



**UNIVERSITY OF GOTHENBURG  
SCHOOL OF BUSINESS, ECONOMICS AND LAW**

**The Art of Measurement**

*Exogenous Activation of Self-Control with Simple Verbal Sentences in  
Intertemporal Choice*

Henri Lindroos

Master of Science in Economics

Master Degree Project No.

Supervisor Peter Martinsson

## Abstract

Recent neurological studies have found first causal evidence for a neural self-control mechanism in decision-making in intertemporal choice (e.g. Hare et al. 2009, 2011 & 2014, Figner et al., 2010). Figner et al. (2010) study was conducted by using a choice task design with binary questions between hypothetical sooner-smaller (SS) and larger-later (LL) monetary rewards. The researchers in that study used repetitive transcranial magnetic stimulation (rTMS) to endogenously disrupt the left lateral-prefrontal cortex in individuals. They found out that the rTMS stimulation led to a decrease in self-control, which resulted in these individuals selecting fewer LL choices. This was especially true with the subset of choices that had intermediate magnitude differences (approximately between 5 and 20%). These rewards were temporally to be received “now”, or in 2 or 4 weeks time. In this subset the choice conflict between the SS and LL rewards was found to be the largest. Also, the successful triggering of self-control processes with external attention cues in intertemporal choice with binary dietary questions has been recently studied and proposed by Hare et al. (2011). **The objective** of my study is to test the triggering of endogenous self-control processes with exogenous attention cues in a binary choice task with 16 questions that are particularly designed to represent a large choice conflict between the SS and LL hypothetical monetary rewards. **My method** is to attempt to facilitate self-control by the use of a simple verbal sentence that includes functions such as cognitive inhibition of a prepotent response, response time, and a two-relational inverted value judgment. To my knowledge, my experiment is the first time that triggering of self-control with external attention cues with binary hypothetical financial delay discounting questions has been studied. The intervention, a simple verbal sentence, is designed within the implementation intention structure, an accomplished self-regulation tool from cognitive psychology that allows an effective way to automatize goal-directed behavior in a specified cue environment (Gollwitzer and Sheeran, 2006). The treatment sentence is specifically designed for the purpose of self-control facilitation in the binary choice task context but it is also intended to be modifiable to various general uses outside the experiment environment. **The main hypothesis** is that the result of the exogenously activated self-control intervention will enable subjects in this group to resist the temptation of the SS choice and thus choose more of the larger-later rewards on average than the individuals in the group who receive no intervention. **The results** of this experiment suggest that the intervention leads to subjects on average choosing significantly more LL choices in comparison with the control condition. Thus my **conclusion** is that the findings present first evidence for the utility of simple verbal sentences as exogenous facilitators of self-control in hypothetical financial delay discounting. Due to the simple nature of verbally formulated self-control tools, the cost-efficient moderation of immediate gratification has the potential to create enormous societal and economic benefits.

**Key words:** Normative economics, behavioral economics, experimental economics, piceoeconomics self-control, financial delay discounting, intertemporal choice, delay of gratification, implementation intentions, temporal delay, exogenous activation of self-control, inversion of thought, general semantics, the art of measurement.

**Acknowledgments:** I want to thank my supervisor of this thesis, Prof. Peter Martinsson for his patience and valuable feedback, Prof. Conny Wollbrant for his quality advice on the literate formatting, Prof. Michael Kirchler for his inspiration on behavioral economics, Prof. Peter Gollwitzer for his motivating words of encouragement, Doc. Prof. Daria Knoch for her altruism, my friend Lukas Schultze for his thoughtful comments throughout the process, my friend David Ericsson for guidance on statistics and finally my parents for everything else.

## **Contents**

<b>ABSTRACT</b>	<b>2</b>
<b>1. INTRODUCTION</b>	<b>5</b>
<b>ECONOMIC THEORIES OF SELF-CONTROL: A BRIEF REVIEW</b>	<b>8</b>
<b>COMMITMENT DEVICES</b>	<b>11</b>
<b>DIFFERENCES IN DELAY DISCOUNTING EXPERIMENTS WITH HYPOTHETICAL AND REAL REWARDS</b>	<b>12</b>
<b>THE RELATION WITH IMPULSIVITY IN HYPOTHETICAL FINANCIAL DELAY DISCOUNTING AND REAL-WORLD IMPULSIVE BEHAVIOR</b>	<b>12</b>
<b>NURTURE: CULTURAL DIFFERENCES IN DELAY DISCOUNTING</b>	<b>13</b>
<b>NATURE: ROLE OF DISPOSITION IN DELAY DISCOUNTING</b>	<b>13</b>
<b>CURRENTLY KNOWN NEURAL PROCESSES ASSOCIATED WITH INTERTEMPORAL CHOICE</b>	<b>13</b>
<b>IMPLEMENTATION INTENTIONS</b>	<b>14</b>
<b>ATTENTION</b>	<b>15</b>
<b>QUERY THEORY AND REVERSAL OF THE VALUE JUDGMENT</b>	<b>16</b>
<b>COGNITIVE RE-CONSTRUAL, PRE-COMMITMENT, MOTIVATION AND WILLPOWER</b>	<b>16</b>
<b>2. MATERIALS AND METHODS</b>	<b>17</b>
<b>EXPERIMENTAL DESIGN</b>	<b>20</b>
<b>INTERVENTION DESIGN</b>	<b>22</b>
<b>3. DATA AND ANALYSIS</b>	<b>27</b>
<b>4. RESULTS</b>	<b>29</b>
<b>5. DISCUSSION</b>	<b>33</b>
<b>6. REFERENCES</b>	<b>37</b>
<b>7. APPENDIX</b>	<b>42</b>

## List of Abbreviations

ADHD	Attention deficit hyperactivity disorder
AoM	Art of Measurement
BMI	Body-mass-index
DLPFC	Dorsolateral prefrontal cortex
DU	Discounted utility
fMRI	Functional magnetic resonance imagining
IFG	Inferior frontal gyrus
LL	Larger-later choice
RT	Response time
rTMS	Repetitive transcranial magnetic stimulation
SS	Sooner-smaller choice
SES	Socioeconomic status
VMPFC	Ventromedial prefrontal cortex
WHO	World health organization

# 1. Introduction

*"Be still my heart; thou hast known worse than this."* – Homer (900 BC - 800 BC)

In our daily lives we are repeatedly required to enter decision-making situations where immediate gratification leads to suboptimal results in comparison with the long-term benefits of temporal delay. The types of decisions that have outcomes that play out over time are called intertemporal choices (Berns et al., 2007). Many times these situations are also in a binary form, in terms of varying magnitudes and times of delivery, consisting of a short-term pleasurable expected outcome and a long-term beneficial expected outcome. Also, often these situations occur repeatedly instead of as a single choice. The immediate reward is many times given disproportionate weight when we make decisions in this type of contexts. For example, when we fail to pursue our health goals and instead fall for the pleasurable taste of an available chocolate treat, or when a person seeking to quit smoking fails to say no to a cigarette offered at a party by an attractive stranger, we are choosing the type of sooner-smaller (SS) rewards that present suboptimal long-term outcomes. Its opposite, the larger-later (LL) choice, is often characterized by the required willpower to say no to a desire and persist in situations where it is reasonable to estimate that choosing LL will lead to more positive long-term effects. These types of situations are defined by the struggle between the alternatives of a sooner-smaller reward the impulsive choice and a larger-later reward the self-controlled choice (Odum, 2011). The impulsive choice can also be defined as temptation, seduction or spend-thriftiness (Ainslie, 1974).

Economists and psychologists define the above-described phenomenon as temporal discounting. There is some experimental evidence from economists for the resistance of temptation playing a consequential role in real-life choices (for empirical evidence, see e.g. Della Vigna and Malmendier, 2006, Houser et al., 2008, and Burger et al., 2009). An ongoing interdisciplinary work by economists, psychologists and neuroscientists attempts to investigate how to help people to resist the temptation of immediate gratification and thus reduce the large societal costs associated with loss of self-control. For example, according to Lopez et al., 2014, approximately 40% of deaths in the United States every year are attributable to self-control failures (see also Mofitt et al., 2010). A commonly proposed method, by economists, to increase the individual's ability to resist a temptation is a commitment device. Commitment devices include tools such as choice restrictions

(Wertenbroch, 1998), saving plans (Asharf et al., 2006, Benartzi and Thaler, 2004), payments (Gine et al., 2009) or rules (Baron 2000). Taxes on addictive goods, e.g. for tobacco use, have also been used as self-control devices, but there is some research that questions their effectiveness (Fletcher and Sindelar, 2009). Recently, self-control tools studied by neuroscientists, such as simple verbal sentences as external attention cues, have shown significant effects of successful activation of neural self-control processes in decision-making involving dietary choices (e.g. Hare et al., 2011). In the next paragraphs I will go on to make a short summary of these recent neurological findings on self-control that are closely related to my current research, and then go on to present the theory and motivation behind my paper. After that I will briefly return to the economic theory behind the hyperbolic discounting phenomena.

In a study on self-control with binary dietary choices by Hare et al. (2009) the researchers found out that successful and unsuccessful dieters have differences in how they weigh taste versus health characteristics of food choices. The unsuccessful dieters weight taste only, whereas the successful dieters weight both taste and health. The successful subjects were able to activate their neural self-control processes endogenously. In Hare et al. (2011) they continued to study the phenomena. The researchers used functional magnetic resonance imaging (fMRI) to investigate the effect of exogenously activated health cues on neural self-control processes, that are associated in the dorsolateral prefrontal cortex (DLPFC) and inferior frontal gyrus (IFG), and value signal processes in the ventromedial prefrontal cortex, in dietary choices between healthy and less tempting and unhealthy and more tempting foods. The interesting finding of that study was that the neural processes associated with self-control could be triggered by external verbal cues that focus the attention of the decision-maker to the healthiness of the food choices. This means that they could then make the participants in the intervention group who lacked endogenous self-control to behave like the successful dieter subjects in their previous (2009) study.

The findings of Hare et al. (2014), that suggested that the neural mechanisms of successful self-control are similar in choice tasks concerning both dietary and hypothetical monetary choices, encouraged me to continue to study the use of external attention cues in a financial delay discounting environment. Figner et al. (2010), who presented the first causal evidence for activation of neural self-control processes in intertemporal choice, studied the effects of an intervention with binary choices and valuation tasks with varying monetary amounts and

times of payment. The intervention in that experiment was an internal disruption of the left DLPFC with a repetitive transcranial magnetic stimulation (rTMS), which led to a decline in the ability to activate endogenous self-control. Thus the subjects in the intervention group ended up choosing less LL choices than the comparison groups. This was found to be particularly true in the subset of binary decisions that represented a large choice conflict between the immediately available SS rewards and LL reward (for a review of other experimental designs, see Andersen et al., 2011). My objective is to follow the pattern of discovery of Hare et al. by testing if simple verbal sentences can be used to induce exogenously activated, and automatized, self-control with hypothetical monetary choices between sooner-smaller and larger-later rewards (see a fMRI study on differences of hypothetical versus real money gains and losses in intertemporal choice, by Bickel et al., 2009). Further, I will attempt to use a self-regulation tool called an implementation intention (for a meta-analysis of implementation intentions see Gollwitzer and Sheeran 2006) as a structure for my intervention design, as it has been shown to exogenously induce automatized self-regulation in various different decision-making domains. As to my current knowledge this is the first time that an exogenous activation of self-control is attempted in a hypothetical financial delay discounting experiment, although mental self-control tools and implementation intentions have before been studied in relation to resistance of tempting stimuli (e.g. Hofmann et al., 2010),

My main hypothesis is that the exogenous activation of self-control, by the use of a successfully designed verbal sentence that is presented inside an implementation intention structure, will result in subjects in the intervention group selecting on average more of the later-larger choices in comparison with the baseline group. The motivation behind my study is in the vision that if the public is educated about tools such as the self-control facilitating simple verbal sentences, that are so cost-efficient and simple to use, there will potentially be significant economic and societal advantages. If people who lack natural endogenous self-control can activate it with the use of simple tools, then the economy will benefit tremendously as the costs associated in suboptimal decision-making due to lack of self-control can be significantly reduced (on costs of self-control see e.g. longitudinal studies by Casey et al., 2011 and Mischel et al., 2011, also Tangney et al. 2004). Among these tools are skills such as inhibition of an impulsive response, patience, willpower and the ability to consider a choice from a two-relational and inverted point of view. This paper thus takes a perspective of normative economics.

## Economic theories of self-control: A brief review

For an extensive critical review on time discounting and time preference, see Fredrick et al. (2002).

The standard economic model, the discounted-utility (DU) model, assumes a constant rate exponential discounting of future rewards (Samuelson, 1937). The exponential discounting of future rewards means that it assumes decision-maker rationality in that the value of the reward is discounted at a constant rate independent of the length of delay.

