981).

Participants were informed that all of their choices were entered into a lottery which included all participants of the same day. By the end of the day, a winner and one of his choices was drawn and paid out. This means that participants had the actual chance to win one of the amounts of money they had chosen, which should have motivated them to consider their answers carefully enough. This form of 'random lottery incentive' was chosen, to incentivise participants to state their real preferences (Cubitt, Starmer & Sugden, 1998).

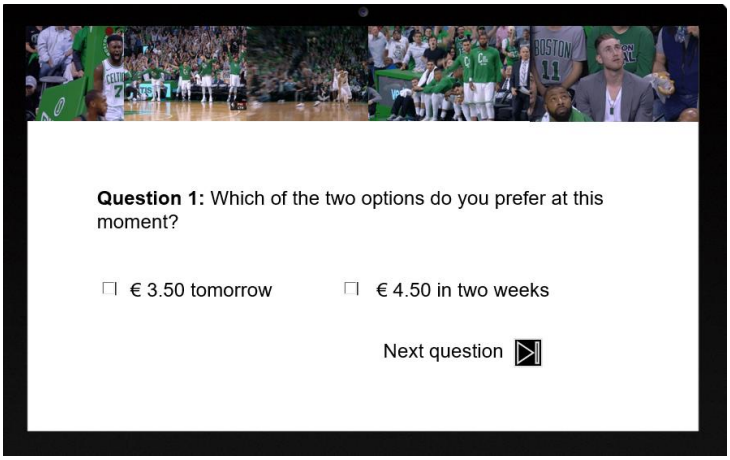
While the participants were answering the intertemporal choice questions, a banner showing short videos was present on the top of the screen of each intertemporal choice question. An example of such is shown in Figure 1. The control group did not face any further instructions about these banners.

Table 1: Overview intertemporal choices based on Li (2007)

Which of these two options do you prefer at this moment?			
Question 1:	€ 3.50	tomorrow or € 4.50	in two weeks?
Question 2:	€ 5.00	tomorrow or € 6.25	in two weeks?
Question 3:	€ 10.00	tomorrow or € 12.00	in three weeks?
Question 4:	€ 14.00	tomorrow or € 21.00	in four weeks?
Question 5:	€ 30.00	tomorrow or € 34.00	in two weeks?

This table illustrates the intertemporal choice questions participants faced in the field experiment of this thesis.

Figure 1: Example question experiment



The treatments which are referred to as 'Treatment Spill-Over' as well as 'Treatment Cookie' differed from the control group in that they received different instructions (Appendix A) and found themselves in a different setting which is described below.

Treatment Spill-Over: In this treatment group, the general existence of an inhibitory spill-over was tested. Based on the design of the 'attention control' task by Tuk et al. (2015), the first treatment group was informed that for the success of the experiment and their task performance, their concentration was of high importance and therefore they should ignore the distractions in the form of banners on top of the screen. Under no circumstance were they to look there and in case it occurred they should continue to attempt to refocus. According to Hypothesis 1, this intentional act of inhibition control should spill-

over to participants' answering behaviour, encouraging them to choose the later reward option in the five intertemporal choice questions presented in Table 1 (Tuk et al., 2011; Tuk et al., 2015).

Treatment Cookie: This treatment was constructed to test Hypothesis 2, whether the introduction of a tempting stimulus would affect the inhibitory spill-over effect. Similar to the research design of Li (2007), in this study, fresh cookies served as the additional tempting stimulus intended to engage participants' reward system (Li, 2007; Heatherton & Wagner, 2011). Similar instructions (Appendix A) as in 'Treatment Spill-Over' were given to the participants with the exception that cookies were placed directly in front of the participants, to ensure that they would notice their smell, similar to Li (2007) who used the scent of candles. During the instructions the cookies were presented as a form of compensation for the participation. Subjects were told that they were more than welcome to enjoy them, even during the task, to make the stimulus more salient.

To assess further determinants of individuals' answering behaviour, in addition to the questions about their intertemporal preferences, questions to assess the participants' level of self-control ability utilizing the 'Brief Self-Control Scale' by Tangney et al. (2004) were included in the questionnaire. This scale measures individuals' general, self-reported levels of self-discipline in every-day life situations and a high score has been found to correlate with less problems in inhibition control, which is of interest of this research. An exemplary version is illustrated in Table 2. As the experiment took place in Graz, Austria, the adapted, German version by Sproesser, Strohbach, Schupp and Renner (2011) and published by Universität Konstanz was utilized for the purpose of this thesis.

Table 2: Brief Self-Control Scale (Tangney et al., 2004)

Using the scale provided, please indiciate how much of the following statements reflects how you typically are.

	Not at all				*Very much*
I am good at resisting temptation	1	2	3	4	5
I have a hard time breaking bad habits	1	2	3	4	5
I am lazy	1	2	3	4	5
I say inappropriate things	1	2	3	4	5
I do certain things that are bad for me, if they are fun	1	2	3	4	5
I refuse things that are bad for me	1	2	3	4	5
I wish I had more self-discipline	1	2	3	4	5
People say that I have iron self-discipline	1	2	3	4	5
Pleasure and fun sometimes keep me from getting work done	1	2	3	4	5
I have trouble concentrating	1	2	3	4	5
I am able to work effectively towards long-term goals	1	2	3	4	5
Sometimes I cannot stop myself from doing something, even though I know it is wrong	1	2	3	4	5
I often act without thinking through all the alternatives	1	2	3	4	5

Moreover, general questions about gender, age as well as hunger and mood (Sinha, 2009) were included to control for these confounding factors (Tuk et al. 2015; Li, 2007; Fujita, Trope, Liberman & Levin-Sagi, 2006).

After each day of the experiment, a winner of the lottery and one of his choices were drawn using an online tool (Random Name Picker, 2018). The winners were informed, and payment was arranged via the email address they had provided at the end of the questionnaire.

