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Well begun is half done

-A study about procrastination-

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Abstract

While a considerable amount of research has been made on the discounting of future rewards, this thesis seeks to improve our knowledge of how people discount arduous tasks. Reward discounting has traditionally been modeled geometrically with the discounted utility model but has lately come into question by scientist favoring the hyperbolic model. The hyperbolic model implies that peoples preferences change as the decision comes closer in time and explains time inconsistent and irrational behavior such as willingness to forgo a later, larger reward in order to receive a smaller sooner reward, especially when the smaller reward becomes imminently available. However, very little research has been made on discounting negative events such as arduous tasks supposedly leading to procrastination. The results of this study performed on 80 first year SSE students aren't fully captured by any of the two models. Instead of deferring an arduous task to a later point in time, a majority of the subjects performed the task as early as possible. Furthermore, when the start up cost of the tasks where removed an overwhelmingly large proportion of the sample (97%) chose to perform the task early although this was neither necessary nor even rational. We interpret these findings to mean that none of the conventional models of intertemporal choice really captures the mechanics of discounting arduous tasks. Instead, we propose two new variables, *anticipation* and *working modus* that can help to explain the behavior shown by the students in this study. We also propose how these variables can be incorporated into current models of inter-temporal choice.

Keywords

Hyperbolic discounting, Exponential discounting, Quasi-hyperbolic discounting, Start-up cost, Intertemporal choice, Procrastination, Preference reversal, Present-bias

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Nothing is so fatiguing as the eternal hanging on of an uncompleted task.

-William James

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1. Introduction

While recent economic literature often assumes that people procrastinate when faced with an arduous task, the results of this thesis actually show signs of the opposite. The 80 subjects included in the experiment surprisingly showed a strong tendency to perform an arduous task earlier than necessary, without there being any obvious reasons as to why. Even more surprisingly, removing the effect of start up costs, seemed to almost completely eradicate the tendency to postpone the task.

1.1 Background

Scientists increasingly question the foundations of conventional economic theory, especially the assumption that people behave rationally. No more is this true, than in the field of intertemporal choice. The discounted utility model has long been the standard for analyzing intertemporal choice. However, results from recent empirical studies seem to indicate that people's behavior contradicts many of the assumptions made by the discounted utility model. For example[1], imagine that you have to carry out an arduous activity. You can choose between doing 7 hours of the activity today or postpone it and do 8 hours of the activity tomorrow. Now imagine that you are making the same choice but one month in the future. You can now choose between doing 7 hours of the arduous activity in one month, or 8 hours in one month and one day. Common sense tells us that people might choose to procrastinate the activity in the first case but very few would choose the later option in the second case. This is also what the scientists O'Donoghue and Rabin (1999)[2] argue in their study *Doing it Now or Later*. While the conventional discounted utility model assumes that individuals rationally discount future costs and benefits exponentially, i.e. at a fixed rate, recent empirical research identifies another pattern. In circumstances ranging from dieting to addiction, studies have shown that people are often temporarily willing to forgo a later, larger reward in order to receive a smaller sooner reward, especially when the smaller reward becomes imminently available. This is usually referred to as hyperbolic discounting and implies that preferences between options can change as the decision comes closer in time, thus giving rise to time inconsistent behavior. However, while the research on such hyperbolic discounting of rewards seems to have a

[1] Example inspired from an example in O'Donoghue T. & Rabin M., 1999
[2] O'Donoghue T. & Rabin M., 1999, p. 103

robust foundation in empirical data, not much empirical research has considered the discounting of negative events such as arduous tasks supposedly leading to procrastination. Scientists have only assumed that people discount arduous tasks in the same way as they discount rewards. Our study shows that this may not be the case. Instead of taking the easy way out and procrastinate when faced with an arduous task, the subjects in our study chose to perform the task as early as possible. Furthermore, when we measured whether removing the subjects' start up costs would influence the results an overwhelming majority (97%) of the subjects choose not to procrastinate but to carry out the experiment on the earlier occasion. We interpret these results to mean that none of the conventional models of intertemporal choice really captures the mechanics of discounting arduous tasks. Instead, our results seem to indicate that the subjects showed total opposite behavior from what would have been expected by the conventional theories. To explain the findings in this study, we propose two new variables, *anticipation* and *working modus*. We also describe how these variables could be integrated with the conventional models of intertemporal choice.

1.2. Problem area and purpose

This paper deals with the problem of making decisions over time in connection with procrastination. Previous research in this area regarding decision-making over time has generally focused on the discounting of various future rewards[3]. The results from these studies has often contradicted the assumption made in conventional economic literature that people in general tend to discount rewards exponentially. Instead, there seems to be a tendency for both humans and animals to discount rewards hyperbolically in an empirical setting[4]. However, this paper will be based on the definition of procrastination used in society at large, that is, that people instead of procrastinating in order to benefit from a quick reward, do so to postpone an exhausting experience until later. This paper is therefore focused on how individuals discount arduous tasks as opposed to rewards.

The purpose of this study will be to test if there is a way to remedy the deferral of arduous task. Our suggested treatment to procrastination is to bring the subjects physically and mentally closer to the task at hand. This has been achieved through the removal of start up costs.

[3] Ainslie. G., 2008, p. 3-5

[4] [4]Ainslie, G. 2008, p.4

1.3 Limitations

This paper will only deal with the study of arduous tasks that could be related to procrastination. Aversive events not demanding any active effort will therefore not be included in this study. There have, for example, been other studies made where the participants have been given the ability to choose between when in time they would be subjected to high bursts of noise.[5] Even though this surely could be defined as an aversive task, it doesn't require any active effort from the participant during the moment the participant is subjected to the noise. The mentioned study can thus not be linked to the definition of procrastination that we aim to further investigate in this paper.

In this study, only students from the Stockholm School of Economics will be studied. Thus, the paper does not intend to give an answer to if people in general discount arduous task exponentially or not. Conclusions will therefore only be made about students at SSE at the time the study was made. However, this does not rule out that the data produced in this paper could serve as a guideline to how people in general tend to discount arduous task, even though this cannot be proven from a strictly scientific standpoint. Age, could for example be an important factor that this study won't take into consideration. It would not for example be unreasonable to believe that older participants would have learned from earlier mistakes and thus would not be as prone to procrastinate as much as younger individuals.

1.4 Hypothesis

Hypothesis: The removal of startup costs has no influence on the subjects' choice mechanisms.

[5] Navarick, D.J., 1982

2. Methodology

We have chosen to base our methodology on Karl Poppers theories about how scientific knowledge is produced. Thus, we have found it appropriate to use a quantitative methodology. However, one should note that Popper himself never actively promoted this (or any other) specific form of methodology. However, a quantitative methodology does come as a direct consequence of Poppers falsification principle, as qualitative, individual dependent methods makes falsification harder.[6] A quantitative methodology also suits our area of research and the mathematically based theories used in this paper.

2.1 Study approach

In accordance with Popper's theories, we have chosen to use a Hypothetico-deductive approach. Such an approach could be divided into three steps:

1. A hypothesis is formed
2. A deductive conclusion is drawn from the given hypothesis
3. It is tested if there is any empirical proof for such a conclusion

Let's say for example that an (utterly uneducated) ornithologist decides to find out what color a swan has. Because he has only seen white swans before, he sets up the hypothesis "All swans are white". He then draws the deductive conclusion that "If I see a swan, it will be white". After this, he ventures into nature to find himself a swan. Should this swan be black (which exists) the hypothesis could be rejected and a new one created "A swan is either black or white". If the swan on the other hand is white, the hypothesis would remain unchanged and the ornithologist would still assume that "All swans are white" until he saw a black one. It is thus worth noticing here that the knowledge produced through the studies approach would not necessarily be true. Instead it would only be a

[6] Björkegren, D., 1988, p. 113

result of the best information available at the time. So what Poppers suggests (in accordance with many other philosophers of science) is that it is impossible to obtain perfect knowledge about ones surrounding world.[7] An individual always interprets his or hers surroundings in order to understand it. Thus a person is always a victim of his or hers own interpreting framework. A person can never place itself outside this framework and see the world objectively. Without such a framework the world be utterly incomprehensible. In order to improve ones interpretive framework and thus the knowledge one has, one should always seek to test the truth of the interpretations that the framework consists of. It is important to note here the difference between seeking answers that confirms ones assumptions about the world and to try to improve ones knowledge through testing its accuracy. The first of this two could easily lead to what is known as confirmation bias. Just as a person with low self-confidence is more vulnerable to negative critique than good, there is a risk that scientist tend to confirm their own theories and ignore contradicting facts. It was just in order to fight such a bias that Popper introduced his Falsification principle - that is, to first formulate a hypothesis and then test how robust this hypothesis is.