Exponential temporal discounting equation is as follows,

$$V = Ae^{-kD}$$

*Where  $V$  is the value of the delayed outcome,  $A$  is the amount of the delayed outcome,  $e$  is a mathematical constant, a base of the natural logarithm,  $D$  is the delay until the receipt of the outcome and  $k$  is the discount parameter i.e. rate of discounting.*

The modeling of intertemporal choice with a constant discount rate assumes time consistent behavior. Time consistent behavior assumes that the prospect of two future rewards, a sooner-smaller (SS) and a larger-later (LL) one, are of equal value to the decision-maker if the SS reward is available “now” or at some future point in time, when the LL reward is in both cases available after an equal delay e.g. “two days later”. For many decades now, this time consistency assumption of the DU model, and also its other assumptions, has been challenged by vast evidence from animal and human studies on intertemporal choice (see e.g., Mischel, et al., 1989, Hoch and Loewenstein, 1991, Ainslie, 1992, Baumeister and Vohs, 2007, Metcalfe and Mischel, 1999). The findings of these studies suggest that temporal discounting displays increasing patience with time. The subjective value of the reward is declining as the temporal delay between the SS and LL choices becomes bigger, i.e. the “available now” SS reward is being overweighed (Ainslie, 1974). Based on these findings behavioral economists and psychologists have built models that assume hyperbolic (Mazur, 1987) or quasi-hyperbolic (Laibson, 1997) discounting of subjective value. These models predict that SS rewards are on average overweighed, which is due to impulsivity in delay discounting decisions. Equal growth in delay results in bigger discounts of value during short delays than in long delays. Therefore the hyperbolic discounting is said to create a preference reversal over time.



A hyperbolic temporal discount equation is as follows (Loewenstein and Prelec, 1992),

$$V = A / (1 + kD)$$

*Where V is the value of the delayed outcome, A is the amount of the delayed outcome, e is a mathematical constant, a base of the natural logarithm, D is the delay until the receipt of the outcome and k is the discount parameter i.e. rate of discounting.*

Strotz (1955) in his seminal paper was the first to present a model of dynamic inconsistency to account for the problem of intertemporal consumption utility maximization. He suggested that discount rates are higher in the short-run than in the long-run, meaning that people are patient when it comes to choices between the SS and LL reward when they are both presented at some future date, but when there is an opportunity for immediate gratification, then the behavior is often impatient. Giving an example involving bananas, if there is a choice between a banana at time  $t$  or two bananas at time  $t+1$ , people would have a harder time choosing e.g. “two bananas later” when the “one banana” is available “now” rather than when the both banana options exist at some distant time point. Strotz begins his (1955) paper by saying that, “Our answer is that the optimal plan of the present moment is generally one which will not be obeyed, or that the individual’s future behavior will be inconsistent with his optimal plan. If this inconsistency is not recognized, our subject will typically be a “spendthrift”, a term which has no meaning in existing utility theory but which becomes explicated in the theory presented here.” This was the criticism of the DU model that fueled much of the later work of economists and psychologists on time inconsistent behavior.

In their paper, “Economic Theory of Self-Control”, Shefrin and Thaler (1978) continued on the work of Strotz who repeatedly mentioned the concept of self-control in connection with intertemporal choice, but without accounting for it in his model. Shefrin and Thaler added the concept of self-control to their model of dynamic inconsistency. They comment on Strotz’s model by saying that “The remarks seem to be based not on the model (in which it is always rational to do what is best given today’s preferences) but rather on Strotz’s value judgment that the high discount rates observed in the short run are inappropriate. To make the model complete, however, it is only necessary to have the individual share Strotz’s value judgment. Since delay of gratification is more difficult as the object of desire draws nearer, observed discount rates become high in the short run. Sophisticated Individuals will recognize this internal, systematic bias and, like the man in the restaurant, they will rationally take steps to

reduce the costs of this bias. The contribution of this paper is to explicitly recognize these costs, and to show how they can be incorporated into an economic model of intertemporal choice.” The model of Shefrin and Thaler (1978) then added the dual nature of the decision-maker by modeling the decision-maker with an analogy of an organization, consisting of a combination of two conflicting selves, a “planner” and a “doer”. These “sophisticated individuals” could then plan to behave in an unbiased way and thus avoid falling trap to the inconsistency that results from the “doer’s” impulsive approach.

Later, in the (quasi-) hyperbolic model ( $\beta$ - $\delta$  model) of Laibson (1997) the conflict of the time consistent and time inconsistent discounting behavior is taken into account in his model by using the “beta” and “delta” parameters. In the model, the dynamically inconsistent decision-maker is assumed to exercise an imperfect commitment technology in choosing between an illiquid asset  $z$  and a liquid asset  $x$ . The decision-maker may consume her liquid assets now, turn the illiquid assets into cash and consume in a later time-period or borrow against the illiquid assets and also receive the cash of the loan only at a later time-period. The discount function attempts to take into account the results of animal behavior experiments from e.g. Ainslie et al. (1992). The exponential discount function  $\delta$  is of a constant function, whereas the  $\beta$  is of a hyperbolic function. The combination of these two discount functions forms the quasi-hyperbolic discount structure. The formulation of the quasi-hyperbolic utility function is as follows,

$$\forall t, U^t(u_t, u_{t+1}, \dots, u_T) = \delta^t u_t + \beta \sum_{\tau=t+1}^T \delta^\tau u_\tau$$

*Where  $u_t$  is a person’s instantaneous utility in period  $t$ .  $\beta < 1$  implies a biased preference for present utility.  $\beta$  and  $\delta$  are constants between 0 and 1.*

More recently, in spirit of Shefrin and Thaler’s work, Fudenberg and Levine (2006) presented their model of a “dual-self” that accounts for self-control problems in time inconsistency. The model is based on the recent neurological findings of human fMRI studies that suggest that different neural processes account for short-term impulsive behavior and long-term planned behavior. Other recent contributions to the modeling of self-control in intertemporal choice include Gul & Pesendorfer (2004), Brocas and Carrillo (2014).

## **Short review of evidence of hyperbolic discounting behavior from the field and laboratories**

Study by Angeletos et al. (2000) revealed behavioral evidence on that hyperbolic households, which are households that hold relatively more illiquid and relatively less liquid assets use more credit cards and experience a greater drop in consumption around retirement. In a field study by Della Vigna and Malmendier (2006) the researches found out that U.S. health club members overestimate their future self-control or efficiency, by the less active members overpaying for per-visit price by committing to a payment plan instead of paying on per-visit basis, which results in significant excess costs over what the standard DU model would imply. A laboratory experiment on temptation and commitment by Houser et al (2010) used repeated tempting choices with the option to commit, which was possible by removing the tempting option. Their findings revealed a significant consistency with the Fudenberg and Levine (2006) hyperbolic discounting model of decisions under temptation in that if the individual who decides to choose to forego a tempting option she will not change the decision (i.e. not opt for the commitment cost) when the tempting choice is presented repeatedly. Burger et al. (2009) in their field experiments on willpower depletion and procrastination, which are problems that are strongly associated with lack of self-control, showed results that were consistent with all the modern behavioral models of self-control.

### **Commitment devices**

A commitment device could be anything from a savings plan to a promise, but in economics it is often modeled as a commitment contract that includes a cost when failing at self-control. For an overview on commitment devices, see Brocas et al. (2004). A fictitious example of a commitment device can be again taken from Homer's Odyssey when Odysseus, the hero of the story, waxes his men's ears and then gets himself bound to the mast of the ship in order to avoid falling for the sirens' deadly temptation and states, "but you must bind me hard and fast, so that I cannot stir from the spot where you will stand me ... and if I beg you to release me, you must tighten and add to my bonds." A modern example of a commitment device would be cutting up one's credit cards (Bryan et al. 2010) in order to avoid impulsive spending behavior, or the use of contractual commitment services like stickK ([www.stickk.com](http://www.stickk.com)) or pre-commitment applications like

SelfControl ([www.selfcontrolapp.com](http://www.selfcontrolapp.com)) that aim at avoiding the entering of distractive websites.

## **Differences in delay discounting experiments with hypothetical and real rewards**

There are a number of studies on the differences of hypothetical and real rewards in delay discounting experiments. According to Frederick et al. (2002) overwhelming majority of these studies conclude that hypothetical rewards are a valid proxy for delay discounting with real rewards. The benefit of using hypothetical rewards over real ones is in that they allow the use of large monetary choice sums that make the results of the experiments applicable for understanding real-life delay discounting behavior. For example, a within-subjects design analysis by Madden et al. (2002), Johnson & Bickel (2002), Bickel et al. (2009) on delay discounting, and on social discounting by Locey et al. (2011) found no significant differences in how real and hypothetical rewards are discounted.

## **The relation with impulsivity in hypothetical financial delay discounting and real-world impulsive behavior**

Reimers et al. (2007 & 2009) in their study on temporal choice with a large sample (around 48,000 UK-resident participants) found an association with measures of early sexual activity, infidelity, smoking, drug use, above normal (and below normal, to some extent) body-mass-index (BMI) and increased preference for the hypothetical sooner-smaller (impulsive) reward. Also demographics such as younger age, lower income, lower education and female gender were associated with a preference for the SS reward. This study provided evidence for financial discounting being associated with real-world impulsivity, implying that economic decision-making partially correlates with impulsivity in other domains of life. Research by Tangney, Baumeister and Boone (2004) found correlations between high self-control scores and high grade point average, self-esteem, less alcohol abuse, less impulsive eating, better relationships and interpersonal skills, more optimal emotional responses and fewer psychopathology reports. These studies provide a scratch at the surface of the topic of how self-control is an important characteristic in relation to quality of life.

## **Nurture: Cultural differences in delay discounting**

Study by Takahashi et al. (2009) confirmed the predictions of cultural neuroeconomic theory, which states that Westerners have an analytical cognitive style of allocating their attention in intertemporal choice decisions and that that is different from Easterners who approach similar decisions holistically. The result is that Westerners are more impulsive and inconsistent in intertemporal choice in comparison to Easterners. These cultural differences suggest that nurture, and most importantly the way people allocate their attention, plays a significant role in how people make decisions in intertemporal choice. It would logically follow that *learning* then can influence people how they approach intertemporal choice decisions. The findings of Takahashi et al. (2009) are therefore encouraging for this study of exogenous interventions that seek to increase the role that nurture plays in delay discounting behavior.

## **Nature: Role of disposition in delay discounting**

Although nurture plays a significant role in intertemporal choice, individuals also are by nature very different in how they discount future rewards (Shamosh et al., 2008). Interestingly, in their study Shamosh et al. (2008) found a negative relation between delay discounting and intelligence. According to Gianotti et al. (2012) some of these differences in delay discounting are due to genetic factors. Also, Anokhin et al. (2011) research on twins provides evidence for heritability of delay discounting in humans. Boettiger et al. (2007) in their study “Immediate reward bias in humans” found significant genotype effects of variation in dopamine metabolism on temporal discounting behavior. These studies suggest that disposition, or “nature”, is of major influence in delay discounting decision-making. Due to dispositional factors some people have more difficulties in activating the self-control processes endogenously than others. This is the group of people that would benefit the most of the use of self-control tools.

## **Currently known neural processes associated with intertemporal choice**

Intertemporal choice behavior is connected to specific neural processes. Two systems that have for some time been speculated to be relevant in intertemporal choice decisions are the intuitive system, that values primarily or only SS rewards, and the reflective system, that

values both SS and LL rewards. The quasi-hyperbolic model ( $\beta$ - $\delta$  model) represents this theory of two separate neural processes. According to McClure et al. (2004a, 2007) the neural processes behind the intuitive system ( $\beta$ -system) are correlated with activity in ventral striatum, ventromedial prefrontal cortex (VMPFC) and posterior cingulate cortex. The neural processes behind the reflective system ( $\delta$ -system) were found to correlate with activity in dorsolateral prefrontal cortex (DLPFC) and posterior parietal cortex. This separation is also known by the name of dual-process theory (Evans & Stanovich, 2014). Recent findings provide first causal evidence that in addition to these separated neural processes associated in decision-making in intertemporal choice there may also be a neural self-control account that is responsible for subjective valuation of choices (Figner et al., 2010, Hare et al. 2009, 2011 & 2014, Kuhn et al. 2014).

## **Implementation intentions**

Professors Peter Gollwitzer, Thomas Webb, Gabriele Oettingen and Paschal Sheeran have been the central researchers in designing and extensively studying the use of simple verbal sentences that aim at increasing self-regulation in individuals in various different contexts of goal attainment processes. These simple verbal sentences are called implementation intentions. “Implementation intentions are if-then plans that spell out in advance how one wants to strive for a set goal. For the if-component, a critical cue is selected (e.g., a good opportunity, an anticipated obstacle) that is linked to a goal-directed response in the then-component. Implementation intentions are known to enhance the rate of goal attainment. They do so by delegating action control to situational cues thus endowing action control with features of automaticity.” quoted directly from (Gollwitzer & Oettingen, 2013). For an informative paper about the different functions of implementation intentions, see “How to Maximize Implementation Intention Effects” by Gollwitzer et al. (2010). Most interestingly for my experiment, implementation intentions have been studied in the context of delay of gratification in children with and without ADHD (Gollwitzer et al., 2011). The results of that study suggest that delay of gratification can be increased with the use of implementation intentions.