4. Data & Analysis

4.1 Econometric model

This thesis investigates factors contributing to the ability to exert self-control, in particular the inhibitory spill-over effect. In this analysis, self-control is proxied by intertemporal choice questions meaning participants' decision between a sooner smaller reward and a later larger reward. In their studies both, Tuk et al. (2015) and Tuk et al. (2011) use the aggregate number of times a subject chose the 'later' reward as the dependent variable. However, describing her procedure Li (2007) mentions the use of logistic regressions in her analysis of the answers to intertemporal choice questions which indicates the treatment of the dependent variable as a binary one. As participants in this experiment faced five different trade-offs, the sequence of such trade-offs might have impacted their decisions because they might have gotten tired during the experiment. Consequently, the questions themselves and their order might be of high importance. To control for this effect, the answers were not analysed on an aggregate level, but per question, similar to the procedure of Li (2007). Hence, to test the hypotheses of this thesis, the dependent variable was treated as a binary choice. Self-control, the dependent variable, was measured as the probability of choosing the payment which will occur later in time.

A probit model allows for the analysis of which factors influence the probability of the dependent variable taking the value one, which corresponds to the choice of the later occurring payment. As mentioned, each subject answered five different questions in total, which means that questions appeared in five periods. This implies a panel data structure. Hence, for the purpose of this analysis and to take advantage of the panel data structure, a random effects probit model was chosen. As the main explanatory variable namely, the treatment variable did not vary over time, the random effects model was selected as opposed to a fixed effects or first difference model (Moffatt, 2015; Wooldridge, 2015). To confirm the robustness of results obtained by the models, poisson regressions were run[3].

[3] For these regressions, similar to Tuk et al.(2015), the dependent variable was treated on an aggregate level per subject. In other words, the dependent variable was treated as a count variable, as it denoted the sum of answers indicating self-control per subject. Thus, a poisson regression was chosen as the appropriate model (Wooldridge, 2015a).

4.2 Descriptive statistics and variables

The sample consisted of a total of 124 individuals, 51% of which were women. Per individual, there were five observations leading to a total of 620 observations for this analysis.

'Self-control': This is the dependent variable in this analysis, which depicts participants' answers to each intertemporal choice question. It is a binary variable which represents a proxy for self-control measured on a question level. If participants were able to wait longer for their payoffs and therefore chose the 'later' option, this variable took the value one. Looking at the descriptive statistics by treatment demonstrated in Table 3, 'Treatment Cookie' exhibited the highest number of answers indicating self-control, followed by the control group and 'Treatment Spill-Over' with the lowest number of 'Self-Control Choices'.

Table 3: Number of 'Self-Control Choices' per treatment

Control Group	115
Treatment Spill-Over	114
Treatment Cookie	118
Total	347

This table illustrates the number of times individuals of each condition chose the later payment.

'Treatment': 'treatment' is a categorical variable which indicates whether a participant was part of the control group (treatment=1) or either of the two treatment groups. If participants received the additional instructions, intended to trigger their inhibitory system (Appendix A), he or she was part of the 'Spill-Over Treatment' and this variable took the value two. If in addition to the instructions, they received a cookie as a compensation for the participation, which should activate their reward system, they were part of the 'Cookie' treatment and this variable took the value three. The control group consisted of 40 participants while the treatment group one was made up of 41 participants and 'Treatment Cookie' entailed 42 participants.

'Question_nr': As demonstrated in Table 1, participants faced five questions in which they had to choose whether they preferred to obtain sooner or later payments. Each question differed in terms of absolute amount to be won as well as relative differences between the two payments. For instance, as can be seen in Table 1 the maximum amount to be won in question three was 6.25 euro, while in question 5 subjects had the chance to win 34 euro. In Also, in question 3, participants had the chance to win either 5 euro tomorrow or wait two weeks for a 25 % increase in the prize, while in question five waiting two weeks only resulted in a 13% increase of money that could be won. As these differences might have had an effect on participants' choices, the question number was included as a categorical variable. This means that each trade-off was assigned a number between one and five. For most questions, there

was an even distribution of answers, meaning that 'self-control' took the value one in around 50 % of the cases in each question. The exception was question four which as shown in Table 1 depicted a trade-off between '€ 14.00 tomorrow or € 21.00 in four weeks'. Here, 77 % of all participants chose the 'later' reward. This question was the question with the biggest gap between the two amounts. Thus, most people were expected to choose the later reward.

'Subject_id': This variable identifies all the observations for the same individual. This variable is fixed for each individual and does not change over time. The sample consisted of 124 individuals.

'Question_period:' In total, participants faced five questions, therefore they provided answers at 5 different periods resulting in data with a panel data structure. As the order of the questions was shuffled for each participant, 'question_period', a variable denoting the period at which each of the questions appeared for each subject, constitutes the time variable of this panel data structure which takes values between one and five.

'High_selfcontrolscore': denotes a dummy variable indicating whether the participant achieved a score on the 'Brief Self-Control-Scale' (Tangney et al., 2004) higher than the median score of participants in this experiment. Of all 124 participants, 64 achieved a score higher than the median while 60 scored lower. Throughout this following sections, a score above the sample's median will be referred to as a high score and therefore high self-control ability and vice versa. Regarding the differences in behaviour between the high and low groups, among those who scored higher, the later, higher reward was chosen 180 times, whereas in the low group 167 observations reported a value of one for the dependent variable.

'Age': denotes a discrete variable representing the age of each participant. The minimum age amongst the participants was 18 and the maximum was 60 with a mean of approximately 32. The standard deviation of age of this sample was 12.33 years.

'Hungry': is an ordinal variable which depicted individuals' self-reported score on a scale from one to five about how hungry they were. As it was shown that being hungry can affect self-control (Briers, Pandelaere, Dewitte, & Warlop, 2006), this variable was included in the analysis.

'Mood': is an ordinal variable ranging from one to five. After completing the survey, individuals had to report their current mood.

Table 4: Descriptive Statistics Additional Control Variables

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Age	620	31.48	12.33	18	60
Mood	620	4.26	0.73	2	5
Hungry	620	2.52	1.26	1	5

This table presents an overview of the descriptive statistics of the additional control variables.