2.2 Choice of hypothesis

With the chosen approach in mind, the question has been formulated in a hypothetical form. We have chosen to test whether the removal of startup cost play any difference in the participants choice when in time to perform an arduous task. By formulating the hypothesis as "The removal of startup costs has no influence on the subjects' choice mechanisms" a falsification would prove that the removal of startup cost in fact play a role in the participants decision making.

The test criteria would here be determined by if a significant change could be seen between a treatment group and a control group, where the treatment group won't have any startup cost while the control group will. If a statistically significant difference in choice patterns could be detected between the two groups, one would be able to draw the conclusion that the removal of startup costs influences the participants' decision making progress.

[7] Björkegren, D. 1988, p. 9

2.3 Choice of object of study

The reason for choosing students from Stockholm School of Economics to take part in the study was partly based on accessibility, partly based on a belief that SSE students generally are both driven and well organized which we assumed would increase the chance of rational behavior and exponential discounting. A contradicting result would however not exclude the possibility that hyperbolic discounting of arduous tasks could be common among people in general. In this paper it is assumed that the students are naïve. Naive subjects can be compared to sophisticated subjects where the sophisticated subjects are able to foresee that they will have self-control problems in the future and the naïve subjects are unaware of future self-control issues.[8]

2.4 The execution of the study

We first started off by dividing our subjects, which consisted of (mainly) first year SSE students, into two sample groups - one control group and one treatment group. This was done in order to see if our treatment (the removal of the startup costs) would have any effect. The subjects were randomly divided into these groups. We then sent out two different (yet very similar) emails, one to each group asking them to participate in the experiment.

In both mails it was stated that a reward of 200 SEK would be handed out if the participant would perform a task taking approximately 30 minutes. The task could be performed on which ever of two specific days (Monday or Thursday) and wherever there was Internet access. The task could also be performed whenever from 00:00 and 03:00 the following day. In this way, we would give the test subjects as much flexibility as possible while still maintaining the discrete intervals of the two days that the experiment required. We could thus emulate a more real life like situation. The task itself would consist of 15 questions and a deadline for registration was also set to Wednesday the week before the launch of the experiment.

It's worth noting here that we chose not to differ the workload between the two days. What implications do this entail? A person who discounts arduous task hyperbolically will always chose to

[8] Our definition of naive and sopisticated subjects is taken from O'Donoghue T. & Rabin M., 1999 p. 104

perform the task on the latter of the two days. A person who discounts arduous tasks exponentially, will always choose to perform the task on the latter of the two days, given that their $\delta < 1$. Should it instead be $\delta = 1$, the participant would be indifferent between the two days. Thus we know, that a person who choses to perform the task on Thursday could be either discounting hyperbolically or exponentially, while a person who choses to perform the task on Monday could only be discounting exponentially with an $\delta = 1$.

In the email to the treatment group however some additional information was added. For this group, it would also be required to perform a much smaller task (answering a control question) on the day not chosen to perform the big task.

We also visited the students in one of their lectures to further promote our experiment. At this occasion, nothing more was disclosed about the experiment other than that it would take approximately 30 minutes to complete, and that it yielded 200 SEK. The students where then offered to sign up on the spot if they wanted to, or of course by replying to the mail we already sent.

Since the answering rate of the test group seemed to be somewhat lacking another email was sent out to the treatment group on Wednesday morning to remind them of the deadline the same night (23:59).

After the registration deadline had expired, an informative email was sent out on Friday. The letter confirmed that the subject had been registered and also provided further insight into the task by an attached pdf-file containing an exemplary assignment. The letter sent to the treatment group also contained a table to further convey the message that a small assignment had to be carried out on the alternative day.

On the coming Monday the subjects in both the treatment group and the control group was further split into five different groups to a total of ten groups. This was done in order to avoid cheating. The small groups where ordered to count different letters in the same texts, everything else was identical. However, between the control group(s) and test group(s) there was a difference. After the treatment group had filled out their contact information, they were immediately faced with an

option to either complete the task today, or answer a control question and perform the task on Thursday instead. This option was not included for the control group.

Other than that, the experiment was identical. The task itself would consist of 15 questions where the participant would count letters in specific texts. The texts chosen were all segments from different Hollywood blockbuster manuscripts. There were no specific reason for choosing such text other than our personal interest in movies, and to throw the participants a little bit off the real purpose of the study. The latter was further enhanced by instructions to "be as precise as possible" and "to take it slow and concentrate". The participants were also asked to specify whether they recognized some of the texts, and compare how they thought they performed compared to the others who did the task. These questions only served as distractions as well.

The emails containing the experiments differed between the two groups. While both of them stated that cooperation or "random guessing" was prohibited, the email to the control group stated that the participant where free to click the link to the experiment only if he/she wanted to. The treatment group, however, were strictly forced to open the link, fill out contact information and at least answer the control question. This means that when the subjects in the treatment group were faced with the choice of completing the study now or later, they would have already been forced the pay the start up cost. The subjects in the treatment group would thus already have "begun working" when choosing whether or not to complete the larger task (answering the question). However, without eliminating the startup cost on both occasions, this would not have been a fair choice. Let's say for example that there where to be no control question on Thursday. Then of course the student would choose to complete the study on Monday after having paid the startup cost on that day (since this would be cheaper than paying the startup cost once again on Thursday to complete the task)[9].

On Thursday three different emails were sent out. One to the participants pertaining the control group who had not completed the task on Monday, one to the participants pertaining to the test group who had completed the task on Monday and one to those who had chosen to instead answer the control question. The content of these emails where similar in nature, reminding the participants to fulfill their respective obligation.

[9]Depending on how strongly the participant would discount the events.

The subjects who had fulfilled their obligations where then awarded the 200 SEK. In connection with the handout of money, the participants were asked to answer two questions: "1. Did you regret that you performed the task on the day you did?" and "2. Where there any one reason for you to choose the day you did?". The first question could serve as something of a guide as to whether the person discounted hyperbolically or not, since this entails making decisions your pleased with at the moment, but seen at a distant doesn't appear as good anymore. The second question was posed in order to find out if the participant in fact made a decision at all, or if he/she was forced to commit on performing the task at one of the days for a specific reason (i.e. wedding, exam, etc).

2.5 Quality of the study

For every scientific study it is very important that the study, and in our case, the experiment is of high quality. The quality of the study is best ensured by having a high reliability and validity.

2.5.1 Reliability

The reliability measures the trustworthiness of the study. A high level of reliability means that a study at a certain point in time should be able to be replicated several times and still get the same result.[10,11] Thus, the reliability tells us the difference between the true and the observed value. A quantitative approach generally increases the probability that the study can be replicated and therefore also increases the reliability. In our case, our sample of over 40 participants in each group means that a randomly selected sample can be assumed to be normally distributed. Therefore it can also be assumed that any replicated study would yield the same results. However, our sample has not been randomly selected, but was instead based on which of the students that chose to participate in the study. This means that the reliability can be questioned. Finally, an in depth description of our study's approach and procedure contributes to the reliability as the study can be replicated in more identical way. A high reliability does not mean that the study has a high validity. The validity cannot, however, be higher than the reliability of the study.

[10] Trost, J. (2001)
[11] Söderlund, M., 2005

2.5.2 Validity

The validity shows if the study measures what it intended to measure. The validity can be expressed as the correlation between the theoretical definition and the operational definition where the theoretical definition is the specification of the question formulation and the operational definition is the specification of the study's approach. Validity is usually divided into internal and external validity. The internal validity measures whether the result in the study is a reflection of the reality,[12] while the external validity measures whether the result can be generalized.[13]

2.5.2.1 Internal validity

The internal validity measures whether the study is a good reflection of reality. There is a risk when it comes to the inner validity that our experiment setting can differ from how things are experienced in real life, and that the results of the experiment doesn't accurately portray reality. Is for example the task in the experiment arduous enough to cause procrastinating behavior in the first place?