Implementation intentions have specially designed structure that separates it from base goals. “While goal intentions (goals) have the structure “I intend to reach Z!” with Z relating to a desired future behavior or outcome, implementation intentions have the structure “If situation

X is encountered, then I will perform the goal-directed response Y!” Thus, implementation intentions define when, where, and how one wants to act on one’s goal intentions. In order to form an implementation intention, individuals need to identify a goal-relevant situational cue (such as a good opportunity to act, or an obstacle goal striving) and link it to an instrumental goal-directed response. Goal intentions merely specify a desired future behavior or outcome. On the contrary, the if-component of an implementation intention specifies when and where one wants to act on this goal, and the then-component of the implementation intention specifies how this will be done. For instance, a person with the goal to reduce alcohol consumption might form the following implementation intention: “And whenever a waiter suggests ordering a second drink, then I’ll ask for mineral water!” Empirical data supports the assumption that implementation intentions help close the gap between holding goals and attaining them. A meta-analysis based on close to a hundred studies shows a medium to large effect on increased rate of goal attainment.” quoted directly from (Gollwitzer and Sheeran, 2006). The brilliance of implementation intentions lies in its simplicity of use, cost-efficiency and the automatic activation of the goal-directed behavior, which requires no conscious exertion of attention when the cue situation occurs. This saves the individual from the depletion of the precious willpower resource, which is specifically important for enabling successful self-control (Wagner et al, 2013 and Kuhn et al., 2014).

## **Attention**

Recent neuroimaging studies have identified attention to be divisible into three different functions that have their individual neurotransmitter modulators and which are also identifiable in separate neural activity processing. The three different functions are orienting, alerting, and executive attention (Posner and Rothbart, 2007). The role of executive attention is relevant in connection to my experiment, since it involves mechanisms for the monitoring and resolving of conflict among cognition, affect and responses. The objective of my intervention is to stimulate the executive attention networks by exogenously steering the attention to a cue specific goal-directed response, which involves a facilitation of the individual’s self-control processes. This objective of forming an attention cue that seeks to induce endogenous self-control is somewhat similar to that of the Hare et al. (2011) study.

## **Query theory and reversal of the value judgment**

Johnson, Keinan and Häubl in their paper *Aspects of Endowment: A Query Theory of Value Construction* (2007) suggested that the order of the perception of values, or query, is influenced by the way the decision-maker focuses her attention to the choice. One (fourth) of the premises of the query theory is that the decision-makers approach the choice valuation in differing ways that are activated according to their position, e.g. if the decision-maker is a seller or a buyer in considering a transaction. A chooser (in the case of a transaction decision in an endowment effect experiment) usually makes her judgment from the perspective of first considering why to not enter into the transaction and then secondly why to enter one, whereas the opposite seems to hold true for the sellers. The theory sheds light to the intuition that when people approach decisions with different orders of query this leads to differences in value construction. The results of Johnson, Keinan and Häubl's experiment showed that by reversing the order of the query to an unnatural sequential perception pattern, by making sellers list value-decreasing aspects of the endowment first and choosers to list value-enhancing aspects first, the endowment effect was eliminated completely. According to Kahneman and Miller (1986) decision makers usually make the value judgment from the perspective of "what are the advantages of the status quo?" first and then only after evaluate the advantages of the opposite perspective. These findings would in theory lead to differences in situations where people are asked for "what they would prefer", contra being asked to consider first "what they would not prefer", and where they still are required to "choose according to their preferences". Koriat, Lichtenstein and Fischhoff (1980) found effects similar to Johnson, Keinan and Häubl in relation to reversal of order in asking the subject if she is wrong, rather than if they are right. This reversal was found to reduce overconfidence effects.

## **Cognitive re-construal, pre-commitment, motivation and willpower**

Cognitive re-construal is the cognitive reconstruction or visualization of one's goal intention into a task that seeks to activate a higher motivation in the individual's goal attainment pursuit. Magen and Gross (2007) found out that cognitive re-construal is beneficial in resisting temptation of the immediate reward in a hand-grip task. The goal in this task was to hold-on to the hand-grip device as long as possible, which required that the participant resisted the temptation of stopping due to the painful nature of the task. In their study,



participants in the treatment group who construed the task as a test of willpower were able to resist temptation better than the group that did not receive the cognitive re-construal intervention. Cognitive re-construal focuses the individual's attention to an ex ante specified goal intention, which makes the exercise of willpower easier. According to e.g. Baumeister, Vohs and Tice (2007), willpower is an important component in self-regulatory processes. Willpower to exert self-control is a limited energy resource and can be depleted, almost like a muscle that gets tired, when used. Being repeatedly exposed to a tempting object will result in depletion of willpower and increased difficulty to resist it. Also low blood glucose levels have shown to have negative effects on willpower. Implementation intentions are among the suggested tools to reduce the depletion of that valuable resource. In addition to willpower, Baumeister and Vohs (2007) suggest that motivation also plays a significant role in using self-regulation to achieve a goal or meet a standard. Its role is two-folded though, as motivation can either create a conflict between selfish and social motives or be a benefit for effective self-regulation. In relation to willpower, pre-commitment has been recently studied as an effective tool for activating neural self-control processes that lead to a successful resistance of the tempting SS choice (Crockett et al., 2013).

## **2. Materials and methods**

### **Subjects**

108 Swedish students, men and women (50,9% and 49,1% respectively), between the ages of 19 to 29 years from Gothenburg University School of Business, Economics and Law participated anonymously to this non-incentivized experiment.

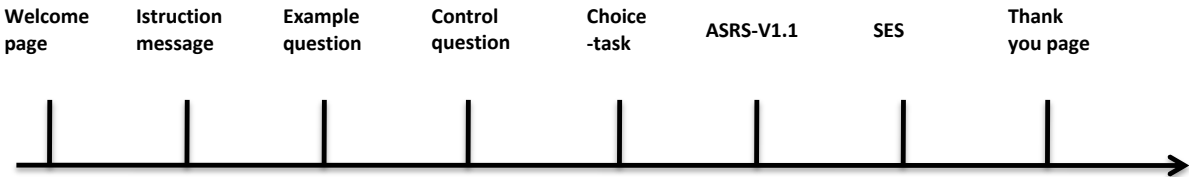
### **Materials**

The participants took part to the study by receiving a link to the experiment that was conducted by using the SurveyMonkey.com online survey service (Gold plan). The participants were contacted by university email and were asked to take part in an experiment on economic decision-making that takes on average eight minutes to complete. The participants answered to the experiment at the university computers or at home on their personal computers.

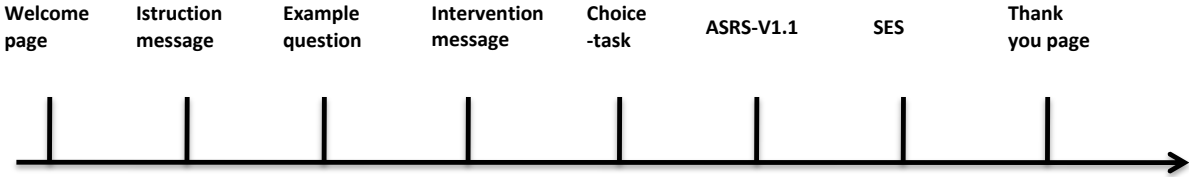
# Procedure

The computerized session started when the participant entered the link in their browser. A pseudo-random algorithm included in the service divided the participants equally into two groups with 54 participants in each condition. The other group received no intervention, but only a control question to check if they understood the instruction message, and the other group received an exogenous self-control intervention.

Intervention condition experiment timeline:



No-intervention condition experiment timeline:



After receiving the welcome page message titled “Economic Decision-Making Task” the participants all were given the same instruction message. The first paragraph of the instruction message was formulated by following the example of Murphy et al. (2001) instruction message. The instruction message of my experiment was as follows:

*”Please read the following instruction message carefully:*

*The options are about money you will receive either immediately or later. Suppose as if the options were about real money. Two amounts of money appear on the monitor. A decision takes place when you check a box under the amount you prefer and then press the “Next” button on the screen. Your job is to choose which of the two amounts of money is most appealing to you. All choices are unrelated to each other so answer every question on an*

*individual basis. Just judge each amount based on what is most appealing to you. Remember that there are no 'right' or 'wrong' answers in this task.*

*On the next page you will receive a practice question. After that you get a short message and then answer the 16 questions. Please answer the experiment alone, in one sitting and focus on it. Also, put away any media that would hinder your attention to the task.”*

The Murphy et al. (2011) instruction message was chosen as an example, because it provided a clear and applicable standard that was used in a similar choice task design. After the instruction message all the participants received an example question (see appendix page 42 for a screenshot) that was intended as a visualization device so that the intervention condition would have an easier time to mentally simulate the situational cue and then link it to the intended goal-directed behavior in the choice task.

On the next page the participants received either the baseline condition or the treatment condition stating, *“Past research has shown that people approach tasks with different goals, which are important in determining their outcomes. That said, I would like you to memorize a goal for this task. Following the goal is important in that it will help you to ensure a quality decision-making process. In order to help you memorize the goal, I would like you to read the sentence below with full attention and then say it out loud to yourself three (3) times:*

*'IF I AM ASKED WHAT I WOULD PREFER, THEN I WILL IGNORE MY IMPULSIVE OPINION AND TAKE TIME TO MEASURE WHICH ONE IS THE WORSE CHOICE ... AND THEN SELECT THE OTHER ONE!'*

*After you are done with the memorization, please write the sentence down (in lower case letters/small letters) to the box below:”* The baseline condition involved a control question about the first page task instructions that they were then asked to answer into a text box:

*“In order to check that you have understood the instructions on the first page, please state what is your purpose in this choice task by writing it down in a single sentence to the text box below:”*

The choice task with the 16 binary questions was then started (see appendix page 42 for a screenshot). After the first eight binary questions the participants were asked to re-state the sentence that they wrote down at the time when they either received the intervention or the no-intervention message:

*“Great! We have now come halfway to the task. I would like you to try hard to remember what you wrote down into the box at the beginning of this experiment. Please try to remember the sentence by writing it to the box below:”*

The re-stating of the sentence was then followed by the remaining eight binary choice task questions. After the choice task was completed, the experiment continued with the Adult ADHD Self-Report Scale (ASRS-V1.1) Symptom Checklist Part A, which consists of six questions and is intended to provide clues about potential adult age ADHD symptoms (see the appendix for the whole questionnaire and its interpretation). If the subject answers 4 or more questions above a highlighted scale, then the result suggests a potential case of adult age ADHD (see the questionnaire and instructions about its interpretations in the appendix).

The last part of the experiment was a Socio-Economic Status (SES) survey including questions about gender, effect of 200-1000 SEK on monthly budget and self-reported average response time per choice task question (screenshot in appendix pg. 43). The experiment then ended with a “thank you” message. The survey tool collected the IP addresses of participants, date and time of completion and total experiment completion times. Also the non-completed experiments were collected (63% who entered the experiment completed it in its entirety).

## **Experimental design**

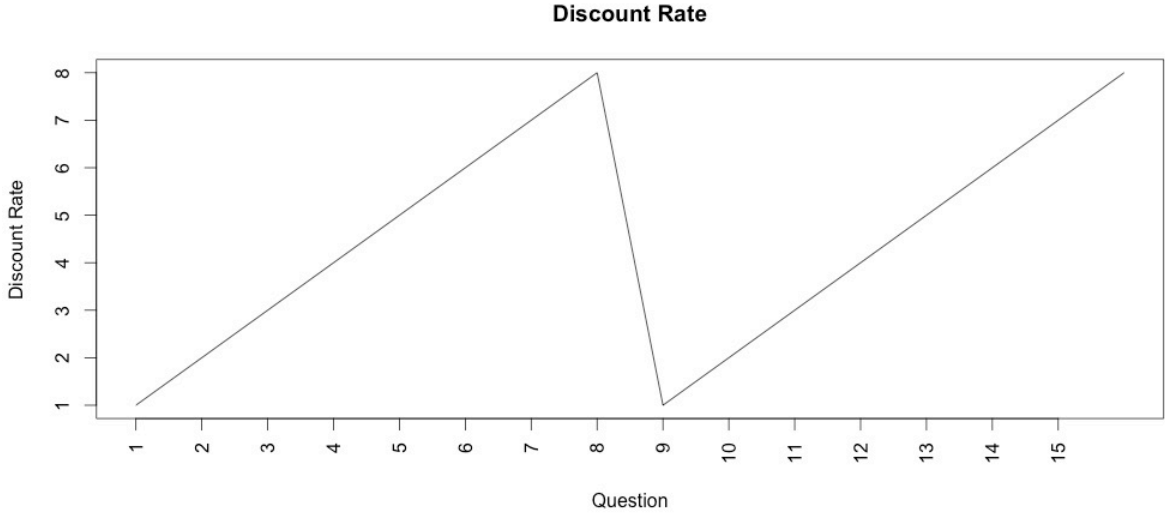
### **Choice task**

I have designed a novel intertemporal choice task where participants in both groups answered 16 binary choices that offered a sooner-smaller (SS) and a larger-later (LL) reward with magnitude differences that aimed at producing a large choice conflict. The reasoning behind having multiple choices is that this better represents the nature of SS choices in real-life, since they are often in a repeated form, instead of a single choice form (Houser et al. 2010). The reward magnitude differences were chosen as a result of the findings in Figner et al. (2010) where they discovered that intermediate magnitude differences present the largest choice conflict and thus demand the most self-control in resisting the pleasure of the immediately available SS. This would imply a relatively even distribution between the SS and LL choices among the no-intervention group of subjects. In addition to the differences in reward magnitudes between SS and LL, the LL reward was stated to be received either 2 or 4 weeks later than the SS reward that was always stated to be received now (the time of receiving LL

follows the form of a continuous sequence of “in 2, 4, 2, ..., 4 weeks”). The “now-or-later” design is in line with the findings of Figner et al. (2010), where they found that the self-control is needed when the tempting SS choice is available now, rather than at some future time (i.e. where SS was being received in “2 weeks” or “4 weeks” instead of “now”). The order of appearance of the rewards on the screen, either the SS or the LL choice presented on the left, was randomly flipped throughout the experiment. Reward magnitudes of SS were chosen by using the randomizer.org random number generator. The rewards were presented in Swedish currency (SEK) and were between amounts of 200 and 1000 SEK. The LL rewards differed from SS by an incrementally increasing factor until the mid-point of the task and then starting again after the mid-point from low magnitude difference to a larger (LL was larger than SS by 4, 6, 8, 10, 12, 14, 16, and 18%). The incrementally increasing monetary amounts represent an increasing difficulty to resist temptation until the mid-point, where the same process is restarted (naturally with different randomly chosen monetary amounts). Also, at the mid-point, the participants in the intervention condition were asked to re-state the goal intention sentence. The no-intervention group participants re-stated the control question answer. This question was done to check if the individuals had followed the instructions.