5. Results

This section provides an overview as well as interpretation of the results obtained using the methodology explained above. In addition to that, the assumptions that need to hold for this model will be presented.

5.1 Hypothesis testing

5.1.1 Hypothesis 1 & 2

To test the first two research hypotheses which anticipate the existence of an inhibitory spill-over effect within the sample and its sensitivity to a tempting stimulus, a series of six random effects probit models was run including different combinations of explanatory variables. A collection of these probit panel regressions can be found in Table 6 under 'Robustness checks' in this subsection. To choose a model for this analysis, each of the models was compared by assessing the AIC and BIC statistic which are indicators for the goodness of fit implying how well each model describes the variation within the data penalized for the number of explanatory variables. Based on those values, Model 2 was chosen as the most fit model, as both its AIC as well as its BIC are the lowest when comparing all models. Even though in Models 3 to 6 more explanatory variables than in Model 2 were included, they scored worse on these indicators, implying that the addition of the independent variables decreases the model fit. Therefore, Model 2, which stated the probability of choosing the 'later' option as a function of the treatment group as well as the question number, was chosen for further interpretation and to test both Hypothesis 1 and Hypothesis 2.

$$self - control_{it} = \beta_0 + \beta_1 treatment_i + \beta_2 question\_nr_{it} + u_{it} + \alpha_i \qquad \textbf{(Model 2)}$$

To account for possible autocorrelation between the error-terms within participants as well as heteroskedasticity, standard errors were clustered at the participant level (Wooldridge, 2015b). The results are reported in Table 5.

Table 5: Model 2 Results

	Coefficients	Average Margins	P-values (margins)
Probability to exert self control			
Treatment Spill-Over	-0.225 (-0.65)	-0.049	0.518
Treatment Cookie	-0.0464 (-0.13)	-0.010	0.896
Question 2	-0.283* (-1.74)	-0.066	0.078*
Question 3	0.0340 (0.17)	0.008	0.867
Question 4	1.181*** (5.66)	0.250	0.000***
Question 5	0.0573 (0.27)	0.013	0.791
Constant	0.171 (0.63)		
Rho	0.660		

This table reports the results of the random effects probit regression also referred to as 'Model 2'. In this regression, 'self-control' is the dependent variable and 'treatment' and the question number served as explanatory variables. The portion of the total variance that is due to panel level variance is portrayed under 'Rho'. The coefficients that represent the baseline for the analysis are not reported in the table. The t-statistics are shown in the parentheses and significant results are indicated as follows:
*p<0.10, ** p<0.05, *** p<0.01

Hypothesis 1

The work of Tuk et al. (2015) suggests that when an individual exercises self-control willingly in one task, it is easier for him or her to exert self-control in a different, additional task at the same time. As the design of this thesis was based on one of their studies and this research aims to gather further proof for the inhibitory spill-over effect, a similar direction as found by Tuk et al.(2015) was expected, which lead to Hypothesis 1.

H1: Intentionally exercising self-control in one task will increase inhibition in another unrelated task.

The testing of this research hypothesis entailed the analysis of whether the coefficient of the treatment variable specifically the one of 'Treatment Spill-Over' was greater than zero. Hence, the research hypothesis translated into the alternative hypothesis in the statistical test of the coefficient of the specific treatment variable. Furthermore, the average marginal effect of the treatment variable was assessed. However, examining both the coefficient as well as average marginal effect of 'Treatment Spill-Over' reported in Table 5, compared to the control group, the signs of both indicate a negative effect on the probability to exert self-control holding all other factors fixed. This direction of the effect suggested that being in 'Treatment Spill-Over' as opposed to the control group decreased the probability to choose the 'self-control' option, even after controlling for question specific effects. Therefore, this result did not provide any proof of an inhibitory spill-over effect, but the direction implies rather the opposite. The effect of 'Treatment Spill-Over' appeared to be more in line with the strength model in that the probability that an individual exerts self-control declined with the additional self-control task (Baumeister & Heatherton, 1996). However, this effect was not significant even at the 10 % significance level and therefore the null hypothesis that there is no significant difference between 'Treatment Spill-Over' and control group could not be rejected. Thus, no evidence for the first research hypothesis was found.

Hypothesis 2

In her work Li (2007) discusses the role of a tempting stimulus in intertemporal choice making. In her studies, the smell of cookies through scented candles as well as pictures of savoury food were used as such stimuli. To create a similar situation, participants during this study were presented with fresh cookies which they were informed that they were more than invited to consume. Following the reasoning of Li (2007) Hypothesis 2 was developed.

H2: *The introduction of an additional, tempting object requiring self-control will decrease the inhibitory spill-over effect*

This research hypothesis represented the alternative hypothesis in the statistical test of the coefficient of the treatment variable of 'Treatment Cookie'. 'Treatment Cookie' was expected to decrease strength of the inhibitory spill-over effect of 'Treatment Spill-Over' due to the saliency of a

tempting reward or 'appetitive stimulus' (Li, 2007). However, as Table 5 shows, the sign of the coefficient as well as the average marginal effect of this treatment, holding all other factors constant implies a different direction. When set in reference to 'Treatment Spill-Over', the probability to choose self-control increased as the negative effect of 'Treatment Cookie' compared to the control group was less negative than 'Treatment Spill-Over' as shown by Table 5. This direction was unexpected, as the stimulus should have stimulated participants in 'Treatment Cookie' to prefer the sooner rewards and not improve their self-control performance compared to 'Treatment Spill-Over'. Compared to the control group, the probability of exerting self-discipline declined, which could be due to an activation of the reward system and therefore declined self-control ability (Li, 2007). Still, looking at the summary statistics in Table 3, this result is unexpected because 'Treatment Cookie' exhibits the highest number of choices indicating self-control. Nevertheless, also the effect of 'Treatment Cookie' was not significant, even at the 10 % significance level which means that the null hypothesis that the results of the treatments do not differ significantly could not be rejected and no proof for the second research hypothesis could be produced.