2.5.2.2 Outer validity

The outer validity measures to what extent the result of the study is generalizable.[14] The study's quantitative approach contributes to a higher outer validity and makes it easier to draw general conclusions. However, it is not the purpose of this paper to draw conclusions about the public in general. The fact that we reached out to all first year SSE students (based on that the registered students in course 404 in microeconomics contained the whole first year population) and that our sample represents a significant part of the full sample (24%) affects the outer validity positively. There is however a risk that the students willing to take part in our experiment was more prone to "get things done" while true procrastinators might have chosen not to sign up for our experiment.

[12] Merrian, S. B., 2004
[13] Svenning, C. (2000)
[14] Ibid.

3. Theoretical Framework

This chapter will primarily focus on two different models of intertemporal choice; the discounted utility model and the model of hyperbolic discounting. The discounted utility model was formulated by Samuelson in 1937 and almost immediately became the framework of choice for analyzing intertemporal decision.[15] In the discounted utility model, utility from future events is discounted in the same way as interest is discounted from future returns in economic calculations. Samuelson himself was very cautious when he presented the discounted utility model, stressing the arbitrariness of the underlying assumptions.[16] Samuelson pointed out that: "It is completely arbitrary to assume that the individual behaves so as to maximize an integral of the form envisaged in the discounted utility model. This involves the assumption that at every instant in time the individuals satisfaction depends only upon consumption at that time, an that furthermore, the individual tries to maximize the sum of instantaneous satisfactions reduced to some comparable base by time discount".[17] However, to this day, the discounted utility model is probably still the most commonly used model for analyzing inter temporal choice, arguably because its simplicity of use.

Although several of the assumptions made in the discounted utility model has been useful in a theoretical setting, many empirical studies have shown that the assumption made by Samuelson has proven to be a somewhat poor approximation of reality. In this theory chapter we will provide a quick overview of some of the assumptions required for the discounted utility model as well as common critique directed towards the model. In the end of the chapter we will describe one of the alternative theories of inter temporal choice, hyperbolic discounting.

[15] Loewenstein, G., 1992, p.20
[16] Ibid.
[17] Samuelson, P, 1937, p.159

3.1 Discounted utility model

The discounted utility model states, in its simplest form, that a person will prefer consuming $c \equiv (c_0, \dots, c_t)$ before $c' \equiv (c'_0, \dots, c'_t)$ if and only if,

$$\sum_{t=0}^{T} \delta^t \, u(c_t) > \sum_{t=0}^{T} \delta^t \, u(c'_t),$$

where u is a utility function and δ is a discount rate where $0 < \delta < 1$. An important thing to note here, is that the discount rate's derivative is constant for all *t*. This means that c_t will be preferred to c'_t in every time period given that $u(c_t) > u(c'_t)$. To exemplify this, imagine a person choosing between eating spaghetti or potatoes. Perhaps the person prefers spaghetti over potatoes so that $u(spaghetti_t) > u(potatoes_t)$, since $\frac{\Delta\delta^{t+1}}{\Delta\delta^t}$ is constant, he/she will always prefer eating spaghetti over potatoes in every time period.

3.1.1 Assumptions for the discounted utility model

The discounted utility model is based on several assumptions about peoples inter temporal behavior. It's important to notice that the discounted utility model is based on more assumptions that those described in the following parts of this thesis. For example, the model assumes additive separability and independence, which means that utility from consumption at a certain point in time is independent of consumption at any other point in time. This means that a person that preferred spaghetti in our example above would continue to prefer spaghetti over potatoes today even if he had spaghetti yesterday and was expecting to have spaghetti tomorrow.

However, it is not the purpose of this thesis to explain all the assumptions made by the discounted utility model but rather focus on the few assumptions most relevant to our study. These assumptions will be described in more depth below.

3.1.1.1 The assumption of time consistency, stationarity and a constant discounting rate

The discounted utility model assumes a constant rate of discounting. This implies that a given time delay leads to the same degree of time discounting regardless of when it occurs[18] and that preferences between two different outcomes at different points in time does not change.
Under exponential discounting, a one day delay has the same significance if it means deferring an outcome from today until tomorrow, or from one year from today to a year and a day from today.[19] Formally Fredrick, Loewenstein & O'Donoghue (2002) expressed this statement as:

$$U_T(X) > U_T(X') \Leftrightarrow U_{T'}(X) > U_{T'}(X') \qquad T < T' < 0.$$

This implies that the preference between the two alternatives X and X' is not affected by the shift in time from T to T'. Thus, as an example given in Thaler (1981), a person who is indifferent between the choice of one apple today and two apples tomorrow should also be indifferent between the choice of one apple in one year and two apples in one year and one day.[20]

The stationarity condition, which implies logarithmic discounting at a constant rate, states that it is only the absolute size of the time delay between two different options that affects time discounting.

Fishburn and Rubinstein (1982) formulated the stationarity property as:

$$(x, t) \sim (x', t') \Rightarrow (x, t + \varepsilon) \sim (x', t' + \varepsilon').$$

Fishburn and Rubinsteins formula implies that the preference for consumption is only affected by the size of the interval between t and t'. A person who is indifferent between the choice of x at time t and the choice of x' at the time t' will continue to be indifferent between these options even if they are both delayed with the same constant ε. This means that if an individual is indifferent between receiving one apple today and two apples tomorrow, they should also be indifferent between the choice of receiving one apple in one year or two apples in one year and one day.

[18] Loewenstein, G. et al., 1992, Choice over time, p. xiii
[19] Ibid.
[20] Thaler, R., 1981

As first noted by Strotz (1955), exponential discount functions also implies that behavior and preferences between different options will not change over time.[21] For example, a person who prefers going on a trip to Italy in twelve months to going on a trip to Spain in eleven months should also prefer the trip to Italy after eight months have passed and continue to prefer the Italy trip even after eleven months when the date for the trip to Spain arrives. Strotz was also the first economist to consider alternatives to exponential discounting[22] seeing "no reason why an individual should have such a special discount function".[23] Strotz also stated that for any discount function other than exponential, people would have something he called time-inconsistent preferences; their preferences change systematically with the passage of time.[24] Time inconsistent behavior is different from a high rate of discounting which is possible in the discounted utility model. A high rate of discounting purely states that earlier outcomes are much preferred to later outcomes while time inconsistent behavior refers to changes in time discounting as a function of time passed.[25]

3.1.2 The assumption of positive time preference

Another characteristic that is usually assumed for the discounted utility model is positive time preference. In the discounted utility model the positive discount rate is expressed by $0 < \delta < 1$. This implies that utility, and consumption in the case of the discounted utility model, is more valuable the sooner it happens. In short, the assumption of a positive time preference in the discounted utility model means that people have a preference to bring forward consumption and defer costs. The reasoning behind assuming a positive time preference is usually explained with psychological examples such as the shortness of life, underestimation of future desires and lack of self-control among others.[26]

[21] Loewenstein, G. et al., 1992, Choice over time, p. xiii
[22] Camerer. C. et al., 2004
[23] Strotz, R. H., 1956, p.172
[24] Strotz, R. H., 1956
[25] Loewenstein, G. et al., 1992, Choice over time, p. xiii
[26] Loewenstein, G., 1992, p.3-34

3.2 Criticism against the discounted utility model

While Strotz might have coined the expression time-inconsistency among economists, many 19th century economists had already showed awareness of the non-constancy of discounting.[27] Spinoza had already in 1677 commented on this phenomenon:

> "We can only distinctly imagine distance of time, like that of space, up to a certain limit, that is just as those things which are beyond two hundred paces from us, or, whose distance from the place where we are exceeds that which we can distinctly imagine, we are wont to to imagine equally distant from us an as if they were in the same place, so also those objects whose time of existing we imagine to be distant from the present by a longer interval than that which we are accustomed to imagine, we imagine all to be equally distant from the present, and refer them all as it were to one moment in time."[28]

More recently, Chung and Herrnstein (1964) showed non-exponential discounting in an empirical study with pigeons.[29] Richard Thaler (1981) was the first to criticize the discounted utility model based on empirical studies with human subjects. His study showed evidence of several patterns incompatible with the discounted utility model such as higher discounting of gains than losses and higher discounting of small outcomes than large.[30]

3.2.1 Diminishing rate of discounting over time

While Thaler (1981) and other economists have raised several concerns with the credibility of the discounted utility model, we will focus on the most relevant area of criticism for this thesis; the constant discounting rate over time. The following parts will explore a few of the phenomena that led to the criticism of a constant discounting rate.