In the paragraph below (Graph 1) I have illustrated the relationship between the discount rate, on the vertical axis, and question order, on horizontal axis.

**Graph 1**



By observing the graph one can see how the discount rates fluctuate throughout the task design. The discount rates begin from 4% (question 1) and go up to 18% at mid-point (question 8), with 2 percentage point increases, and then again repeat the same pattern from

question 9 through 16. The time of payment for the LL choice differs for the discount rates by a continuous pattern of “in 2 weeks (question 1), in 4 weeks (question 2), ..., in 4 weeks (question 16)”. The questions with the same discount rate in the second half of the choice task have different times of payment. For example, the question 1 has a 4% discount for the LL choice and a 2 week payment date and its pair in the second half of the choice task, the question 9, which also has a 4% discount rate but a 4 week payment date.

**Hypothesis 1:** The choice task design will on average present a large choice conflict between the SS and LL choices for the individuals in the no-intervention group, i.e. implying a close-to-even (close to 50-50 split) choice distribution.

## Intervention design

With the use of general semantics, my intervention will attempt to help the individual to discover the choice that is most rational to her. I further speculate that the decision-maker who receives my intervention will be able to, on average, be more rational if she ignores the impulsive opinion, takes time to think (measure) and approaches the choice from a two-relational, instead of a single-relational, inverted perspective. Later in this paper I will refer to the intervention design by the name of the Art of Measurement (AoM) -device.

**Table 1. Description of the AoM –device functions**

List of AoM –device functions	Aimed purpose of the function
Implementation intention sentence structure	Automatized goal-directed behavior in a situational cue environment
Inhibition of a prepotent response	Behavioral inhibition by blocking an impulsive decision
Response time	Patience to take time to measure/reflect
Two-relational inverted value judgment	Activation of executive cognitive functions and self-control processes

An ancient example of a self-control activating verbal sentence can be observed in the ancient Greek poet Homer's quote from approx. 800 BC, "Be still my heart; thou hast known worse than this.", where the aforementioned person repeats a verbal sentence aloud that seeks to remind himself about past difficulties in order for him to overcome the present one. The quote is a relevant example to the intervention of this study, because there is a link to ancient Greece in the way the rhetorical functions of the AoM -device are designed. Further, the intervention is formatted inside an implementation intention structure that consists of if- and then- sentence components (Gollwitzer and Sheeran, 2006).

The exogenous activation of self-control will be attempted with the following simple verbal sentence.

### **The AoM –device:**

*"If I am asked what I would prefer, then I will ignore my impulsive opinion and take time to measure which one is the worse choice, ... and then select the other one!"*

The sentence consists of a situational cue, the if-component of an implementation intention structure, and after the first comma, a goal-directed response, the then-component of an implementation intention structure. The then-component consists of three different functions. The ideas behind the components and functions are described in the paragraphs below. The part of the intervention sentence that is explained in the next paragraph is highlighted by the bolded format.

### **The situational cue**

*"If I am asked what I would prefer, then I will ignore my impulsive opinion and take time to measure which one is the worse choice, ... and then select the other one!"*

The if-component of an implementation intention structure forms a cue to an ex ante specified environment. The wording that is highlighted above is mentally linked to the individual choice task screen where the question, "What would you prefer?" is stated. The situational cue is then activated when the participant reads the literal question on the screen. The situational cue could also be modified to various other types of situations, e.g. "If I am being asked that do I want to have a smoke..." The flexibility behind the implementation intention structure allows that this cue can also be a physical or mental environment or an emotional state (Gollwitzer et al. 2007).

## **Rhetorical functions behind the AoM –device**

The exogenous activation of the neural self-control process in the simple verbal sentence format contains three functions that are installed in the then-component of the implementation intention structure. The then-component aims at automatized goal-directed actions. The functions are 1. inhibition of a prepotent response, 2. response time and 3. A two-relational inverted value judgment. These three functions aim at specific cognitive effects in the individual receiving the intervention and memorizing it.

### **Function one: Inhibition of a prepotent response**

*“If I am asked what I would prefer, then **I will ignore my impulsive opinion** and take time to measure which one is the worse choice, ... and then select the other one!”*

Behavioral inhibition is a key component in the successful resistance of repeated temptation (Polivy, 1998). Inhibition of a prepotent (impulsive) response has been found to be beneficial in decision-making where executive neural processes are required for better performance in a task (Li et al., 2006b, Diamond et al., 2002). When the temptation of acting impulsively and choosing the SS is large, the inhibition will be particularly important. Requiring the decision-maker not to act impulsively will be used in the intervention since the neural processes behind impulsive decision-making account for overweighing of the SS reward. In attempt to overcome this I have included an inhibition of a prepotent response, a behavioral inhibition, as the first function of the intervention. This function attempts to block the subject’s impulsive response and therefore allow for the operation of executive cognitive functions. The executive cognitive functions are planned as separate goals in the following stages of the then-component.

### **Function two: response time**

*“If I am asked what I would prefer, then I will ignore my impulsive opinion **and take time to measure which one is the worse choice, ... and then select the other one!**”*

There are an increasing number studies about response time (RT) in economic decision-making (Chabris et al., 2008, Rand, Greene & Nowak 2012, Schotter & Trevino 2010, Ratcliff & Rouder 2009, and Rubinstein 2013 to name a few). This literature focuses mainly on documenting response times for correct and incorrect choices in different type of decision-making tasks. To shortly summarize the findings in these studies is that faster response time



indicates more instinctive or intuitive cognitive processes and the slower response time are correlated with more reflective and rational thinking. This interpretation often links this literature to the dual-system process perspective as suggested by e.g. Frederick and Kahneman (2005). Research by Habris et al. (2008) is also of relevance, since it studied RT in intertemporal choice in a binary choice set similar to the one used in this experiment. They conclude by saying that, "...Response time data sheds light on both our preferences and on the cognitive processes that execute those preferences." Recent neuroimaging studies have also found a relation between response time and valuation of monetary rewards in short-term temporal discounting (Gregorios-Pippas et al., 2009). As the temporal delay of the reward increased, already during a short delay of 4-13.5 seconds, the subjective reward valuation was decreased. The AoM –device takes RT into account by attempting to allow some time for the activation of reflective neural processes, which intends to make the responder more patient in her decision-making.

### **Function three: A two-relational inverted value judgment**

*"If I am asked what I would prefer, then I will ignore my impulsive opinion and take time to measure which one is the worse choice, ... and then select the other one!"*

Introverted parallelism of thought is a rhetorical concept that is common in many historically known works of western literature. One of the most known users of this concept was the Greek poet Homer (Samuel Eliot Bassett, *The Poetry of Homer*, Volume 15, pg. 126). Also, the philosopher Socrates used this rhetorical device, the "Homeric hysteron proteron" The inversion of words and ideas was many times present in his dialogues that Plato documented into literate form. Similar transpositions are also found in the narratives of William Shakespeare. They are utilized even in popular culture by the imaginary figure Yoda of the Star Wars saga. The reversion of words in a sentence is an attempt of making the reader to exert more attention to the idea behind the sentence. The unnatural order of words causes confusion in the individual, which I then speculate to stimulate additional attention.

"This was what I meant when I spoke of impressions which invited the intellect, or the reverse, those which are simultaneous with opposite impressions, invite thought; those which are simultaneous do not." Socrates in Plato's *The Republic*.

The goal-directed behavior of an inverse value judgment attempts to implement this above-mentioned rhetorical device. Instead of an idea of a preferred choice as a 1-relational or

singular option, now there is a division into two parallel options: the worse and its opposite. The division thus involves the concept of plurality in the form of two contradicting values. This parallelism is then presented in an inverted, and therefore unnatural, fashion attracting the attention to the worse choice first and measuring it against its opposite. This type of introverted parallelism of thought is an idea that was inspired by the theory of logic (Jacquette, 2002). In relation to the Johnson, Keinan and Häubl (2007) findings on the reversal of the natural order of query in an endowment transaction, the third function of the AoM -device seeks to influence the decision-maker by considering the value judgment in an unnatural way. I speculate that the subject is making a more impulsive decision when she is asked “*what would you prefer?*”, and then choosing according to her preferences, than when she is considering the decision first from the perspective of “*which is the worse choice?*”, given the same question. The unnatural sequence pattern of the value judgment would thus result in the subject receiving the manipulation condition being on average more reflective rather than impulsive.

What Socrates called by the name of “the art of measurement” is a careful observation about the relative values in binary choices. The word ‘*measure*’ is then used in the sentence in order to direct the additional attention to a thoughtful examination of the question, which I speculate to lead to an increase in executive control processes.

In terms of logic, the undivided and natural approach to the value judgment would be presented in a following way:

*“...choose the best choice!”*

A divided and natural value judgment would be as follows:

*“...measure and compare the two choices, ... and then select the better one!”*

Whereas the inverse order of the divided value judgment, in an unnatural or inverted form, is presented as:

*“...measure which one is the worst choice, ... and then select the other one!”*

Neuroimaging studies have found evidence for relational integration, or the simultaneous consideration of multiple relations, to require complex reasoning that is associated with prefrontal cortex activity (Christoff et al. 2001). A 2-relational reasoning includes two dimensions being considered simultaneously, i.e. they are integrated, whereas a 0-relational

and 1-relational reasoning does not. 2-relational reasoning is then more complex and requires additional executive control, which was in the Christoff et al. (2001) study measured as an increase in prefrontal cortex activity. My speculation is that the additional executive control in theory then allows for the opportunity to activate endogenous self-control processes. As the following quote suggests, Socrates was also aware of the rhetorical power behind a relational integration process.

“...when there is some contradiction always present, and one is the reverse of one and involves the conception of plurality, then thought begins to be aroused within us...” (Socrates in Plato’s *The Republic*).

The interplay of these three functions in a verbal sentence form, within the implementation intention structure, is hypothesized to exogenously induce automatized self-control in individuals who are lacking natural endogenous self-control. Implementation of the AoM is materially cost-free and only requires the individual to believe in its effects and then exert attention for a brief time to verbally or literally (or both) formulate it. This happens by planning its specified cue, i.e. the if-component of the implementation intention structure and then memorizing the sentence, preferably by writing it down with a pen and a paper and then stating it out loud to oneself.

**Hypothesis 2:** The intervention group will on average choose significantly more LL rewards than the no-intervention group, due to the memorized AOM-device (an exogenous activation of self-control), which is speculated to be a result of an increased ability to resist the temptation of the SS choice.

### **3. Data and analysis**

The behavioral data of the 108 participants was analyzed by using between-groups t-test and a One-Way ANOVA. The dependent variable was the mean fraction of LL choices out of the total of 16 binary choices. The independent variable was the intervention ( $x=1$ ) or no-intervention ( $x=0$ ) subject group condition. We also analyzed the effects of the self-reported response time, answers to the World Health Organization’s Adult ADHD Self-Report Scale (ASRS-V1.1) Symptom Checklist Part A. Answers to socio-economic status (SES) questions were also analyzed.

*Correlation.* A correlational study between the two groups revealed a significant ( $p=.017$ , Sig. 2-tailed) correlation between the mean fractions of LLs out of the total 16 choices ( $\text{corr}=.229$ ). *Randomization.* The One-Way ANOVA analysis of the other variables showed that there was no between-group differences in gender ( $F=.036$ ,  $p=.849$ ), ASRS-V1.1 answers ( $F=1.96$ ,  $p=.164$ ) or impact on budget ( $F=.015$ ,  $p=.901$ ). There was a significant differences in self-reported response times at the 5% level ( $F=4.295$ ,  $p=.041$ ) though. This implies that the subjects in the intervention condition reported that they took more time on average to answer to each choice task question. This is perhaps because they could have been following the function two (response time) of the AoM –device or otherwise been more patient and/or reflective in making their choices. Mean total completion time of the experiment also revealed to be significantly different at the 10% level ( $F=3.351$ ,  $p=.070$ ). Mean total completion time for the intervention group was 9 minutes and 9 seconds, whereas it was 7 minutes and 59 seconds for the control group, and 8 minutes and 34 seconds for the total sample. The found difference is logical, since in addition to the observed longer time per choice task question the intervention sentence took more time to implement than the control condition. *Gender differences.* I also conducted a One-Way ANOVA between-groups analysis separately for both genders, which showed a significant effect for male-only group ( $F=4.743$ ,  $p=.034$ ) and a non-significant effect for the women-only group ( $F=2.269$ ,  $p=.138$ ) implying that the males were more effected by the treatment.