Control Variables

As described above, participants faced different trade-offs regarding the overall amount of the potential pay-off as well as the relative differences between the pay-offs in each question. Hence, the variable 'question_nr' was included to analyse whether a specific question affected participants' answering behaviour. Results of the average margins are reported in Table 5.

Indeed, as shown in the results of Model 2 in Table 5, compared to question number one, question number two which regarded the payoff between '5.00 euros tomorrow and 6.50 euros in two weeks' was on average decreasing the probability to choose the 'later' option by 6.5 percentage points, ceteris paribus. This effect is significant at the 10% significance level. This result was unexpected as this trade-off neither depicted the question with the smallest amount nor smallest relative difference and therefore should not have pushed participants towards a specific answer. Also, compared to the trade-off of question number one, question number four increased the probability to choose the later pay-off by 25 percentage points, ceteris paribus. An effect that was significant at the 1% significance level. The effect of question four was expected, as it denoted the question with the highest relative difference, which was expected to encourage the choice of the later reward. These results showed how participants' answers might be affected by both, different overall amounts included in the trade-offs and the relative differences.

Robustness check

As robustness checks for the results obtained in this analysis, a poisson regression including the treatment variable as an independent variable was performed. The results of the poisson regression described in this section can be found in Table 10 under Model 2a. Moreover, the results of the additional models run were examined and compared to Model 2. Each additional model consisted of an additional control variable. The first one to be included was 'question_period' in Model 3. In the further models the control variables 'age' as well as 'hungry' were included respectively. In Model 6 'mood' was added to the control variables. Hence, Model 6 contains all available explanatory variables. The table below shows the results for the coefficients across all models. Data regarding the control variables had been gathered throughout the analysis as especially mood and hunger have been found to affect self-control ability (Tuk et al. 2015; Li, 2007; Fujita et al., 2006). However as demonstrated by the results in Table 6, none of the control variables were significant and the AIC and BIC scores did not improve with their inclusion.

Overall, the sign of the coefficient for the 'Treatment Spill-Over' did not change in any of the models. Also, the results of the poisson regression show a negative direction in the expected count of self-control answers for 'Treatment Spill-Over' compared to the control group. Both of these analyses provided evidence for the robustness of the results for this treatment in Model 2.

Regarding 'Treatment Cookie' however, the results of the poisson regression indicated an increase in the expected number of self-control answers compared to the control group. Also, as soon as the additional explanatory variable age was included in the additional random effects probit models, the direction of the coefficient changed and remained positive for all additional models. This result casted doubt on the robustness of the coefficient in Model 2 which was chosen for this analysis. The coefficient for 'Treatment Cookie' in each of the additional models suggested an outcome that is more in line with the descriptive statistics reported above which show how 'Treatment Cookie' exhibited the highest number of 'self-control choices'.

Table 6: Regression Results Hypothesis 1&2

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Probability to exert self-control						
Treatment Spill-Over	-0.203	-0.225	-0.235	-0.136	-0.133	-0.105
	(-0.67)	(-0.65)	(-0.67)	(-0.36)	(-0.35)	(-0.27)
Treatment Cookie	-0.0565	-0.0464	-0.0448	0.105	0.105	0.119
	(-0.18)	(-0.13)	(-0.13)	(0.26)	(0.26)	(0.30)
Period 2			-0.194	-0.194	-0.194	-0.193
			(-0.90)	(-0.92)	(-0.92)	(-0.92)
Period 3			0.00542	0.00545	0.00565	0.00585
			(0.03)	(0.03)	(0.03)	(0.03)
Period 4			0.268	0.268	0.268	0.270
			(1.29)	(1.26)	(1.26)	(1.26)
Period 5			0.0935	0.0939	0.0937	0.0945
			(0.43)	(0.45)	(0.45)	(0.45)
Age				0.0112	0.0113	0.0118
				(0.84)	(0.85)	(0.88)
Hungry					0.0295	0.0293
					(0.26)	(0.26)
Mood						0.0998
						(0.49)
Constant	0.331	0.171	0.150	-0.287	-0.367	-0.822
	(1.58)	(0.63)	(0.50)	(-0.47)	(-0.54)	(-0.71)
Rho	0.588	0.660	0.665	0.664	0.664	0.662
N	620	620	620	620	620	620
AIC	736.9	690.1	693.2	694.5	696.4	698.2
BIC	754.6	725.6	746.4	752.1	758.4	764.6

This table reports the results of the random effects probit regressions referred to as Model 1-6. In all regressions, 'self-control' is the dependent variable and 'treatment' , 'question_nr', 'question_period', 'age', 'hungry' and 'mood' were added one by one as explanatory variables. The portion of the total variance that is due to panel level variance is portrayed under 'Rho'. The baseline groups for the coefficients as well as the coefficients for 'question_nr' are not reported in this table as they are not crucial for the robustness check. The t-statistics are shown in the parentheses and significant results are indicated as follows:
*p<0.10, ** p<0.05, *** p<0.01

5.1.2 Hypothesis 3 & 4

Tuk et al. (2015) and Tuk et al. (2011) test whether individuals with a highly sensitive behavioural inhibition system are more susceptible to the inhibitory spill-over than those with a lower sensitivity. While Tuk et al. (2011) find a significant effect, Tuk et al. (2015) have not been able to. To further investigate the role of individual differences regarding inhibition control, in this thesis, an index, whose results are connected to the sensitivity of the 'Behavioural Inhibition System' (Shackman et al., 2009) was chosen namely the 'Brief Self Control Scale' developed by Tangney et al. (2004). Due to the results obtained by Tuk et al. (2011), the research hypotheses, Hypothesis 3 and 4 were formulated.

H3: Individuals of high self-control ability are expected to experience a higher inhibitory spill-over effect compared to those of lower self-control ability.

H4: The expected effect due to the tempting stimulus is smaller for people of high self-control ability.