[27] Loewenstein, G. et al., 1992, Choice over time, p. xiv
[28] Ibid.
[29] Loewenstein, G. et al., 1992, Choice over time, p. xv
[30] Ibid.

3.2.1.1 The common difference effect

The common difference effect describes the diminishing rate of discounting as a function of time. The common difference effect can be put in contrast with the stationarity property of the discounted utility model which stated that preferences between options is only affected by the absolute time interval between them as described in section 3.1.1.1. In our example earlier in chapter 3.1.1.1 we stated that the stationarity property implied that if a person was indifferent between receiving one apple today and two apples tomorrow, they should also be indifferent between the choice of receiving one apple in one year or two apples in one year and one day. However, Loewenstein and Prelec (1992) noted that the stationarity property did not correspond well to reality where "preferences between two delayed outcomes often switch when both delays are incremented by a given constant amount".[31]

Loewenstein and Prelec (1991) formulated the common difference effect mathematically as:

$$(x,t) \sim (x',t') \Rightarrow (x,t+\varepsilon) \prec (x',t'+\varepsilon') \qquad x < x', t < t', \varepsilon > 0.$$

Loewenstein and Prelecs formula means that if consumption x at time t is equal to a larger consumption x' at a later time t', then people will prefer the larger consumption x' if both options are shifted forward in time by an equal amount or constant. This implies that impatience decreases as consumption is shifted forward in time and means that the near future is discounted more heavily than the future far away. Lowenstein and Prelec further notes that the common difference effect gives rise to dynamically inconsistent behavior, as earlier noted by Strotz in 1956[32] and therefore contradicts the assumption of the stationarity condition of the discounted utility model.

3.2.1.2 The immediacy effect

The immediacy effect was coined by Loewenstein and Prelec (1991) who found that immediate consumption or rewards are considered to be of far greater importance to people than consumption in the future, even if future consumption is delayed only with a short amount of time. The

[31] Loewenstein, G. & Prelec, D., 1992, p.121
[32] Ibid.

immediacy effect therefore implies an extremely high level of discounting for even short delays of time. Read, Loewenstein and Kalyanarama (1999) stated that "people are dynamically inconsistent, and show a systematic tendency to change their mind in the direction of vices as the moment of consumption approaches."[33] For example, in a study by Read and Van Leeuwen (1998) people could choose between eating junk food or a piece of fruit one week before they would consume it. Around half of all the people chose to consume the piece of fruit. However, immediately before consumption many changed their minds and over 80% of all the subjects decided to eat the junk food.[34]

Another example of the immediacy effect is illustrated with an example inspired from O'Donoghue and Rabin (1999).[35] You should carry out an unpleasant activity. In alternative "A" you can choose between doing 1) 7 hours of work today or 2) 8 hours of work in one week. In alternative "B" you can choose between doing 7 hours of work in one month or 8 hours of work in month and one week. O'Donoghue and Rabin means that while some people might choose to procrastinate and take the later option between the choices in alternative A, very few would choose the later option in alternative B.[36]

Phelps and Pollack (1968) formulated the immediacy effect as:

$$U^0(u_0, u_1, \dots, u_T) = u_0 + \beta \sum_{t=1}^{T} \delta^t u_t,$$

where $\delta \leq 1$ means that there is a constant discount rate and $\beta \leq 1$ describes the immediacy effect.[37] This formula implies that in addition to the positive time preference that is represented by the discount rate δ there is also a present bias represented by β that means that immediate utility is valued $1/\beta$ times more than delayed utility.

[33] Read, D. et al. 1999, p.259
[34] Ibid
[35] O'Donoghue T. & Rabin M., 1999, p. 103
[36] Ibid.
[37] Read, D. et al. 1999, p.259

Laibson (1997) referred to this formula as the quasi-hyperbolic discount function,[38] which we will discuss in chapter 2.3.

3.2.1.3 Reversal of preferences

Take the example above with the arduous activity that had to be performed on one of two occasions. If a person in alternative B chose option 1), to do 7 hours of the activity in one month, then a preference reversal could occur as the arduous activity gets closer in time. On the actual day of the activity, the person could have completely changed his preferences and rather prefer to do 8 hours of the activity the next week. We daily see many examples of these kinds of preference reversals, take for example the preference to eat healthy. One might have a preference to eat healthy and lose weight, however, as dinner time approaches and hunger sets in the preferences switches to ordering that delicious (and unhealthy) pizza. Reversal of preferences is usually illustrated with preference curves.

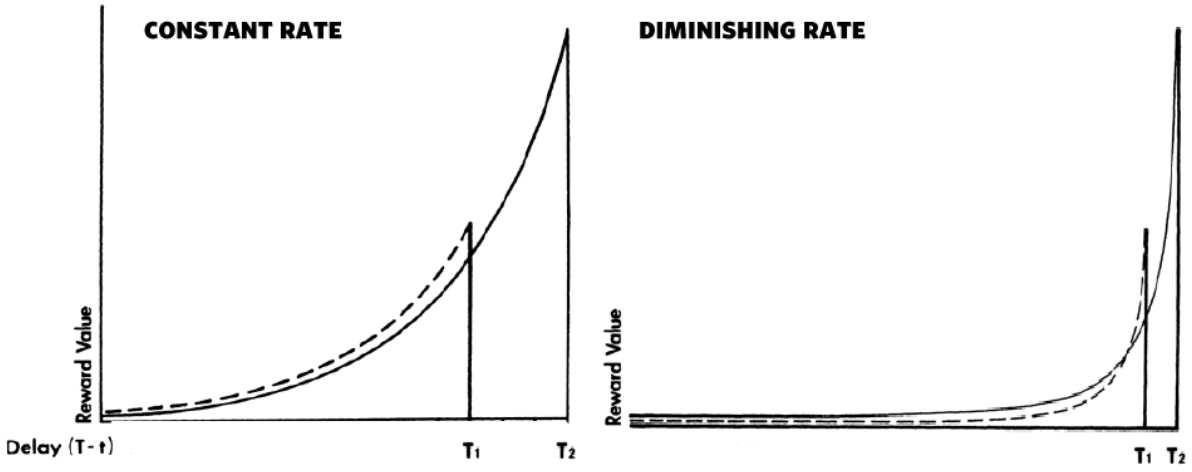

Figure 1 shows constant versus diminishing rate of discounting.

Ainslie and Haslam (1992) show that the constant rate of discounting that the discounted utility model uses implies that preference curves can never cross each other while a diminishing rate of discounting could lead to preference curves crossing and therefore reversal of preferences. The

[38] Read, D. et al. 1999, p.259

preference for one option in one period of time can suddenly change to a preference for another option in another period of time.[39]

3.3 Hyperbolic discounting

Hyperbolic discounting differs from exponential discounting in a way that allows for the previous mentioned phenomena in chapter 3.2 to exist. In fact, hyperbolic discounting allows for both time inconsistent behavior such as reversal of preferences as well as explaining bad habits such as procrastinating or staying up to late.

When faced with a choice between an inferior early option and a superior later option, hyperbolic discounters tend to choose the later superior option when both options are far away but then change their preferences to the inferior option as the options approach in time. Under hyperbolic discounting a person who preferred the trip to Italy over the trip to Spain in our example earlier (chapter 2.1.1.1) when the two options where twelve and eleven months away respectively, would probably prefer the trip to Spain after eleven months, as soon as it was possible to depart to Spain. For a hyperbolic discounter, the trip to Spain becomes disproportionally tempting when it is immediately available but the trip to Italy is still one month away.[40]

A few theorists have argued that simple discounting can explain all behaviors that are usually considered irrational, such as for example addictions or preference reversals.[41] Logue (1988) argued that preference reversals among organisms occur because of a limited awareness of the future.[42] Becker and Murphy (1988) meant that impulsive behavior ultimately depends on discounting the future too much.[43] However, these theories fail to explain cases where the subjects knows that they will change their mind in the future but still have a hard time preventing the undesired behavior,[44] such as for example sticking to a diet.

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[39] Ainslie, G. & Haslam, N., 1992, p.65
[40] Loewenstein, G. et al., 1992, Choice over time, p. xiii
[41] Ainslie, G. & Haslam, N., 1992, p.62
[42] Ibid.
[43] Ainslie, G. & Haslam, N., 1992, p.63
[44] Ibid.