*Demographics.* Although there were positive coefficients in gender and budget impact, the control variables that consisted of the SES questions proved to be of no statistical significance on predicting subjects' mean fraction of LLs at the 5% or 10% levels. There is a variety of studies that have proven associations between lower discounting and some SES questions though, such as education and smoking (Jaroni et al., 2004), income (Harrison et al., 2002) and age (e.g. Green et al., 1996, Whelan and McHugh, 2009). *Descriptive statistics.* Budget impact: 7.4% of the total sample reported to have no impact at all of the 200-1000 SEK sum on their monthly budget, 28.7% reported a small impact, 52.8% some impact and 11.1% a large impact. ASRS-V1.1 answers: 20 participants or 18.5% had 0 hits, 18.5% 1 hit, 30 or 27.8% 2 hits, 21 or 19.4% 3 hits, 14 or 13.0% 4 hits (the ADHD threshold) and 3 or 2.8% had 5 hits. This would suggest that 15.7% of the participants (17 out of 108) could be suffering from adult age ADHD symptoms. Self-reported response time (RT): 55.6% of the participants took less than 3 seconds to answer each choice task question on average, 43.5% took 3-13

seconds and 0.9% more than 13 seconds. These RT findings then imply that slight majority of participants made quick intuitive decisions.

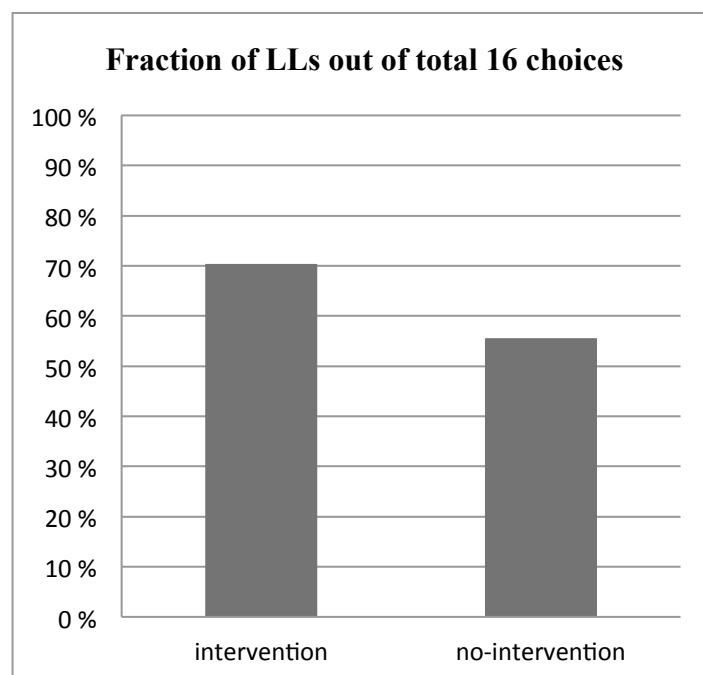
*Homogeneity.* I conducted a Fligner-Killeen test of homogeneity of variances. The results are presented in the table below.

Fligner-Killeen test of homogeneity of variances	Between females in control group and females in treatment group	Between males in control group and males in treatment group	Between control group and treatment group	Between males and females
Chi-squared	12.12	12.94	21.30	10.76
Df	9	10	14	14
p-value	0.21	0.23	0.09	0.70

The results imply that the variances in the each group are the same and thus the variance between the groups is homogenous, except in the case of the control group and treatment group comparison as was ex ante predicted.

## Results

**Table 2.**



Subjects in the no-intervention group selected 55.6% LLs on average, indicating a large choice conflict between the SS and LL choices, which I interpret as a confirming result to my *first hypothesis*. Subjects in the intervention condition selected an average of 70.4% LLs, which was a significantly larger proportion compared with the control group, which responds to a 14.8 percentage unit difference in the means. This confirms my *second hypothesis*. It could be speculated that since the subjects were business and economics students, the proportion of LL choices in the control condition (55.6%) was slightly higher than what could be expected from a sample more representative of the general population, i.e. where the result could be an closer to even (50-50 split) choice distribution as I predicted in my first hypothesis. The standard deviation in both groups was observed to be high (STD  $x=0$ , .316 and STD  $x=1$ , .319). This is likely due to the major individual differences in how individuals discount future values in this type of a binary choice environment. The R squared was observed to be very low (R squared=.052). This is also quite likely because of the large between-subjects variation.

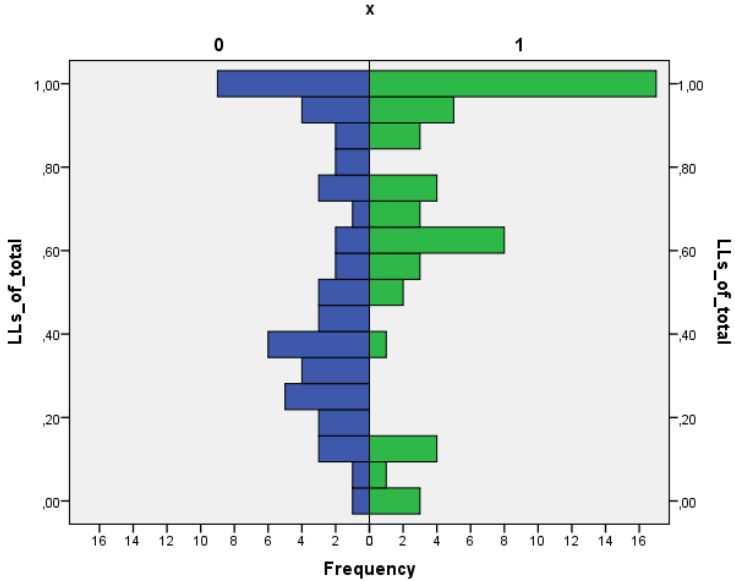
**Table 3.**

<b>p value, Sig. 2-tailed</b>	<b>t-value</b>	<b>F-value</b>	<b>b - coefficient</b>
.017	-2.423	5.869	-.148

The One-Way ANOVA (see appendix pg. 47) and the between-groups univariate analysis revealed that the effect of the intervention was statistically and economically significant at the 5% level ( $p=.017$ , Sig. 2-tailed,  $t=-2.423$ ,  $F=5.869$  and  $b=-.148$ ). These results confirm my second hypothesis that states that an exogenous activation of self-control in the form of a simple verbal sentence, inside an implementation intention structure, leads to participants in the intervention group to select on average more LL choices relative to the no-intervention group. The analysis predicts that the individuals in the intervention group selected on average 14.8% more LLs than in the no-intervention group.

The figure (Figure 1.) below illustrates the comparison of distributions between the intervention ( $x=1$ ) and no-intervention ( $x=0$ ) groups in terms of the subject's relative proportions of LLs chosen out of the total 16 questions.

**Figure 1**



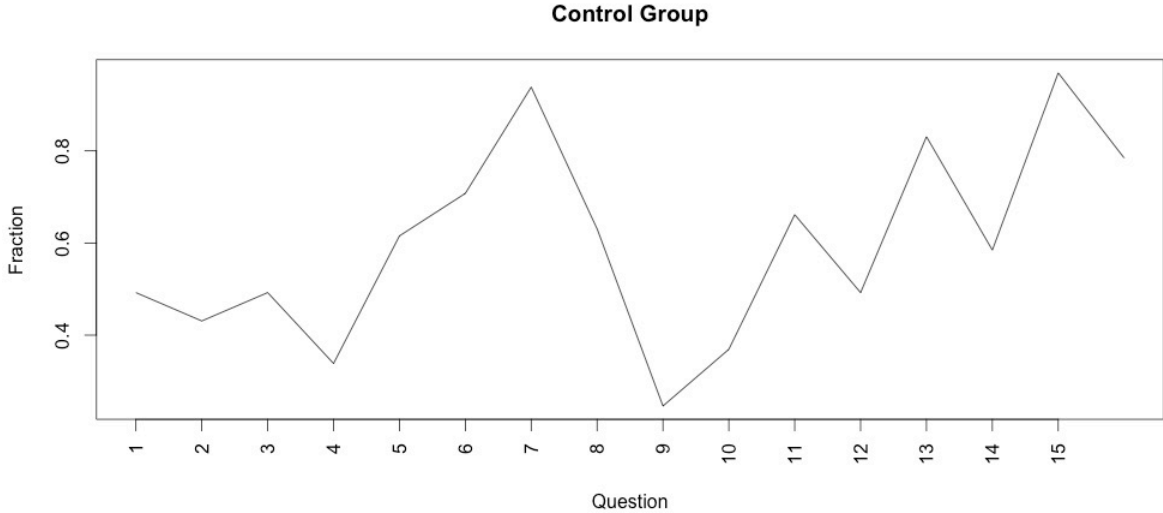
An observation of the figure reveals that the largest difference was in more individuals in the intervention group selecting 16/16 LLs. Interestingly this was also true of the individuals who selected 0/16 LLs, which presented proportionally a much larger number of subjects in the intervention group.

Overall, it is evident that there is a variety of ways how individuals approach the choice task. A choice task design pre-test follow-up discussion, that only included the no-intervention condition, with a select number of participants revealed some insights about these differences. Some subjects (reflective) think in terms of the discount rate by comparing it to what they can receive elsewhere. If the discount rate justifies the delay, they will wait, if not, then they will take the SS. These subjects tend to choose significantly more of the LL choices. Some subjects (heuristic) use rules of thumb such as “how many more beers can I buy with the spread between the SS and LL?” Here again the LL choices are weighted proportionally more than the SSs, but less than in the reflective sub-group. Some subjects (shoppers) think in terms of their budget, i.e. if they need money they always take the SS and if they are in no need of the sum at the moment, they always take the LL. Many of these subjects then have selected either 0% or 100% LLs out of total choices. The follow-up discussions also suggest that the individuals in the reflective sub-group, who take time to measure between the SS and LL, are self-educated about their approach to questions of this nature. The ability to be patient about the decision and in using careful measuring of the choices will in theory activate the executive neural processes and thus also quite likely result in activation of endogenous self-

control. On the other hand, individuals who act more or entirely according to their intuition have more between-subjects variation in their choices between the SS and LL. Their quick *opinion* leads them to a choice, which is dependent on their situational needs and dispositional factors, *contra reasoning*. The AoM -intervention attempted to induce similar behavior as was characterized by the reflective sub-group decision-makers. The results suggest that the attempt was successful.

In the following paragraphs I have made a short qualitative analysis of the results of the choice-task behavior of individuals in the treatment (Graph 3) and control (Graph 2) groups. The graph below (Graph 2) represents the fraction of people in the control group who chose the LL in each question.

**Graph 2**

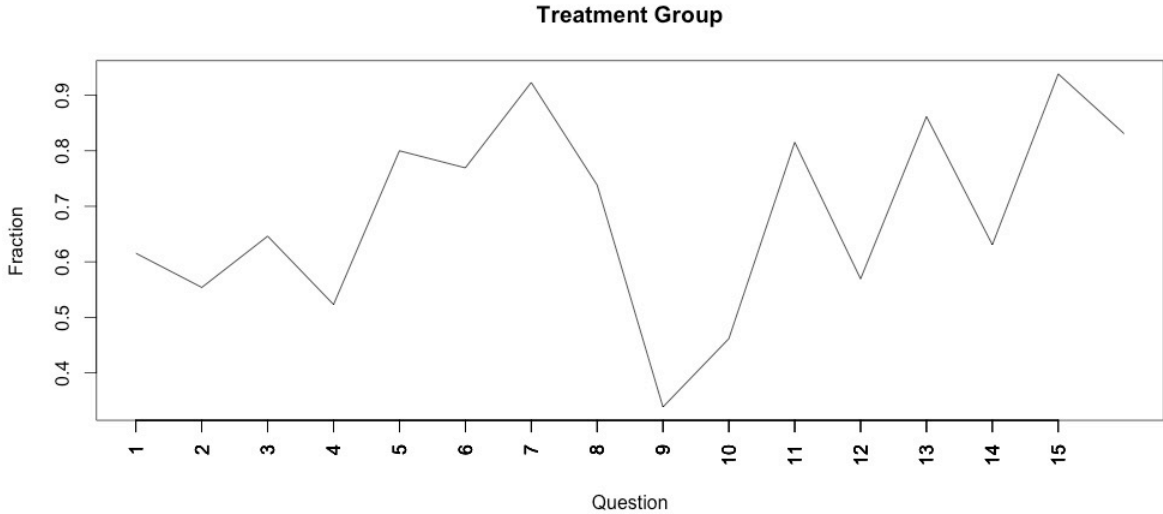


As we can see from the graph, the individuals in the control group had much more volatility between 2-week payment date and 4-week payment date choices during the second half of the choice task than during the first half. This could imply increasing impatience after the mid-point of the choice task to wait for the 4 weeks compared with 2-week payment dates. The low points of the naturally graph represent 4-week payment dates and the high points 2-week payment dates. It could be that people have decreasing willpower to resist the temptation of the SS choice with repeated choices. The questions in this choice task require constant attention because of the changing time dimensions and discount rates.