To be able to test the research hypotheses 'Hypothesis 3' and 'Hypothesis 4', individuals' self-control score and its' interaction with the treatment variable which is necessary to examine potential differences between the treatment effects had to be included in the model. As Model 2 scored better than the other models regarding the AIC and BIC scores, this model was selected as a basis for the development of Model 7 which was constructed by adding the two additional explanatory variables required to test Hypothesis 3 and 4. As the inclusion of individuals' score on the 'Brief Self-Control Scale' (Tangney et al., 2004) might have violated one of the assumptions of a consistent random effects model, the use of Model 7 was restricted to test Hypothesis 3 and 4. These two research hypotheses are the alternative hypotheses in the statistical test examining whether the coefficients of the interactions between the treatment variable and the variable indicating a high ability of self-control are greater than zero. This was conducted using Model 7 illustrated below.

$$self-control_{it} = \beta_0 + \beta_1 treatment_i + \beta_2 question_{nr\,it} + \beta_3 highselfcontrolscore_{it} + \beta_5 highselfcontrolscore_{it} * treatment_i + u_{it} + \alpha_i \quad \textbf{(Model 7)}$$

To obtain an idea about whether a high score changed the effect of a treatment, a scatterplot of the aggregate data on an individual level was created which can be seen in Figure 2. The figure shows the average number of times individuals with a specific score on the 'Brief Self-Control Scale' (Tangney et al. 2004) chose the self-control option on the y-axis and the self-control score these individuals obtained on the x-axis. Looking at the figure, the differences between treatments do not seem to change substantially, the higher the individuals' score on the 'Brief Self-Control Scale'.

Figure 2: Aggregate results across treatments

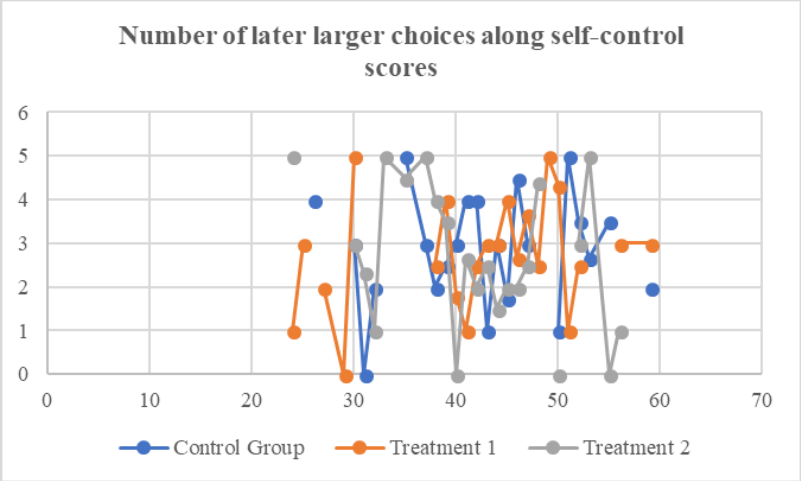


Table 7: Regression Results Model 7

Probability to exert self-control	
Treatment Spill-Over	-0.710
	(-1.34)
Treatment Cookie	-0.0755
	(-0.15)
High Self Control Score	-0.250
	(-0.53)
Interaction: Treatment Spill-Over & High Self Control Score	0.891
	(1.29)
Interaction: Treatment Cookie & High Self Control Score	-0.0373
	(-0.05)
Constant	0.323
	(0.85)
Rho	0.653
AIC	693.8
BIC	742.6

In this table the results for the random effects probit model referred to as Model 7 are reported. 'Self-control' is the dependent variable of this analysis and 'treatment', 'high_selfcontrolscore' as well as an interaction between the two and 'question_nr' are explanatory variables of this analysis. The results for 'question_nr' have been omitted as they are not highly relevant for this presentation. Also, the variables that represent the baseline are not reported in this table. The portion of the total variance that is due to panel level variance is portrayed under 'Rho'.
T-statistics are illustrated in the parentheses and significance levels as follows:
* p<0.10, ** p<0.05, *** p<0.01

To test both Hypothesis 3 and 4, Model 7 which is depicted above was run and the results for the interaction terms are reported in the table above. As illustrated in Table 7, none of the interactions were significant, which implies that there were no significant differences in the treatment effects between different levels of self-control ability. To further analyse the results, the average marginal effects of the treatment variable for individuals both of high and low levels of the self-control were calculated and compared. In Table 8 below, the results for the various treatments at self-control scores below and above the sample's median score are reported.

Table 8: Average marginal effects of 'treatment' in Model 7

	dy/dx	*Standard Error*	*p-value*	*[95% Conf. Interval]*	
Treatment Spill-Over					
at low self-control	-.1585268	.1176515	0.178	-.3891195	.072066
at high self-control	.0399881	.0981463	0.684	-.1523752	.2323514
p-value of Wald test	0.195				
Treatment Cookie					
at low self-control	-.0164589	.1099057	0.881	-.23187	.1989523
at high self-control	-.0252738	.1092413	0.817	-.2393828	.1888351
p-value of Wald test	0.955				

In this table, the average marginal effects of both treatments are reported for both, the variable 'high_selfcontrolscore' taking 0 and 1. Also, the results of two Wald tests, testing for differences in the marginal effects are reported. Significance levels are reported as follows: * p<0.10, ** p<0.05, *** p<0.01

The control group served as the baseline for this analysis and is therefore not reported in the table. As demonstrated in Table 8, for 'Treatment Spill-Over' compared to the control group, the direction of the marginal effect for individuals of low self-control was negative. However, for participants who scored higher than the mean, the direction of the effect changed to positive, which can be interpreted an indicator for the existence of an inhibitory spill-over amongst those of high self-control. From this change one can infer that there might be differences in the susceptibility to the inhibitory spill-over between those of high and low self-control ability which provides support for Hypothesis 3. Similar to the results found by Tuk et al. (2011) who analysed whether different scores on the BIS-scale would lead to different treatment effects, participants of this study who scored higher seem to be more sensitive to an inhibitory spill-over. To test whether there existed an actual difference in the marginal effects of the treatments between individuals of high and low self-control, a Wald test was performed. However, as indicated by the p-value of 0.195 of the test presented in Table 8, there was no significant difference found and therefore no support for research hypothesis number three could be provided.