In order to for the phenomena described by the common difference effect in chapter 2.2.1.1 to exist we need a function that satisfies the formula,

$$u(x)D(t-T) = u(x')D(t'-T) \Rightarrow u(x')D(t-T+\varepsilon) \qquad x < x', t < t', \varepsilon > 0.$$

As we know from chapter 2.2, exponential discounting produces a constant rate of discounting. Ainslie and Haslam (1999) states that in order "for a discount function to produce motivational conflict between alternatives, it must generate curves that either lie so close together as to prevent one from dominating the other, or that cross one another as time elapses..."[45] Ainslie and Haslam further notes that it would be possible that people discount different events with different discount rates. However, this phenomenon would still not explain the instances where impulse decisions forsake a larger long-term reward in order to gain a smaller short-term reward of the same sort.[46]

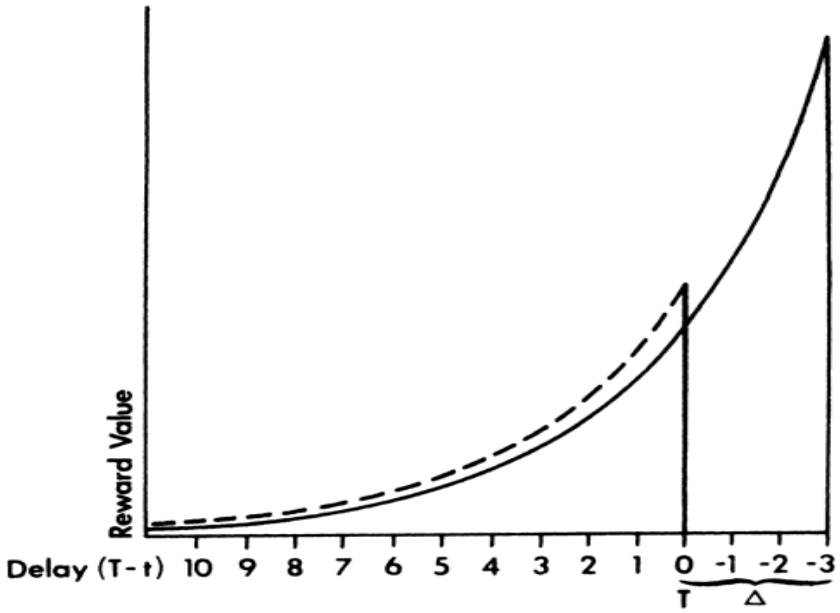

Figure 2 shows two alternative rewards for a certain good available at different times. One reward is available at time t and one reward, which is twice as big is available at t-3. However, the two rewards remain proportional to each other at all possible times before the rewards are available.[47]

[45] Ainslie, G. & Haslam, N., 1992, p.63
[46] Ainslie, G. & Haslam, N., 1992, p.65
[47] Figure taken from Ainslie, G. & Haslam, N., 1992, p.64

The figure above shows two different alternatives of the same event or good. While the steepness of the curve might change as time passes, the curves still remains proportional to one another at all times. Exponential curves can therefore never lead to any preference reversals and exponential discounting gives no explanation for the conflict with short-term and long-term avarice. Thus, the only preference curves that could cause preference reversals would be required to differ in their basic shape from the ordinary exponential discount curve.[48]

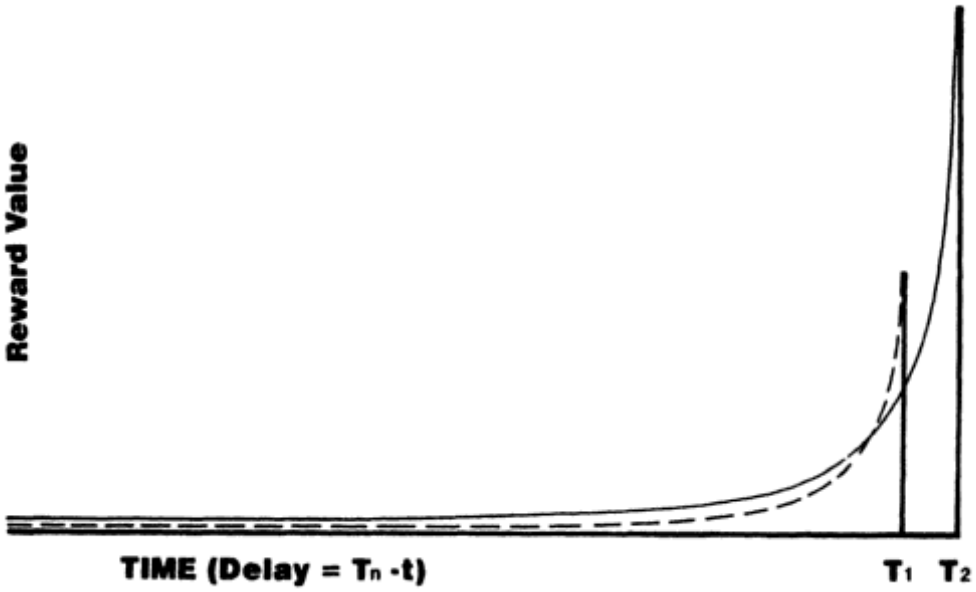

Figure 3 above shows hyperbolic curves with the same rewards as in figure 2, with the difference that these hyperbolic curves correspond to equation (2).[49]

[48] Figure taken from Ainslie, G. & Haslam, N., 1992, p.64
[49] Figure taken from Ainslie, G. & Haslam, N., 1992, p.66

Based on Herrnsteins matching law[50], Mazur (1987) formulated the special function required for hyperbolic discount curves as:

$$V = A(\zeta + \Gamma(T - t)),$$

where V is the goods relative valuation, A is the amount that is possible to obtain, T is the time that the good is available and t is the time of the behavior that obtains A. ζ is an empirical constant that limits maximum value at zero delay and Γ is an empirical constant that modifies the steepness of the delay gradient, that is, the subjects sensitivity to delay.[51]

In the following examples we will set ζ and Γ to 1.[52] In an example taken from Ainslie (1991) Mazurs formula above is used to compare two goods of the same sort that are three units of time apart, with the latter good being objectively twice as large as the earlier. In this example the point where a subject is indifferent between the alternatives will occur when the earlier good is two units of time from being available. When the two goods are five units of time away, the latter larger good is preferred by $2/(1+5+3)=2/9$ to $1/(1+5)=1/6$. However, when the goods are one unit of time away from the earlier good being available, the earlier good is preferred by ½ to ⅖. The smaller good is preferred temporarily as it becomes closer to being available.[53]

The same formula can be used to discount an arduous activity hyperbolically. The inverse hyperbolic curves that can be seen in figure 4 shows that an individual prefers to carry out the arduous activity on the earlier occasion when the decision is far away. As the earlier option approaches in time the preference suddenly shifts and the individual now prefers to defer the activity and carry out the latter alternative instead. In this way, hyperbolic discounting explains the phenomena of procrastinating and deferring arduous tasks.

[50] Herrnstein formulated the matching law in 1961. The matching law describes the valuation of two options when they are in concurrent reward schedules and where behavior to obtain each option is rewarded in an unpredictable way but at a set average rate. Herrnsteins matching law served as a foundation for later models of hyperbolic discounting.
[51] Ainslie, G. & Haslam, N., 1992, p.65
[52] Mazur himself set these parameters to 1 based on that data about their true value is not available. (Ainslie, G. & Haslam, N., 1992, p.65)
[53] Example taken from Ainslie. G., 1991, p. 334

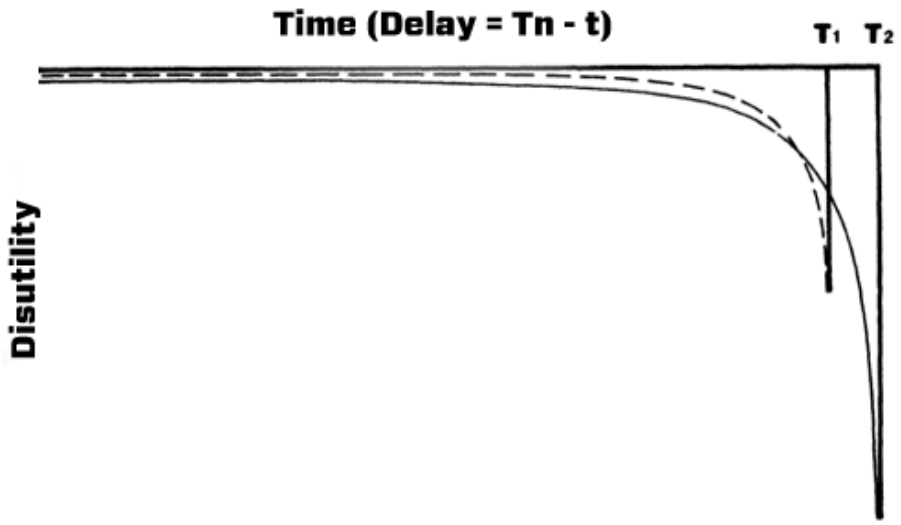

Figure 4 shows hyperbolic curves for arduous activities.