The graph below (Graph 3) represents the fraction of individuals making LL choices per question in the treatment group.



**Graph 3**



Participants in the intervention condition followed almost an identical behavioral pattern as in the control condition, based on the volatility of choices across different time dimensions when comparing the first and second half’s of the choice task. The difference in choice behavior is that in the starting point, especially in questions one (1) to six (6) of the choice task, individuals in the intervention group show a larger fraction of people choosing to wait for the LL choice. It could be that this is due to the overall willpower to resist the SS temptation decreases after the mid-point in this type of a choice-task. Being exposed to similar kind of choices possibly gets repetitive and therefore decision-makers become more impulsive in their choice behavior.

### **4. Discussion**

The findings of this research suggest that an exogenous activation of self-control by the use of a simple verbal sentence inside the implementation intention structure induces people on average choosing more LL rewards than the control group in financial delay discounting with binary hypothetical choices. To my knowledge these results presents first evidence of a successful exogenous activation of self-control with verbal attention cues in hypothetical financial delay discounting. The facilitation of self-control was executed by the use of the Art of Measurement (AoM) –device, which included three functions: 1. Inhibition of a prepotent response, 2. Response time, and 3. A two-relation inverted value judgment.

My personal speculation about the self-control phenomena is that, although a part of the individual differences in delay discounting can be explained by dispositional factors (e.g. Gianotti et al., 2012 and Anokhin et al. 2011), it is because of lack of education about how to activate the reflective processes that most people fail to allocate their cognitive resources in an optimal way. This inability to make patient and self-controlled decisions is being continuously reinforced in our modern western society, because of the influence of impulsive signals that our sensual pattern recognition is daily exposed to in the digital environment. Some credit may likely be given to the way most people consume popular media. The evolution of the brain has probably not caught up with this increasingly high frequency signal environment.

Successful activation of self-control is conditional on the facilitation of automatized self-control in situations where resisting the temptation of the SS choice is of importance. Intuitive judgments may either fail us or bring us to a true opinion, but only the activation of reflective neural processes can provide consistency in the quality of our decision-making. In order to successfully approach decisions involving intertemporal choice one needs to be conscious of the potential difference in outcomes when the decision is approached impulsively contra reflectively. The activation of self-control is included only when executive cognitive control takes place, i.e. the activation of self-control processes is excluded when we act impulsively. It is probably because of this that impulsive decisions often lead to more random outcomes.

The original inspiration behind this study came to being from, first of all, realizing the effectiveness of Professor Peter Gollwitzer's implementation intentions tools in my martial arts training and competition. Secondly, the neurological studies on the brain activity in intertemporal choice provided me with scientific insights that made me guess that an intervention that channels attention could in theory be formulated. After finding out how little I know about how the brain works, I am humbly encouraged to continue learning more in this area of study. Thirdly, the writings of Plato have led to many personal revelations about the workings of the human mind, which of not least the dialogues of Socrates being of major influence. Socrates' dialogues present brilliant interpretations about self-control and its importance for optimal decision-making. The two-relational inverted approach was also an idea that came to my mind by reading the dialogues. It is truly incredible that these observations of human decision-making behavior, consisting of situations where individuals

compare between tempting immediate pleasurable options and later better options, were conducted over 400 B.C.

## **Possible Implications**

How does the AoM –device and other self-control tools then help us to make a better world? On a general note, let us first reflect on the negative relation between delay discounting and intelligence that Shamosh et al. (2008) found in their study. People who had higher intelligence scores also were better in delaying gratification. Would it be outrageous to interpret the relation in a way that if we can help make people to resist the temptation of the immediate (SS) reward and thus be better at delaying gratification, then that by the use of these tools the individuals can become on average more intelligent? I believe that with today's constantly improving brain-imaging technology we have an interesting opportunity to at least test this hypothesis and possibly even develop other tools to improve the mankind's daily decision-making quality.

On a more particular note, problems of self-control like tobacco consumption, obesity, drug-use, excessive drinking, infidelity, sexually transmitted diseases result in negative consequences not only for the individual decision-makers, and also for their friends, family and the society as a whole. My intention was to come up with a decision-making tool that empowers the individual with autonomy over self-control. The tool works because it helps in overcoming the fallacies resulting from impulsive opining and instead facilitates a reflective and self-controlled decision-making process. This intention is distinct from commitment devices e.g. contractual services that are often a costly way of 'outsourcing' the need for self-control. These commitment devices also exclude the individual's utilization of situational rationality. Although in theory commitment devices often sound as a logical way to inhibit the temptation of the sooner-smaller reward, one needs to also consider related psychological processes, such as going public with one's goal intentions, which has actually shown to have negative effects in goal attainment success (Gollwitzer et al., 2009). Scientific inquiry into real-world commitment device's effects would be a highly recommended procedure before suggesting these type of contractual services to others. Examples of such services are stickK and SelfControl that have gained recognition as tools for committing oneself to a goal pursuit process.

If I draw speculate correctly about the Reimers et al. (2007 & 2009) studies, they are suggestive of a conclusion that exogenous self-control facilitations could in theory be beneficial in real life situations. An example of such a measure of self-control, that is consequential for its economic and societal effects, is tobacco use. It is probably needless to here restate the harms of tobacco consumption, when in America only the smoking of tobacco is attributed to approximately 400,000 annual deaths (Giovino, 2007). Fletcher and Sindelar (2009) found out that taxes have close to no effects on reducing smoking in people who lack self-control, since these people are largely unresponsive to the price of cigarettes. Instead the researchers suggested that other means of self-control with the intention of tobacco use reduction should be studied.

The findings of my study would suggest that exogenous activation of self-control with tools like the AoM -device could be one alternative way to approach the problem. As an example, the individual would plan and modify the AoM –device in a following way, “If I feel the desire to smoke a cigarette, then I will ignore my impulsive opinion and take time to measure which is the worse choice ... and then select the other one!” Whenever the members of our society learn to use such self-control tools as the AoM –device, and if even a small fraction of the people lacking endogenous self-control are able to resist the temptation of smoking for example, it would make an instant impact of increasing the life-quality of countless people. This can also be accomplished with minimal costs. Without further extending the speculation about possible benefits in other health related domains like obesity, microeconomic decisions, sexually transmitted diseases and drug consumption, it can perhaps be intuitively concluded that the implications are truly relevant.

As of now I am unaware of an economic model that takes the triple nature of the neural processes in intertemporal choice, the intuitive, the reflective and the self-control, into account. Creating a model inclusive of a parameter representing an exogenous activation of self-control would likely be beneficial for approximating the impact of such self-control tools.

Lastly, my proposal is to call the LL choice by the name “the evolutionary choice” and the SS choice as “the static choice”. This is, because making the LL choice promotes positive intra- and interpersonal growth, or results to higher overall utility than the SS choice. Often the

impulsive choice results in consequences that either hold the status quo or even lead to negative personal development trajectories.

## **Limitations of the present study**

There are several shortcomings that could be improved in future research on this topic. Firstly, instead of self-reported response times, actual response times would be interesting to study which requires more sophisticated experiment materials than the survey tool that was used in this experiment. Also, an incentivized duplication of this study with a larger sample would be of interest to test if a more resourceful experiment leads to different results. A possible enhancement of the experimental design would be in using Sindelar's (Yale Scientific, 2012) question of self-control after thy choice task, "Do you go with your gut when you make decisions?" instead of the WHO's ADHD questionnaire that failed as an attempt to measure individual's self-control outside the choice task environment. Also, the response rate to the experiment would have been possibly much higher if the experimental design of the choice task would have consisted of a smaller number of binary questions. This would have also possibly resulted to a dataset that has a smaller variation between subjects in terms of the fraction of LL choices which would have made the statistical analysis of the results more efficient. The intervention wording could also be optimized. This could be attempted by using a more direct goal-behavior script, such as "...measure, which is the lowest utility choice..." This wording would focus the attention on the concept of "utility", instead of a more general value judgment that was used in the division to "better" and "worse" choices. The AoM – device could be studied in comparison with another intervention design, possibly even a contraceptive treatment which attempts at making the participants in the intervention group more impulsive, rather than more reflective. The econometric analysis could be further improved by using a parametric approach to estimate the temporal discount function. Finally, it would be interesting to use fMRI technology to study the neural processes of decision-makers that implement the AoM –device.

## **5. References**

Ainslie G. *Picoeconomics* (1992). Cambridge: Cambridge University Press.

Ainslie GW (1974). Impulse control in pigeons. *J Exp Anal Behav.* 1974 May; 21(3):485-9.

Adele Diamond, Natasha Kirkham, and Dima Amso. Conditions Under Which Young Children Can Hold Two Rules in Mind and Inhibit a Prepotent Response (2002). *Developmental Psychology*, 2002, Vol. 38, No. 3, 352-362.

Angeletos, G.-M., Laibson, D., Repetto, A., Tobacman, J., & Weinberg, S. (2001). The hyperbolic consumption model: Calibration, simulation, and empirical evaluation. *Journal of Economic Perspectives*, 15, 47–68.

Ashraf, N., Karlan D. and Yin, W. (2006): Tying Odysseus to the mast: Evidence from a commitment savings product in the Philippines. *Quarterly Journal of Economics*, 121(2), 673–697.

Baron, J. (2000): *Thinking and Deciding*, 3rd edition. Cambridge and New York: Cambridge University Press.

Bassett Samuel Elliot. *The Poetry of Homer*, Volume 15, pp. 126-127.

Baumeister, Roy, Vohs, Kathleen and Tice Dianne. *The Strength Model of Self-Control* (2007). *Association for Psychological Science*. Volume 6, No. 6.

Baumeister. Roy, Vohs. Kathleen. *Self-regulation, ego depletion, and motivation* (2007). *Social and Personality Psychology Compass* 1 (2007)

Berns, Gregory S., David Laibson, and George Loewenstein. 2007. Intertemporal choice--toward an integrative framework. *Trends in Cognitive Sciences* 11(11): 482-488.

Benartzi, S., and R. H. Thaler. Save more tomorrow: Using behavioral economics to increase employee saving (2004). *Journal of Political Economy*, 112, S164–S187.

Boettiger CA, Mitchell JM, Tavares VC, Robertson M, Joslyn G, D’Esposito M, Fields HL. Immediate reward bias in humans: fronto-parietal networks and a role for the catechol-O-methyltransferase 159(Val/Val) genotype (2007). *J Neurosci*. 2007 Dec 26;27(52):14383-91.

Brocas Isabelle, Carrillo Juan, Dewatripont Mathias. *Commitment Devices under Self-Control Problems: An Overview* (2004). *The Psychology of Economic Decisions*. Volume 2: Reasons and Choices, 2004, Oxford University Press.

Brocas Isabelle and Carrillo Juan, 2014. Value computation and value modulation: a dual-process theory of self-control. JEL Classification: D03, D87.

Bryan Gharad, Karlan Dean, Nelson Scott. *Commitment Devices* (2010). *Annual Review of Economics* Vol. 2: 671-698.

Bickel, W. K., & Marsch, L. A. (2001). Toward a behavioral economic understanding of drug dependence: Delay discounting processes. *Addiction*, 96(1), 73-86.

Burger, N., Charness, G. and J. Lynham (2009): Three field experiments on procrastination and willpower. Unpublished manuscript.

Buechel, Berno and Mechtenberg, Lydia and Petersen, Julia (2014): Peer Effects and Students’ Self-Control.

Casey B.J., Somerville Leah, Gotlib Ian, Ayduk Ozlem Ayduk, Franklin Nicholas, Askren Mary, Jonides John, Berman Marc, Wilson Nicole, Teslovich Theresa, Glover Gary, Zayas Vivian, Mischel Walter, Yuichi Shoda. Behavioral and neural correlates of delay of gratification 40 years later (2011). *Sackler Institute of Developmental Psychology*. PNAS.

Christoff Kalina, Prabhakaran Vivek, Dorfman Jennifer, Zhao Zuo, Kroker James, Hulyoak Keith, Gabrieli John. Rostolateral Prefrontal Cortex Involvement in Relational Integration during Reasoning (2001). *NeuroImage* 14, 1136–1149 (2001)

Chabris Christopher, Laibson David, Morris Carrie, Schuldt Jonathon, Taubinsky Dmitry. *Measuring Intertemporal Preferences Using Response Times* (2008). NBER Working Paper Series, September 2008.