For 'Treatment Cookie' there were no changes in the direction of the effect between individuals who reported low and those with high self-discipline. Similar to the results in Model 2, the marginal effects for both groups which are shown in Table 8 were negative compared to the control group, but less negative than the effect of 'Treatment Spill-Over' for individuals of low self-control. Despite the

unexpected direction of the treatment effect itself, both the treatment effect at a low self-control level as well as the high self-control level of 'Treatment Cookie' were not significant. To test whether the marginal effects are different from one another, another Wald test was conducted. Also, in this case, there was no significant difference between the treatment effect of 'Treatment Cookie' at different levels of self-control, even at the 10% significance level, shown by a p-value of 0.955.

Robustness check

To check the robustness of the results obtained with Model 7, a poisson regression including the treatment variable, 'high_selfcontrolscore' and an interaction between the two was run. The results are depicted in Table 10 under Model 7a. Also, additional models were created by adding the control variables 'question_period' 'age', 'hungry' and 'mood' one by one to Model 7. As can be seen in Table 9, neither the AIC nor the BIC score improved with the inclusion of the additional variables, which supports the choice of Model 7 for this analysis. In a next step, potential changes in the marginal effects of the treatment variable at the different levels of self-control were assessed. Also, for each model a Wald test was performed to test for possible differences in the treatment effects between individuals reporting a high and a low self-control score.

Table 9 illustrates the average marginal effects of the treatment variables of all models at different levels of self-control as well as the results of the Wald tests. As can be seen in the table below, while the treatment effect of 'Treatment Spill-Over' for individuals with high scores remained positive across all models, the effect for individuals with low scores continued to be negative. Hence, the results for this explanatory variable seem consistent. The results of the poisson regression also show a positive treatment effect for those of high self-control, ceteris paribus. Still, none of the effects were significant. Examining the effect for 'Treatment Cookie' for different self-control levels, in the poisson regression, same as in Model 7, for people of high self-control ability, a lower number of self-control choices was expected compared to the control group, holding all other factors fixed. Nevertheless, in the additional models, a change in the direction of the treatment effect of 'Treatment Cookie' from negative to positive, once the explanatory variable age was included can be seen in Table 9. This casted doubt on the robustness of the coefficient for 'Treatment Cookie' in Model 7. Contrary to the main analyses, the robustness checks of Model 2 and Model 7 used in this analysis indicated a positive effect of 'Treatment Cookie' on the probability to exert self-control compared to the control group. However, neither the marginal effects themselves nor the results of the Wald tests, testing for differences between the marginal effects of the treatments at high and low levels of self-control for any of the additional models were statistically significant.

Table 9: Marginal effects of 'treatment' in Model 7-11

	Model 7	Model 8	Model 9	Model 10	Model 11
	dy/dx	*dy/dx*	*dy/dx*	*dy/dx*	*dy/dx*
Treatment 1					
at low self-control	-.1585268	-.1611253	-.1474225	-.1505012	-.1454224
at high self-control	.0399881	.0391477	.0683527	.0745561	.0812049
p-value of Wald test	0.159	0.192	0.159	0.158	0.156
Treatment 2					
at low self-control	-.0164589	-.0178087	.005124	.0108968	.0129144
at high self-control	-.0252738	-.0230222	.0223331	.0159521	.0180392
p-value of Wald test	0.995	0.973	0.913	0.974	0.974
N	620	620	620	620	620
AIC	693.8	696.9	698.1	699.8	701.5
BIC	742.6	763.4	769.0	775.1	781.2

In this table, the average marginal effects of both treatments are reported for both, the variable 'high_selfcontrolscore' taking 0 and 1 for the random effects probit models referred to as Model 7-11. Also the results of Wald tests performed to test for differences in the marginal effects of each treatment depending on the self-control score are reported. Significance levels are reported as follows: * p<0.10, ** p<0.05, *** p<0.01

Table 10: Results poisson regressions

	Model 2a	Model 7a
Number of Self-Control Choices		
Treatment Spill-Over	-0.0685	-0.175
	(-0.47)	(-0.68)
Treatment Cookie	0.0342	0.186
	(0.25)	(0.87)
High Self-Control Score		0.117
		(0.55)
Interaction: Treatment Spill-Over & High Self Control Score		0.234
		(0.77)
Interaction: Treatment Cookie & High Self Control Score		-0.299
		(-1.03)

In this table, the results for two poisson regressions, Model 2a and Model 7a are reported. In both models, the number of self-control choices per subject is the dependent variable. In Model 2a 'treatment' acts as explanatory variable. In Model 7a 'high_selfcontrolscore' and an interaction term between the variable and 'treatment' are added as explanatory variables. Baseline variables as well as the constant are not reported in the table, as they are not considered crucial for the purpose of this analysis. T-statistics are shown in the parentheses and significance levels are illustrated as follows: * p<0.10, ** p<0.05, *** p<0.01

5.2 Assumptions

For the model to be consistent, certain assumptions have to hold. For example, the composition of the sample has to be random (Wooldridge, 2015). Thus, participants were randomly chosen as they passed the experimenter at the main square of Graz, Austria.

Also, another assumption constitutes the absence of autocorrelation of error-terms as well as heteroskedasticity. However, due to the panel structure of the data autocorrelation of the error-terms as well as heteroskedasticity might present an issue. As mentioned above, to account for these factors, the standard errors in this analysis were clustered at the subject level (Wooldridge, 2015b).

One of the main assumptions of a random effects model, as the one used in this thesis, is that the time-invariant part of the error term does not correlate with any of the explanatory variables (Wooldridge, 2015). As all explanatory variables of the models chosen for the hypotheses testing, except for the score in the 'Brief Self-Control Scale' (Tangney et al., 2004) were selected randomly, the probability that the individuals' fixed error term correlated with these variables is very low. Hence, this assumption is expected to hold for Model 2, which was used to test the research hypotheses, Hypothesis 1 and 2. As the testing of Hypothesis 3 and 4 made it necessary to include the self-control score of individuals, for this model, this assumption is not expected to hold because there might be subject-specific characteristics in the error term that correlate with both the score on the 'Brief-Self Control Scale' (Tangney et al., 2004) and the answering behaviour. Hence, this model might suffer from omitted variable bias. To overcome this issue, an instrumental variable could be utilized (Wooldridge, 2015) and a two stage random effects probit model could be run. For instance, regarding students, students' GPA could be used as an instrument because this measure is said to correlate with the score on this scale (Tangney et al., 2004) but should not affect whether someone prefers an earlier or later pay-off. However, due to the unavailability of data suitable as an instrument for this analysis, this procedure has not been undertaken in this thesis.