Much of the economic literature have made the assumption that for example procrastination is just a preference for having the early reward that not doing the arduous task brings. If procrastination is defined this way, then it would be logical to assume that the same principals from all of the above mentioned examples with immediate rewards would also apply to deferring arduous activities. However, very few studies have actually been made about discounting arduous activities hyperbolically.[54] According to Ainslie (2008) the only study that has been made on the discount curve for procrastinators is a Dutch study where students in a hypothetical setting were asked to rate their motivation to study when they faced five different types of temptation. In this hypothetical experiment their estimated motivation gave rise to a hyperbolic discount curve for every temptation.[55]

[54] Ainslie. G., 2008, p. 3-5
[55] Ibid.

3.4 Quasi Hyperbolic Discounting

In chapter 2.1.1.2 we noted that Phelps and Pollack (1968) had formulated the immediacy effect as:

$$U^0(u_0, u_1, \dots, u_T) = u_0 + \beta \sum_{t=1}^{T} \delta^t u_t \quad 0 < \beta, \delta \leq 1,$$

β is here a representation of the individuals present bias, i.e how much the discount delayed rewards.

This function was later referred to as the quasi-hyperbolic discount function by Laibson (1997)[56] and employed by Laibson (1994, 1997, 1997), Fisher (1997) and O'Donoghue and Rabin (1999).

We will primarily be using this quasi-hyperbolic formula instead of the hyperbolic function proposed by Mazur above. Phelps and Pollacks quasi hyperbolic formula is a simplification of hyperbolic discounting, however, it still captures many of the qualitative features of hyperbolic discounting, while being able to retain much of the analytical tractability of the discounted utility model.[57]

Just as for the discounted utility model, the quasi-hyperbolic formula means that individuals discount future rewards with an exponential factor that increases with the length of delay. However, the quasi-hyperbolic formula also implies that people discount delayed rewards with a constant factor to represent their present bias.

To use a very simplistic example, take our earlier mentioned individual that could choose between a preferred trip to Italy in twelve months and a less appealing trip to Spain in eleven months. In this example, let the objectively valued utility of the trip to Italy be 100 and 60 for the trip to Spain. For simplicity assume $\beta = 0{,}5, \delta = 1$. In this case, when both alternatives are far away the present value of both alternatives is 50 for Italy (0,5*100) and 30 for Spain (0,5*60). However, after eleven

[56] Read, D. et al. 1999, p.259
[57] Fredrick, S., et al., 2002, p. 366

months, at the time for the trip to Spain the present value of the two options have suddenly changed to 50 for Italy (0,5*100) and 60 for Spain (1*60). The hyperbolic discounter now prefers the trip to Spain when it is immediately available.

4. Results

The following results were obtained after the experiment had been carried out. The total number of students approached amounted to $N = 332$ (we consider this to be the population throughout the rest of this paper). This selection was obtained by taking the number of students attending the first course of the first semester on SSE - course 404 in Microeconomics. We soon discovered that of those registered for the course two were attending their second year at SSE. Since we didn't think that the amount of understanding of the subject of the experiment had increased by the second year(in contrast with for example to master students), we choose to include these two in the study. The students were then divided into two groups by a randomization process[58] which yielded $N_X = 164$ students in the control group (group X) and $N_Y = 168$ students in the treatment group (group Y).

4.1 Answering rates

Out of the approached students a total of 80 chose to answer the assignments, $n_X = 44$ out of $N_X = 164$ and $n_Y = 36$ out of $N_Y = 168$. The number of participants who chose to answer the assignments on Monday amounted to $p_{Xm} = \frac{28}{44} \approx 0{,}64$ and $p_{Ym} = \frac{35}{36} \approx 0{,}97$.

$N = 332$	$X(N_X = 164)$	$Y(N_Y = 168)$
Monday	28	35
Thursday	16	1
Total/group	$n_X = 44$	$n_Y = 36$

[58] Subjects were randomly chosen to be part of one of the two groups by using RAND() in excel with the outcome either 0 or 1.

4.2 Hypothesis rejected

Thus, we know that there is a clear difference in the Monday answering rate between the two samples (n_X and n_Y). In order to investigate whether such a difference also could be established between the two groups (N_X and N_Y) we used the following formula for "confidence intervals for the difference between Population Proportion (Large Samples):

$$(p_{Xm} - p_{Ym}) \pm z_{\alpha/2}\sqrt{\frac{p_{Xm}(1-p_{Xm})}{n_X} + \frac{p_{Ym}(1-p_{Ym})}{n_Y}}.$$

For a 99 % confidence interval, $\alpha = .01$ so that $z_{\alpha/2} = z_{0.005} = 2{,}575$.

$$(0.64 - 0.97) \pm 2{,}575\sqrt{\frac{0.64(1-0.64)}{44} + \frac{0.97(1-0.97)}{36}}.$$

This gives that $-0{,}53 < P_{Xm} - P_{Ym} < -0{,}13$. Since 0 is well outside the interval it is suggested that there is in fact a difference in the population proportions between the two groups. In the long run the difference is estimated to be as little as 13% or as high as 53% and 99% of all such intervals would contain the true value of the difference.

However, it should be noted that "large sample sizes" should generally consist of at least 40 observations in each sample. Since the number of participants in group Y only amounted to 36, one could question whether or not the data approximately follows a normal distribution.

4.3 Investigating the groups' preferences when to perform the task

$$P_{Xm} \pm z_{\alpha/2}\sqrt{\frac{p_{Xm}(1-p_{Xm})}{n_X}}$$

A test was performed to determine if there was a tendency among the control group to choose any of the two days to perform the task or if they were indifferent between the two.

$$0.64 \pm 1{,}645\sqrt{\frac{0{,}64(1-0.64)}{44}}$$

The test revealed that in 90 of 100 cases, between 52%-76% of the population will perform the task the first day.

$$P_{Ym} \pm z_{\alpha/2}\sqrt{\frac{p_{Ym}(1-p_{Ym})}{n_Y}}$$

Performing the same test for the treatment group revealed that:

$$0.97 \pm 2{,}575\sqrt{\frac{0{,}97(1-0.97)}{36}}$$

in 99 of 100 cases 89 - 100 % of the population would chose to perform the task on the first day.

Qualitative questions

None of the subjects regretted choosing the day they did. There was no special reason for any of the students to choose the day they did.

5. Discussion

Before analyzing the results, the following conclusions could be made about the various potential outcomes of the study. If the respondents were to perform the task on the second day they could be discounting arduous tasks either hyperbolically or exponentially.

5.1 Consequences of hyperbolic discounting on choice

$$dU^T(du_t, du_{t+1}, \dots, du_T) \equiv \delta^t du_t + \beta \sum_{\tau=t+1}^{T} \delta^\tau du_\tau$$

Given that the subjects' disutility of the task are same on both occasions $du_1 = du_2$ and that the long run discount rate δ is constant and equals (or at least are very close to) 1 respondents performing the task the second day could be discounting the task hyperbolically if $\beta < 1$.

$$du_1 > \beta du_2$$

Since we also assume that our subjects are naive, they are unaware of how they would actually feel on the second day and thus won't plan ahead to avoid the potential angst occurring at that point in time. Clearly, for naive subjects discounting hyperbolically the disutility of performing the arduous task on the first day is higher than performing it on the second day, when choosing on the first day on which of the two occasions to perform the task.