- Crockett Molly, Braams Barbara, Clark Luke, Tobler Philippe, Robbins Trevor, and Kalenscher Tobias (2013). Restricting Temptations: Neural Mechanisms of Precommitment. *Neuron*. Jul 24, 2013; 79(2): pp. 391–401.
- DellaVigna, S. and U. Malmendier (2006): Paying not to go to the gym. *American Economic Review*, 96, 694–719.
- Figner Bernd, Knoch Daria, Johnson Eric, Krosch Amy, Lisanby Sarah, Fehr Ernst, Weber Elke. Lateral prefrontal cortex and self-control in intertemporal choice (2010). *Nature America*, doi: 10.1038/nn.2516
- Frederick Shane and Kahneman Daniel. A Model of Heuristic Judgment (2005). *The Cambridge Handbook of Thinking and Reasoning*, February 2, 2005.
- Frederick Shane, Loewenstein George, O'Donoghue Ted. Time Discounting and Time Preference: A Critical Review (2002). *Journal of economic Literature* Vol. XL (June 2002), pp. 351-401.
- Fletcher J. & Sindelar J. (2009). Tobacco use, taxation and self control in adolescence. Working Paper 15130. National Bureau of Economic Research, July 2009.
- Fudenberg, D. and D. K. Levine (2006): A dual-self model of impulse control. *American Economic Review*, 96, 1449–1476.
- Gul Faruk and Pesendorfer Wolfgang. Self-Control and the Theory of Consumption (2004). *Econometrica*, Vol. 72, No. 1 (January, 2004), 119-158.
- Giovino GA. (2007). The tobacco epidemic in the United States. *American Journal of Preventive Medicine* 33(6 Suppl):S318-326.
- Green, L., Myerson, J., Lichtman, D., Rosen, S., & Fry, A. (1996). Temporal discounting in choice between delayed rewards: The role of age and income. *Psychology and Aging*, 11, 79–84.
- Gine, X., D. Karlan, and J. Zinman (2009): Put your money where your butt is: A commitment contract for smoking cessation. World Bank Policy Research Working Paper No. 4985.
- Gollwitzer Peter, Webb Thomas, Gallo Inge, Miles Eleanor, Sheeran Paschal. Effective regulation of affect: An action control perspective on emotion regulation (2012). *European review of social psychology*. 2012, 23, pp.143-186.
- Gollwitzer Peter, Oettingen Gabriele, Parks-Stamm Elizabeth. Action Control by Implementation Intentions: Effective Cue Detection and Efficient Response Initiation (2007). *Social Cognition*, Vol. 25, No. 2, 2007, pp. 248-266.
- Gollwitzer Peter, Sheeran Paschal. Implementation Intentions and Goal Achievement: A Meta-Analysis of Effects and Processes (2006). *Advances in Experimental Social Psychology*. Vol. 38.
- Gollwitzer, P. M., Sheeran, P., Michalski, V., & Seifert, A. E. (2009). When intentions go public: Does social reality widen the intention-behavior gap? *Psychological Science*, 20, 612-618.
- Harrison, G. W., Lau, M. I., & Williams, M. B. (2002). Estimating individual discount rates in Denmark: A field experiment. *American Economic Review*, 92, 1606–1617.
- Hare T, Malmaud J, Rangel A. Focusing Attention on the Health Aspects of Foods Changes Value Signals in vmPFC and Improves Dietary Choice (2011). *J Neurosci*. 2011;31:11077–11087.
- Hare Todd, Camerer Colin, Rangel Antonio. Self-Control in Decision-Making Involves Modulation of the vmPFC Valuation System (2009). [www.sciencemag.org](http://www.sciencemag.org). 10.1126/science.1169957

- Hare Todd, Rangel Antonio. Neural computations associated with goal-directed choice (2010). ScienceDirect. Current Opinion in Neurobiology 2010, 20:262–270
- Hoch Stephen, Loewenstein George. Time-inconsistent preferences and consumer self-control (1991). Journal of Consumer Research, Vol. 17, pp. 492-507.
- Houser, D., D. H. Reiley, and M. B. Urbancic (2008): Checking out temptation: A natural experiment with purchases at the grocery register. Unpublished manuscript, University of California, Berkeley, University of Arizona, and George Mason University.
- Hofmann Wilhelm, Deutsch Roland, Lancaster Katie, Banaji Mahzarin (2010). Cooling of the heat of temptation: Mental self-control and the automatic evaluation of tempting stimuli. European Journal of Social Psychology, No. 40, pp. 17-25 (2010).
- Jaroni, J. L., Wright, S. M., Lerman, C., & Epstein, L. H. (2004). Relationship between education and delay discounting in smokers. Addictive Behaviors, 29, 1171–1175.
- Jacquette, D. (2002). A Companion to Philosophical Logic. Wiley Online Library. p. 2.
- Johnson Matthew, Bickel Warren. Within-subject comparison of real and hypothetical money rewards in delay discounting (2002). J Experimental Analytical Behavior, Mar 2002; 77(1), pp. 129-146.
- Johnson Eric, Keinan Anat, Häubl Gerald. Aspects of Endowment: A Query Theory of Value Construction (2007). Journal of Experimental Psychology: Learning, Memory, and Cognition 2007, Vol. 33, No. 3, 461–474
- Kahneman, D., & Miller, D. T. (1986). Norm theory: Comparing reality to its alternatives. *Psychological Review*, 93, 136–153.
- Koriat, A., Lichtenstein, S., & Fischhoff, B. (1980). Reasons for confidence. Journal of Experimental Psychology: Human Learning and Memory, 6, 107–118.
- Kuhn Michael, Kuhn Peter, Villeval Marie Claire. Self Control and Intertemporal Choice: Evidence from Glucose and Depletion Interventions (2014). JEL classification: C91, D90.
- Laibson David (1997). Golden Eggs and Hyperbolic Discounting. The Quarterly Journal of Economics, May 1997.
- Locey Matthew, Jones Bryan, Rachlin Howard, 2011. Real and hypothetical rewards in social discounting. Judgment and Decision Making, vol. 6, no. 6, August 2011, pp. 552-564.
- Lopez Richard, Hofmann Wilhelm, Wagner Dylan, Kelley William, Heatherton Todd. Neural Predictors of Giving to Temptation in Daily Life (2014). Psychological Science April 30, 2014 0956797614531492
- Li Chiang-shan Ray, Huang Cong, Constable R. Todd, Sinha Rajita. Imaging Response Inhibition in a Stop-Signal Task: Neural Correlates Independent of Signal Monitoring and Post-Response Processing (2006). The Journal of Neuroscience, 4 January 2006, 26(1): 186-192.
- Loewenstein, G., Prelec, D., 1992. Anomalies in intertemporal choice: evidence and an interpretation. The Quarterly Journal of Economics 107, pp. 573–597.
- Lucy Gregorios-Pippas, Philippe N. Tobler, Wolfram Schultz. Short-Term Temporal Discounting of Reward Value in Human Ventral Striatum (2009). J Neurophysiol. Mar 2009; 101(3): 1507–1523.
- Madden, G. J., Begotka, A. M., Raiff, B. R., & Kastern L. L. (2003). Delay discounting of real and hypothetical rewards. Experimental and Clinical Psychopharmacology, 11, 139-145.
- Magen Eran, Gross James. Harnessing the Need for Immediate Gratification: Cognitive Reappraisal Modulates the Reward Value of Temptations (2007). American Psychological Association. Emotion 2007, Vol. 7, No. 2, pp. 415-428



- Mazur J.E. An adjusting procedure for studying delayed reinforcement. In: Commons M.L, Mazur J.E, Nevin J.A, Rachlin H, editors. Quantitative analysis of behavior: Vol. 5. The effect of delay and of intervening events of reinforcement value. Hillsdale, NJ: Erlbaum; 1987. pp. 55–73. (Eds.).
- McClure S., Ericson K., Laibson D., Loewenstein G., Cohen J. Time Discounting for Primary Rewards (2007). *The Journal of Neuroscience*, 23 May 2007, 27(21)
- Metcalf Janet, Mischel Walter. A Hot/Cool-System Analysis of Delay of Gratification: Dynamics of Willpower (1999). *Psychological Review*, 1999, Jan; Vol. 106, No. 1, pp. 3-19.
- Mischel Walter, Ayduk Ozlem, Berman Marc, Casey B.J., Gotlib Ian, Jonides John, Kross Ethan, Teslovich Theresa, Wilson Nicole, Zayas Vivian, Shoda Yuichi. ‘Willpower’ over the life span: decomposing self-regulation (2010). *Oxford Journals. Social Cognitive and Affective Neuroscience* Volume 6, Issue 2, pp. 252-256.
- Moffitt Terrie, Arseneault Louise, Belsky Daniel, Dickson Nigel, Hancox Robert, Harrington HonaLee, Houts Renate, Poulton Richie, Roberts Brent, Ross Stephen, Sears Malcom, Thomson Murray, Caspi Avshalom. A gradient of childhood self-control predicts health, wealth, and public safety (2010). *Proceedings of the National Academy of Sciences of the United States of America. PNAS Direct Submission*, available through the PNAS open access option.
- Mischel W, Shoda Y, Rodriguez M. Delay of Gratification in Children (1989). *Science Magazine* 20 May 1989, Vol. 244, No. 4907, pp.933-938.
- Murphy James, Vuchinich Rudy, Simpson Cathy. Delayed Reward and Cost Discounting (2001). *The Psychological Record*, 2001 , 51 , 571-588
- Odum Amy. Delay Discounting: I’m a k, You’re a k (2011). *J Exp Anal Behav*. Nov 2011; 96(3): 427–439.
- Posner Michael, Rothbart Mary. Research on Attention Networks as a Model for the Integration of Psychological Science (2007). *Annu. Rev. Psychol.* 2007. 58:1–23.
- Reimers, S., Maylor, E., Steward, N., Chater, N. (2009). Associations between a one-shot delay discounting measure and age, income, education and real-world impulsive behavior. *Personality and Individual Differences* 47 (2009) 973-978.
- Rubinstein Ariel. Response time and decision making: An experimental study (2013). *Judgment and Decision Making*, Vol. 8, No. 5, September 2013, pp. 540–551
- Samuelson Paul. A Note on Measurement of Utility (1937). *Rev. Econ. Stud.* 4, pp. 155-61
- Shamosh Noah, DeYoung Colin, Green Adam, Reis Deirdre, Johnson Matthew, Conway Andrew, Engle Randall, Braver Todd, Gray Jeremy. Individual Differences in Delay Discounting: Relation to Intelligence, Working Memory, and Anterior Prefrontal Cortex (2008). *Association for Psychological Science* Volume 19, No. 9.
- Strotz R.H. Myopia and Inconsistency in Dynamic Utility Maximization (1955). *The Review of Economic Studies*, Volume 23, Issue 3 (1955-1956), 165-180.
- Takahashi Taiki, Hadzibeganovic Tarik, Cannas Sergio, Makino Takaki, Fukui Hiroki, Kitayama Shinobu. Cultural neuroeconomics of intertemporal choice (2009). *Activitas Nervosa Superior Rediviva* Volume 51 No. 1-2 2009
- Tangney, J.P., Baumeister, R.F., & Boone, A.L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality*, 72, 271–324.
- Tourangeau, R., & Yan, T. (2007). Sensitive questions in surveys. *Psychological bulletin* 133.5 (Sep 2007): 859-883.
- Wagner Dylan, Altman Myra, Boswell Rebecca, Kelley William, Heatherton Todd. Self-Regulatory Depletion Enhances Neural Responses to Rewards and Impairs Top-Down Control (2013). *Psychological Science* November 2013 vol. 24 no. 11 2262-2271

Whelan, R., & McHugh, L. A. (2009). Temporal discounting of hypothetical monetary rewards by adolescents, adults, and older adults. *Psychological Record*, 59, 247–258.

Weber Elke and Johnson Eric. *JDM* (2009) *Annu. Rev. Psychol.* 2009. 60:53–85

Wertenbroch, K. (1998): Consumption self-control by rationing purchase quantities of virtue and vice. *Marketing Science*, 17, 317–337.

Yale Scientific.. *The Economics of Self Control* (2012). Article by Shirlee Whol, published on March 14, 2012.

## 6. Appendix

*“It is one of the most pregnant facts of experience that we attach a less importance to future pleasures and pains simply because they are future... To goods which are destined to meet the wants of the future, we ascribe a value which is really less than the true intensity of their future marginal utility... Which of us has not been surprised to find that under the pressure of some momentary appetite, he was not able to refuse some favorite dish or cigar which the doctor had for— bidden—knowing perfectly that he was doing an injury to his health, which, calm consideration would tell him, was much more considerable than the pleasure of that trifling indulgence?... Anyone who knows himself, and keeps his eyes open to what is going on around him, will find this fact of the underestimate of future pleasures and pains exhibited under a thousand forms in the midst of our civilized society. Of the fact then there is no doubt”.*

– Böhm-Bawerk, E., *The Positive Theory of Capital* translated by W. Smart (London: MacMillian & Co.) 1891.

### **Judgment and Decision Making (JDM)**

“The Society for Judgment and Decision Making is an interdisciplinary academic organization which dedicated to the study of normative, descriptive, and prescriptive theories of decision. Its members include psychologists, economists, organizational researchers, decision analysts, and other decision researchers. The Society also publishes the journal called ‘Judgment and Decision Making’” ([www.sjdm.org](http://www.sjdm.org)). Over the past 50 years the JDM reviews has described different decision-making phenomena including categories such as preferences, beliefs, decision under risk and uncertainty, risky choices, intertemporal choice and social

decisions (Weber and Johnson, 2009). The following quote from the 2009 review is informative about their philosophy:

Since its origins in the 1950s, judgment and decision making (JDM) research has been dominated by mathematical functional relationship models that were its point of departure in the form of normative models. This focus on economics and statistics may have led JDM research to underutilize the insights and methods of psychology. Aided by the recent arrival of neuroscience methodologies to complement behavioral research, the field has started to realize, however, that the brain that decides how to invest pension money and what car to buy is the same brain that also learns to recognize and categorize sounds and faces, resolves perceptual conflicts, acquires motor skills such as those used in playing tennis, and remembers (or fails to remember) episodic and semantic information. In this review, we make a strong case for the utility of this realization. –JDM, 2009 review (Weber and Johnson, 2009)

My research process attempts to follow the philosophy of the JDM approach in striving after an open-minded and integrated inquiry into the subject of intertemporal choice and self-control (for a short but informative review on the integration between economics, psychology and neuroscience, see Berns et al., 2007). With this I mean that I have tried to keep a deliberate state of mind in considering influences from cognitive psychology and neuroscience during the different phases of my research. Without the inspiring spirit of the JDM literature, I would have possibly been more restrictive in limiting my reading to economics literature, and quite likely missed on a lot of interesting information.