Another potential issue could be multicollinearity of the explanatory variables (Wooldridge, 2015). As can be seen in the correlation matrices of the models used for this analysis that are reported in Appendix B under 'Correlation Matrix Model 2' and 'Correlation Matrix Model 7', none of the explanatory variables seem highly correlated. Therefore, multicollinearity is expected not to be an issue.

6. Discussion

6.1 Deviations from the inhibitory spill-over literature

Both Tuk et al. (2011) and Tuk et al. (2015) were able to provide significant evidence of the inhibitory spill-over effect. This thesis aimed to do the same by conducting a study whose design was based on the work of both authors. However, no significant effects were found. Therefore, a closer inspection of the differences between the studies that might have caused these results was conducted. The first area of investigation concerned the samples of each study. As far as sample size is concerned, the samples of all three studies including the one conducted in this thesis were of similar size. Thus, the number of participants was not expected to be the reason for these differences in the results.

Another potential point of difference between the samples was age. The mean age of the lab studies of Tuk et al. (2015) was 22.24 years and the average age of the participants in the studies conducted by Tuk et al. (2011) was about 22 years. These numbers differ substantially from the mean age of participants in this study which was 31.47 years. Therefore, a person's sensitivity to the inhibitory spill-over effect might depend on age. Moreover, the standard deviation of participants' age in Tuk et al. (2015) was about 3.09 years, whereas in this sample it was 12.33 years, which can be seen in Table 4 in the descriptive statistics section of this thesis. Consequently, in terms of age the sample of this experiment was much less homogenous. However, Hay and Forrest (2006) find that self-control should be fully developed by adolescence and therefore after this period no age effects are expected.

Nevertheless, age might have impacted behaviour due to another reason. Based on the mean age of the other two studies, it can be inferred that most of the participants were students. The amount of money that the participants played for might play a role for students who do not earn a stable income to support themselves yet. However, during the experiment of this thesis, several of the older participants mentioned how they were indifferent between these sums of money, as the overall amount they could win would not make a difference for their current situation. Thus, this way age could have affected the answering behaviour acting as a proxy for income. This implies that intertemporal choice questions might have to be adapted according to age, the current job situation or income to measure the desired effect.

Another disparity between the studies that could have intensified the effect of age described before was found in the overall amounts of money that could be won. In this study, the potential rewards were less than those presented in the other two studies. The maximum potential reward in this thesis was 34 euro, while in the aforementioned papers participants could win up to 85 dollar. An amount which is substantially higher and might therefore have constituted a much more motivating incentive for individuals to state their actual preferences. However, no information about the pay-off procedure was provided in either study. While Tuk et al. (2011) mentioned that participants were compensated with 10 dollar for their participation, Tuk et al. (2015) did not provide such detailed information. However, both papers based their study including intertemporal choice questions on the procedure of

Li (2007) who did pay out participants through a lottery. Assuming they also adopted this approach, the difference in amounts might have contributed to the differing results. The budgetary constraints of this research however did not allow for higher rewards to be offered and therefore constitute a limitation of this research.

6.2 Validity of intentional measure of self-control

Despite the statistical insignificance of the results, the direction of the effect of 'Treatment Spill-Over' supported the theory of the strength model rather than the inhibitory spill-over, as self-control ability seemed to decrease when participants had to engage in multiple acts of self-control (Baumeister & Heatherton, 1996). It might be possible that participants felt overwhelmed with the task to focus their attention on more than one task. Job et al. (2010) highlight the role of beliefs in personal abilities when completing self-control tasks. As a result, feeling overwhelmed and therefore incapable of completing the task correctly might have affect participants' answering behaviour negatively. Another possible explanation for these outcomes is that participants might not have understood the task properly and therefore might not have focused as much on the inhibition of their impulses as they should have. In their study, Tuk et al. (2011) show the effect of trigger strength on self-control behaviour. If indeed, the measure of intentional self-control was too weak, this could depict the reason for the results. Therefore, the independent variable of 'attention control' in this experiment might not have been the appropriate measure to trigger the inhibition system.

6.3 Effect of the tempting stimulus

Li (2007) shows how an 'appetitive stimulus' in the form of pictures or smell can have an influence on intertemporal choice making, encouraging participants to make more myopic decisions. This thesis aimed to test this effect in the context of the inhibitory spill-over effect by introducing a cookie as compensation for participation. However, the direction of the effect in this line of research, even though it was insignificant, was different from what was expected. The presence of the stimulus seemed to increase self-control behaviour compared to 'Treatment Spill-Over' and also the 'Control Group' after the inclusion of further control variables. One potential reason for these outcomes might have been that the trigger of the inhibition system overall might not have been strong enough. The inhibitory spill-over aside, another explanation could lie within the validity of the cookie as a tempting stimulus. A possible reason for the direction of the effect could have been the framing of the stimulus as a reward for the participation, which might have caused participants to perceive it as an incentive to perform better. As Masicampo et al. (2014) have shown, introducing incentives can improve people's self-control ability in a multiple task setting. Another explanation can be found in the process model (Inzlicht & Schmeichel, 2012). Participants might have viewed the cookie as a reward for later and therefore focused their full attention and motivation on the current task, leading to an increase in their

self-control. Therefore, the validity of the cookie and the way it was introduced as an appropriate proxy for a tempting stimulus is to be questioned.