Should however $\beta = 1$ the subjects would be discounting exponentially since

$$\delta^t u_t + 1 * \sum_{\tau=t+1}^{T} \delta^\tau du_\tau = \sum_{t=0}^{T} \delta^t du_t \,,$$

which is the formula for exponential discounting.

Finally there is also the case of both $\beta < 1$ and $\delta < 1$. Since δ is assumed to be a constant between $0 < \delta < 1$, $\delta\delta$ will always be smaller than δ. This yields that

$$\delta^1 du_1 > \beta\delta^2 du_2 \ ,$$

so that subjects will always prefer to perform the task on the second day during these conditions.

5.2 Consequences of exponential discounting on choice

While subjects performing the task on the second day could indeed be discounting hyperbolically, it cannot be ruled out that they could also be discounting exponentially.

$$dU^T(du_t, du_{t+1}, \dots, du_T) \equiv \sum_{t=0}^{T} \delta^t du_t$$

Given that $\delta = 1$

$$du_1 = du_2,$$

subjects could be indifferent between performing the task on either of the two occasions. As we noted in chapter 3.1.2, the discounted utility model makes the assumption of a positive time preference as expressed by $0 < \delta < 1$. However, a scenario where δ is very close or equal to 1 is plausible when considering that δ is a measure of long run discounting. That is, a subject's discount rate may for instance have effects for intertemporal choice over periods of decades, years, months or even weeks, but perhaps not over a few days. There would then be a 50/50 chance when on the experiments two occasions that an exponentially discounting subject with $\delta = 1$ would perform the task.

If $\delta < 1$ then

$$\delta^1 du_1 > \delta^2 du_2.$$

This would mean that subjects would defer the task to the second day since the disutility of performing the task on the first day would loom larger than performing it on the second day. This comes as a result of the compound discount rate where $\delta > \delta\delta$ since $0 < \delta < 1$.

5.3 Contradicting results of the control group

	$\delta = 1$	$\delta < 1$
$\beta = 1$	**Indifferent** $du_1 = du_2$	**Second day** $\delta^1 du_1 > \delta^2 du_2$
$\beta < 1$	**Second day** $du_1 > \beta du_2$	**Second day** $\delta^1 du_1 > \beta\delta^2 du_2$

By the way the experiment was set up the projected outcome was that subjects would perform the task on the second day for all scenarios except if both $\beta = 1$ and $\delta = 1$ where subjects instead would be indifferent between the two days. In latter case, the indifference of the subjects would yield a result of roughly 50% choosing each day.

However when examining the result of the experiment for the control group only 16 (about 36%) of the 44 subjects performed the task on the second day. In 9 cases out of 10 this means that 52 - 76% of the population would perform the task on first day. Thus neither the sample group nor the population as a whole seems likely to be indifferent between the two days. Instead they are showing a tendency to perform the task on the first day. A majority of the subjects hence seem to lack present-bias preferences. Instead a majority of the group appears to have either β or δ above 1. A $\beta > 1$ would imply that the individuals were affected by some form of a reversed immediacy effect (Chapter 3.2.1.2). Since none of the subjects claimed that they regretted their choice when asked several weeks later, it seems more likely that $\delta > 1$ for the majority of the group since no preference reversal and thus no present-bias effect (β) seems to have taken place[59].

These results are both surprising and intriguing since they seem to contradict the prevailing literature on intertemporal choice claiming that people in general are biased towards the present.[60,61,62] It should however be noted that it does so, only on matters regarding the deferral of arduous tasks (procrastination). Since there seems to be lacking a foundation in terms of empirical research in an experimental setting for the deferral of arduous task[63] we suggest that more research should be carried out on a larger scale in order to further understand the discounting of such tasks.

5.4 Strong effect of treatment in the treatment group

After having eliminated the start up costs (ζ) by inferring them on both occasions and by transferring the subjects of the test group to a "working modus" by having the task immediately ready to perform when choosing, an overwhelming majority of the subjects choose to perform the task on the first day. With 35 (97%) of the 36 subjects performing the task on the first day, in 99 of 100 cases 89 - 100 % of the population would chose to perform the task on the first day.

[59] Given that the time between the experiment and the control questions was sufficient enough time for the subjects to realize that a preference reversal had indeed occurred.
[60] O'Donoghue T. & Rabin M., 1999
[61] Loewenstein, G. et al., 1992
[62] Ainslie, G. & Haslam, N., 1992
[63] Ainslie. G., 2008, p. 3-5

The result of comparing the difference between the two groups revealed that in 99 out of 100 cases, there is a 13%-53% difference. Since a difference between the two groups have been statistically established and the fact that the preference for performing the task on the first day seems so strong in the treatment group, it is safe to say that the treatment has had a significant effect on the subjects' choice mechanisms. Hence the hypothesis can be rejected. The difference however isn't really captured by the models for either exponential nor hyperbolic discounting.

If $\delta = 1$ but $0 < \beta \leq 1$, removing the start up costs (ζ_1, ζ_2) wont change the direction of the "larger than"-sign.

	$\delta = 1$
$\beta = 1$	$du_1 - (\zeta_1 - \zeta_2) = du_2 - (\zeta_1 - \zeta_2)$
$\beta < 1$	$du_1 - (\zeta_1 - \beta\zeta_2) > \beta du_2 - (\zeta_1 - \beta\zeta_2)$

Notice that because the subjects are forced to pay ζ on both occasions regardless of which day they choose to perform the task, both the current start up cost and all future forced start up costs must be included when calculating the disutility of the various outcomes.

Loosening the assumption of $\delta = 1$ so that $0 < \delta \leq 1$ but assigning will yield the following result

	$0 < \delta \leq 1$
$\beta = 1$	$\delta^1(du_1 - \zeta_1 - \delta^1\zeta_2) > \delta^2(du_2 - \frac{\zeta_1}{\delta^1} - \zeta_2)$
$\beta < 1$	$\delta^1(du_1 - \zeta_1 - \delta^1\beta\zeta_2) > \delta^2(\beta du_2 - \frac{\zeta_1}{\delta^1} - \beta\zeta_2)$

So that,

	$\delta = 1$	$\delta < 1$
$\beta = 1$	**Indifferent** $du_1 - (\zeta_1 - \zeta_2) = du_2 - (\zeta_1 - \zeta_2)$	**Second day** $\delta^1(du_1 - \zeta_1 - \delta^1\zeta_2) > \delta^2(du_2 - \frac{\zeta_1}{\delta^1} - \zeta_2)$
$\beta < 1$	**Second day** $du_1 - (\zeta_1 - \beta\zeta_2) > \beta du_2 - (\zeta_1 - \beta\zeta_2)$	**Second day** $\delta^1(du_1 - \zeta_1 - \delta^1\beta\zeta_2) > \delta^2(\beta du_2 - \frac{\zeta_1}{\delta^1} - \beta\zeta_2)$

Thus according to the exponential and hyperbolic models of discounting ζ_{1+2} should not influence when in time the subjects choose to perform the task. Yet the data from the experiment clearly shows that the treatment for the test group (where ζ_{1+2} were removed) had a significant effect on the subjects' decision making. Just as for the control group, nobody in the test group later regretted having performed the task on the day they did, implying that no present bias (β) was in effect. Thus, while keeping within the boundaries of the two models and true to the assumed properties of the models' elements, the only explanation for the test group's strong preference for performing the task on the first day seems to be that the majority of the group has a $\delta > 1$ for discounting arduous tasks.

5.5 The mystery of $\delta > 1$

The majority of both the test group and the control group seem to have a $\delta > 1$. While both groups showed this tendency, the implementation of the treatment seemed to strongly increase the tendency. However, explaining the group's preference to perform the task on the first day solely through the δ parameter seems a bit far stretched since the parameter orginally is supposed to be a measure of long run discounting. We thus assumed in the beginning of this thesis that the parameter was equal (or very nearly equal) to 1 since the experiment lasted shorter than a week. The reasoning behind assuming the parameter to be 1 was that it then wouldn't have any bearing on the subjects' short term decision making. While this assumption was made for $\delta < 1$ the same should also hold true for $\delta > 1$. This is unless the long run value of δ would be extremely high, thus affecting the short term interval investigated in the experiment as well. Although this seems implausible per se, even if it were to be true it still wouldn't explain *why* subjects discounted this way.