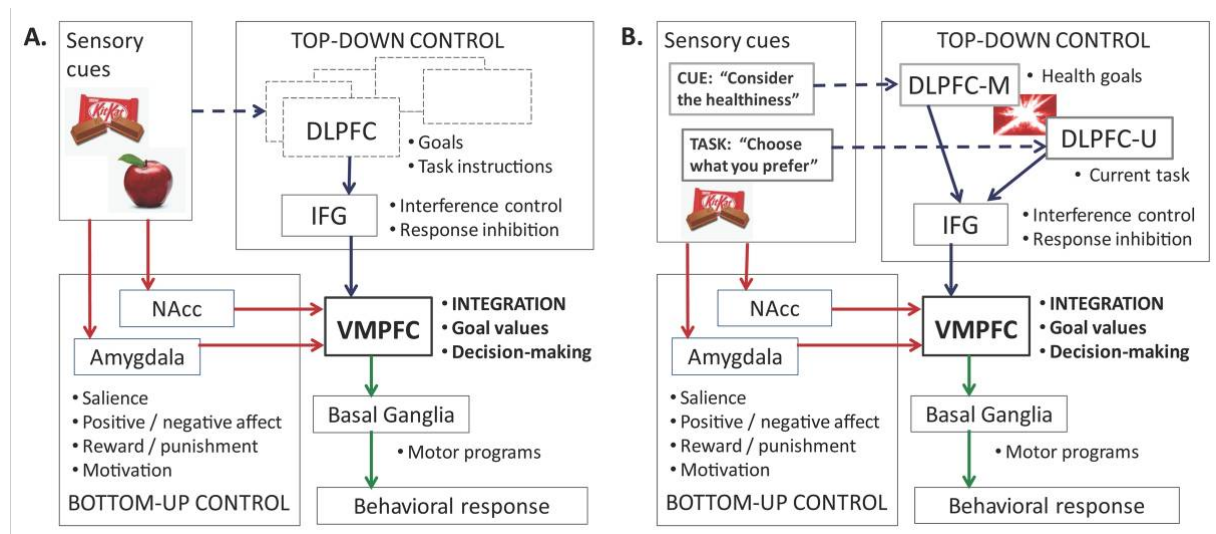
### **Accuracy of survey reports with sensitive questions**

There is marginal evidence for misreporting being common and to a large extent situational when participants are answering sensitive questions that request information that is potentially embarrassing to report. These types of responses that are done privately on a computer are less prone to misreporting rather than in situations where a closer personal proximity to the experimenter can lead to misreporting due to an avoidance of feeling embarrassment (for a review, see Tourangeau & Yan, 2007). The questions in this experiment should not create any feelings of embarrassment, but if that would be the case then the survey format would in theory lead to a fewer number of misreporting than if the experiment was conducted in a laboratory environment.

## Peer effects

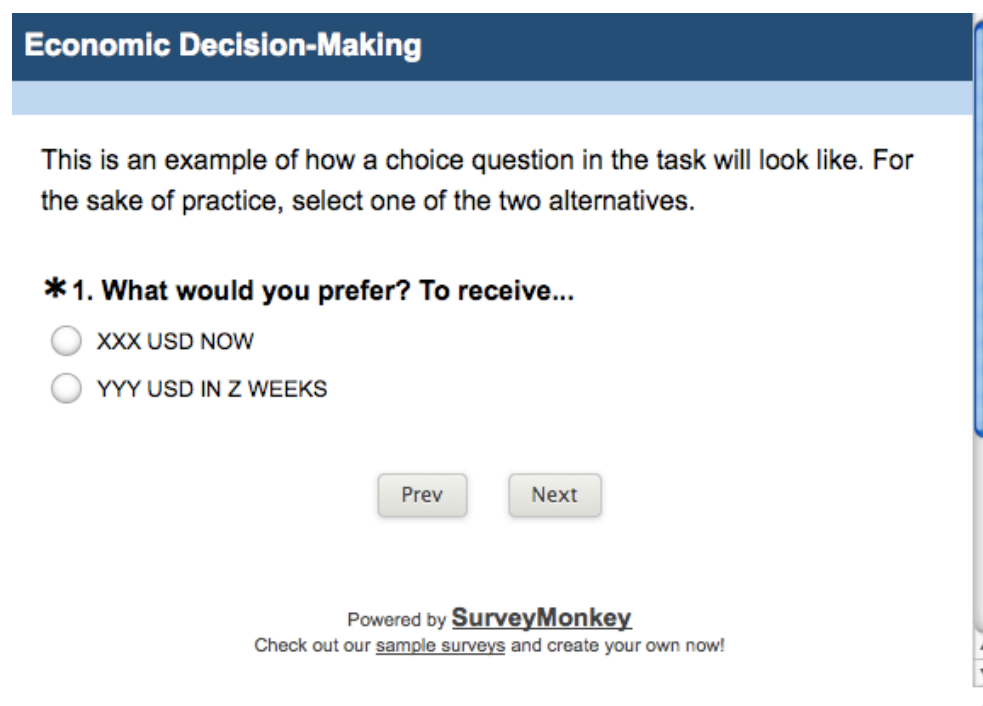
According to Buechel et al. (2014) students with high self-control have better performance in school. This seems intuitive. More interestingly, also having relations with other high self-control individuals results in other social benefits such as having more friends and connections to other well performing peers. That connectedness to well performing peers in itself also improves performance. The aforementioned influence of peers provides important information about how to approach successful goal striving. Whether the information from peers is shared intentionally or unintentionally, good role models matter.

**Figure 1 from “Towards a neurobiological model of cue-induced self-control in decision making: Relevance to addiction and obesity”**



Source: Agnes J. Jasinska, Anand Ramamoorthy, and Christopher M. Crew

## Screenshots of example question, a choice task question and the SES questions



**Economic Decision-Making**

This is an example of how a choice question in the task will look like. For the sake of practice, select one of the two alternatives.

**\*1. What would you prefer? To receive...**

- XXX USD NOW
- YYY USD IN Z WEEKS

Prev Next

Powered by **SurveyMonkey**  
Check out our [sample surveys](#) and create your own now!

## Economic Decision-Making

1/16

### \* 3. What would you prefer? To receive...

- 275 SEK NOW
- 286 SEK IN 2 WEEKS

Powered by **SurveyMonkey**  
Check out our [sample surveys](#) and create your own now!

### \* 21. What is your current education status?

Please state the highest education level today:

Less than high school graduate      High school graduate      Some University education      Bachelor's degree or higher

### \* 22. What is your current employment status?

Please state:

Empoyed      Student      Unemployed

### \* 23. How much would you say that 200-1000 SEK would impact your monthly budget?

Please state the level of impact:

Not at all      Small      Some      Large

### \* 24. How much time did you use approximately per choice task (money sums) question?

Please state self-reported average response time per question:

Less than 3 seconds      3-13 seconds      13+ seconds

### \* 25. Gender

Female

Male

## ANOVA

LLs\_of\_total

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.593	1	.593	5.869	.017
Within Groups	10.702	106	.101		
Total	11.295	107			

### Tests of Between-Subjects Effects

Dependent Variable: LLs of total

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.593 <sup>a</sup>	1	.593	5,869	,017
Intercept	42,815	1	42,815	424,069	,000
x	.593	1	.593	5,869	,017
Error	10,702	106	,101		
Total	54,109	108			
Corrected Total	11,295	107			

a. R Squared = ,052 (Adjusted R Squared = ,044)

### Parameter Estimates

Dependent Variable: LLs of total

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	,704	,043	16,275	,000	,618	,789
[x=0]	-,148	,061	-2,423	,017	-,269	-,027
[x=1]	0 <sup>a</sup>	.	.	.	.	.

a. This parameter is set to zero because it is redundant.

## Descriptives

LLs\_of\_16\_questions

0=Baseline 1=AoM	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
					0	54		
1	54	,7037	,31919	,04344	,6166	,7908	,00	1,00
Total	108	,6296	,32489	,03126	,5677	,6916	,00	1,00

## Choice distribution of the 16 questions in the two conditions

LLs \* x Crosstabulation

		x		Total	
		0 (Base)	1 (AoM)		
LLs	0	Count	1	3	4
		% within x	1,9%	5,6%	3,7%
	1	Count	1	1	2
		% within x	1,9%	1,9%	1,9%
	2	Count	3	4	7
		% within x	5,6%	7,4%	6,5%
	3	Count	3	0	3
		% within x	5,6%	0,0%	2,8%
	4	Count	5	0	5
		% within x	9,3%	0,0%	4,6%
	5	Count	4	0	4
		% within x	7,4%	0,0%	3,7%
	6	Count	6	1	7
		% within x	11,1%	1,9%	6,5%
	7	Count	3	0	3
		% within x	5,6%	0,0%	2,8%
8	Count	3	2	5	
	% within x	5,6%	3,7%	4,6%	
9	Count	2	3	5	
	% within x	3,7%	5,6%	4,6%	
10	Count	2	8	10	
	% within x	3,7%	14,8%	9,3%	
11	Count	1	3	4	
	% within x	1,9%	5,6%	3,7%	
12	Count	3	4	7	
	% within x	5,6%	7,4%	6,5%	



13	Count	2	0	2
	% within x	3,7%	0,0%	1,9%
14	Count	2	3	5
	% within x	3,7%	5,6%	4,6%
15	Count	4	5	9
	% within x	7,4%	9,3%	8,3%
16	Count	9	17	26
	% within x	16,7%	31,5%	24,1%
Total	Count	54	54	108
	% within x	100,0%	100,0%	100,0%

## Correlations

### Correlations

		x	LLs_of_total
x	Pearson Correlation	1	,229*
	Sig. (2-tailed)		,017
	N	108	108
LLs_of_total	Pearson Correlation	,229*	1
	Sig. (2-tailed)	,017	
	N	108	108

\*. Correlation is significant at the 0.05 level (2-tailed).

## **Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist Instructions**

*The questions on the back page are designed to stimulate dialogue between you and your patients and to help confirm if they may be suffering from the symptoms of attention-deficit/hyperactivity disorder (ADHD).*

Description: The Symptom Checklist is an instrument consisting of the eighteen DSM-IV-TR criteria. Six of the eighteen questions were found to be the most predictive of symptoms consistent with ADHD. These six questions are the basis for the ASRS v1.1 Screener and are also Part A of the Symptom Checklist. Part B of the Symptom Checklist contains the remaining twelve questions.

### **Instructions:**

#### **Symptoms**

1. Ask the patient to complete both Part A and Part B of the Symptom Checklist by marking an X in the box that most closely represents the frequency of occurrence of each of the symptoms.
2. Score Part A. If four or more marks appear in the darkly shaded boxes within Part A then the patient has symptoms highly consistent with ADHD in adults and further investigation is warranted.
3. The frequency scores on Part B provide additional cues and can serve as further probes into the patient's symptoms. Pay particular attention to marks appearing in the dark shaded boxes. The frequency-based response is more sensitive with certain questions. No total score or diagnostic likelihood is utilized for the twelve questions. It has been found that the six questions in Part A are the most predictive of the disorder and are best for use as a screening instrument.

#### **Impairments**

1. Review the entire Symptom Checklist with your patients and evaluate the level of impairment associated with the symptom.
2. Consider work/school, social and family settings.
3. Symptom frequency is often associated with symptom severity, therefore the Symptom Checklist may also aid in the assessment of impairments. If your patients have frequent symptoms, you may want to ask them to describe how these problems have affected the ability to work, take care of things at home, or get along with other people such as their spouse/significant other.

#### **History**

1. Assess the presence of these symptoms or similar symptoms in childhood. Adults who have ADHD need not have been formally diagnosed in childhood. In evaluating a patient's history, look for evidence of early-appearing and long-standing problems with attention or self-control. Some significant symptoms should have been present in childhood, but full symptomology is not necessary.

## Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist

Patient Name		Today's Date					
Please answer the questions below, rating yourself on each of the criteria shown using the scale on the right side of the page. As you answer each question, place an X in the box that best describes how you have felt and conducted yourself over the past 6 months. Please give this completed checklist to your healthcare professional to discuss during today's appointment.			Never	Rarely	Sometimes	Often	Very Often
1. How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?							
2. How often do you have difficulty getting things in order when you have to do a task that requires organization?							
3. How often do you have problems remembering appointments or obligations?							
4. When you have a task that requires a lot of thought, how often do you avoid or delay getting started?							
5. How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?							
6. How often do you feel overly active and compelled to do things, like you were driven by a motor?							

Part A