Another explanation for the insignificance of the influence of the cookie might be differences between the sample of this study, which is made up of a cross-section including various age groups and the one of Li (2007), which consisted mainly of students. Again, students might respond differently to these intertemporal choice questions and stimuli than other age groups for the reasons mentioned in the section above.

6.4 Suitability of Incentives

Usually in a random lottery incentive scheme where a number of choices between pay-offs are taken, each individual is paid out one of his or her choices which are drawn randomly (Starmer & Sugden, 1991). Due to budgetary constraints in this thesis, only one choice of one participant was paid out each day. Hence, the probability to win the actual choice might have been too small to provide sufficient motivation for participants to state their real preferences. Also, most participants had questions about this random lottery incentive which suggests that they might not have understood it properly and therefore they might not have had the proper incentive.

7. Conclusion and further research

Inhibition control is a phenomenon whose key drivers have yet to be determined. In the prevailing literature, there are different approaches in doing so. This thesis intended to contribute to the research on self-control by substantiating the existence of an effect, examined in recent self-control literature, the inhibitory spill-over effect. To do so, the existence of this effect and whether it would withstand an environment of temptation was analysed through a field experiment based on previous research. Moreover, the role of self-control as a general characteristic of individuals' personality measured by a high score on the 'Brief Self-Control Scale' (Tangney et al., 2004) as a facilitating factor of this effect was tested. Nevertheless, no significant results for any of the theories tested were obtained.

This casts doubt on the generalizability of the results of Tuk et al. (2011) and Tuk et al. (2015), who provided the main evidence for the inhibitory spill-over effect. One of the differences that was identified between the studies of both Tuk et al. (2011) and Tuk et al. (2015) and this experiment was age. Due to the different levels of income, different age groups might not respond to all measures of self-control such as intertemporal choice questions in the same way, which calls for further investigation of the matter.

In addition to that, the validity of the trigger of the inhibition system used in this thesis was questioned. Therefore, the influence of varying intensity of triggers of the inhibition system could be investigated as well as the impact of individual differences such as the score on self-control measures on the susceptibility to such triggers and therefore the inhibitory spill-over effect. The further analysis of these factors could contribute to the further understanding of and help to provide further proof for the inhibitory spill-over effect and therefore a better understanding of the processes underlying self-control, an ability which is an important determinant of individuals' welfare in society (De Ridder et al., 2012; Gathergood; 2012; Tangney et al., 2004).

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Appendix A

Instructions Treatment Group Spill-Over

"My name is Eva Straka and I am studying for a Master's degree in Economics and Business: Behavioural Economics' at Erasmus University in Rotterdam. Currently, I am doing a research project for my Master thesis for which I need your support. I would like to conduct a small questionnaire you. In the following questions, you will be asked whether you prefer a smaller reward tomorrow or a bigger later in time. The answers of you and the other participants that are participating in this experiment today will be entered into a lottery and one choice will be drawn and paid out. This means you have the chance to win the money you choose in one of the questions. Therefore, please be sure to state your real preferences and provide your email address in the end, so that I can contact you in case you are the winner and arrange the payment. The transfer of payment will be controlled by my supervisor. In the end, there will be some general questions. To answer the questions, select your answer by clicking the checkbox. Above these questions, there will be banners displaying different short videos. For the success of the experiment and your performance, it is of high importance that you do not under any circumstances look at these pictures while you answer the questions. In the end, there will be some general questions. To answer the questions, select your answer by clicking the checkbox"

Instructions Treatment Group Cookie

"My name is Eva Straka and I am studying for a Master's degree in Economics and Business: Behavioural Economics' at Erasmus University in Rotterdam. Currently, I am doing a research project for my Master thesis for which I need your support. I would like to conduct a small questionnaire you. In the following questions, you will be asked whether you prefer a smaller reward tomorrow or a bigger later in time. The answers of you and the other participants that are participating in this experiment today will be entered into a lottery and one choice will be drawn and paid out. This means you have the chance to win the money you choose in one of the questions. Therefore, please be sure to state your real preferences and provide your email address in the end, so that I can contact you in case you are the winner and arrange the payment. The transfer of payment will be controlled by my supervisor. In the end, there will be some general questions. To answer the questions, select your answer by clicking the checkbox.'

Above these questions there will be banners displaying different short videos. For the success of the experiment and your performance, it is of high importance that you do not under any circumstances look at these pictures, while your answer the questions. In the end, there will be some general questions. Also, as a small 'Thank you' for the participation I have organised some cookies you are very welcome to enjoy, if you like. To answer the questions, select your answer by clicking the checkbox."

Appendix B
Correlation Matrices

Table 1 Appendix: Correlation Matrix Model 2

	Treatment Spill-Over	Treatment Cookie	Question 2	Question 3	Question 4	Question 5
Treatment Spill-Over	1					
Treatment Cookie	0.4564	1				
Question 2	0.0671	0.0043	1			
Question 3	-0.0253	-0.0428	0.4358	1		
Question 4	-0.0011	0.0354	0.1113	0.2849	1	
Question 5	0.0810	0.0953	0.4491	0.5599	0.3258	1

This table contains the correlation matrix regarding the main explanatory variables of Model 2.

Table 2 Appendix: Correlation Matrix Model 7

	Question 2	Question 3	Question 4	Question 5	Treatment Spill-Over	Treatment Cookie	High Self-control score	Interaction 1	Interaction 2
Question 2	1								
Question 3	0.4365	1							
Question 4	0.1138	0.2858	1						
Question 5	0.4497	0.5590	0.3268	1					
Treatment Spill-Over	0.1104	0.0012	-0.0521	0.0433	1				
Treatment Cookie	0.0407	-0.0395	-0.0472	0.0601	0.4744	1			
High Self-control score	0.0895	-0.0029	-0.0486	0.0117	0.5056	0.5371	1		
Interaction 1	-0.1005	-0.0478	0.0372	-0.0105	-0.7666	-0.3621	-0.6797	1	
Interaction 2	-0.0273	0.0164	0.0923	0.0160	-0.3439	-0.7182	-0.6762	0.4615	1

This table contains the correlation matrix regarding the main explanatory variables of Model 7.