There could of course be several reasons for this. For one, perhaps the students in the test group didn't fully understand (in spite of clear instructions) that they would have to pay ζ on both occasions and that it therefore didn't matter. However, since subjects who didn't complete what was required of them on both of the days were excluded from the experiment, it doesn't seem plausible that this was something the subjects included did not understand on the first occasion.

Another reason for the given results could perhaps be contributed to what a majority of the subjects who performed the task on the first day stated when they, several weeks later was asked why they performed the task the day they did - "I just wanted to get it over with". This could imply that the subjects experienced the task as something that bothered them even as they were occupied by other things than the task per se. Elster & Loewenstein (1992) is touching on this subject discussing the role of anticipation. The authors cites an article explaining how people knowing that they were about to lose their jobs felt worse anticipating the unemployment than during the actual period of unemployment. Yet another article cited explains how college students preferred Fridays to Sundays, although school was mandatory on Fridays. These examples indicate that anticipation plays an important part in peoples' lives. We also believe it could help getting further insight into how people discount arduous tasks.

> "We define *savoring* as the process of deriving positive utility from anticipation of desirable events, and *dread* as the emotional impact of contemplating future negative experiences. Savoring and dread act as multipliers of experience, causing individuals to experience the hedonic impact of future events repeatedly before they actually occur; as Shakespeare's Julius Caesar states, 'cowards die many times before their deaths'."[64]

In other words, while positive future experiences create anticipatory longing, negative experiences could possibly create anticipatory angst (or "dread"). In such a case deferring the negative experience potentially wouldn't ease the subjects angst caused by anticipation. Since the anticipatory angst is possibly weighing heavier on the shoulders of the subject than the burden of actually performing the task, getting rid of the task as soon as possible is preferred. This is quite different from the anticipatory longing created by an approaching positive experience where the subject would want to consume the experience as soon as possible sacrificing a later larger reward.

5.6 Formulating a model for anticipation

Let's say that ϕ symbolize anticipation and that $\phi \geq 1$. Further assume that ϕ only affects future periods. Given that $\beta = 1$ and $\delta = 1$ we thus will get the following result:

$$du_1 < \phi du_2 \text{ if } \phi > 1$$
$$du_1 = \phi du_2 \text{ if } \phi = 1,$$

that is, the angst created by anticipation will influence the subject to perform the task on the first day given that the subject's long run discounting don't effect the choice mechanism and that the subject isn't present biased.

[64] Elster & Loewenstein, 1992

However, if we loosen these assumptions and let $0 < \beta \leq 1$ and $0 < \delta \leq 1$ we will get the following formula

$$dU^T(du_t, du_{t+1}, \dots, du_T) \equiv \delta^t du_t + \beta\phi \sum_{\tau=t+1}^{T} \delta^\tau du_\tau,$$

allowing for the following outcomes depending on the value of β, δ & ϕ:

	$\delta = 1$	$\delta < 1$
$\beta = 1$	$\phi > 1$: First day $\phi = 1$: Indifferent	$\phi = \frac{1}{\delta^2}$: Indifferent $\phi > \frac{1}{\delta^2}$: First day $\phi < \frac{1}{\delta^2}$: Second day
$\beta < 1$	$\phi = \frac{1}{\beta}$: Indifferent $\phi > \frac{1}{\beta}$: First day $\phi < \frac{1}{\beta}$: Second day	$\phi = \frac{1}{\beta\delta^2}$: Indifferent $\phi > \frac{1}{\beta\delta^2}$: First day $\phi < \frac{1}{\beta\delta^2}$: Second day

Since the majority of the subjects don't seem to have been present biased (which implies $\beta = 1$) and since δ is a measure of long run discounting (which implies $\delta = 1$) the parameter ϕ could be one way to explain the peculiar results of our experiment. As the table above also states, there could also be a combination of the three parameters that are the reason for the results. In this way, the subjects could in fact still be influenced by both β and δ only that the effects of the anticipatory parameter ϕ are covering them up.

5.7 Explaining the difference between the two groups

While the anticipatory effect could be part of explaining why both groups had a tendency to perform the task on the first day, it still doesn't shed much light on why the treatment had such a potent effect. If the majority of both groups wanted to get the task done in order to get rid of their

anticipatory angst, then why was this desire so much larger in the test group? There are mainly just two (intertwined) differences between the control group and the test group.

One - they had to pay ζ on both occasions, thus eliminating the effect of ζ. Depending on the values of β and δ it could for example have been rational to perform the task on the first day given that ζ had been paid for that day and that the first day completion of the task would mean that no more work had to be done. But since the experiments forces the test group to pay ζ on both occasions the two costs cancel out each other.

Two - when the subjects of the test group where to make the choice when to perform the task, they were in immediate contact with the task itself since ζ had already been paid. We believe this to be the most important difference. Since the payment of the two ζ's cancel out each other, they really shouldn't have any real effect on the subjects' choice mechanisms. Instead the immediacy of the task at hand seems to be the most important contributor to the strong preference of the test group to perform the task on the first day. This is a very peculiar result.

Our interpretation of this is that people (or at least our subjects) could in fact be present biased. But not present biased in terms of deferring the cost of a smaller task in order to pay a larger task cost later. Instead, we believe people to have a bias towards being stationary. That is, staying in the same modus as they presently are. We therefore suggest a parameter of stationarity $\varpi \in (0,1)$ where $\varpi = 1$ would indicate a person who is not currently in a working modus, while $\varpi < 1$ would indicate a person who is. We also believe that there is an unknown correlation between the amount of work performed and ϖ, where an increasing amount would at some unknown rate lower ϖ (and thus ultimately increase the likeliness of a first day task completion).

$$dU^T(du_t, du_{t+1}, \dots, du_T) \equiv \delta^t du_t \varpi + \beta\phi \sum_{\tau=t+1}^{T} \delta^\tau du_\tau,$$

So that,

	$\delta = 1$	$\delta < 1$
$\beta = 1$	$\phi = \varpi$: Indifferent $\phi \neq \varpi$: First day	$\phi = \frac{\varpi}{\delta^2}$: Indifferent $\phi > \frac{\varpi}{\delta^2}$: First day $\phi < \frac{\varpi}{\delta^2}$: Second day
$\beta < 1$	$\phi = \frac{\varpi}{\beta}$: Indifferent $\phi > \frac{\varpi}{\beta}$: First day $\phi < \frac{\varpi}{\beta}$: Second day	$\phi = \frac{\varpi}{\beta\delta^2}$: Indifferent $\phi > \frac{\varpi}{\beta\delta^2}$: First day $\phi < \frac{\varpi}{\beta\delta^2}$: Second day

Since $0 < \varpi \leq 1$ and only affects the current period and $\phi \geq 1$ and only affects future periods, as long as they are different from 1 they will increase the possibility of the subject performing the task on the first day. While the control group is assumed to have $\phi \geq 1$ they are also assumed to have $\varpi = 1$ since they were not in a working modus when deciding whether to perform the task or not. The test group on the other hand is assumed to enjoy the boost provided by $\varpi < 1$ thus explaining their strong preference to complete the task the first day.

6. Conclusion

By the way the experiment was set up both the discounted utility model and the hyperbolic discount model predicts that a majority of the subjects would perform the task on the second day. The only exception would be if δ where subjects would be indifferent between the two days according to the discounted utility model.

However, the results of the experiment showed that in 9 cases out of 10, 52 - 76% of the population would perform the task on first day during the control group's conditions. Hence, it doesn't seem likely that the group is indifferent between the two days (and by no means that they would prefer the second day). Under the conditions of the test group remarkably in 99 out of 100 cases 89 - 100 % of the population would chose to perform the task on the first day. This suggest that either (or both) β and/or δ would be above one for a majority of the subjects.

Since δ is a measure of long run discounting assumed to be very close to 1 for a short interval of a few days it doesn't seem likely to have influenced the subjects' choice no matter if $\delta > 1$ or $\delta < 1$. Neither does it seem plausible that $\beta > 1$ since it is a measure of present bias in the way that one would prefer to forfeit a smaller, sooner task in order to perform a larger, later task. With $\beta > 1$ this would imply that the subject would prefer the smaller, sooner task and thus defeating the purpose of the parameter itself. Instead it is suggested that something outside of the models are affecting the way the subjects choose. Anticipation ϕ is here suggested as one possible parameter that could have influenced the subjects.

After having discussed the surprising outcome of this initial data, the hypothesis that start up costs would have no influence on the subjects choice was tested. While the majority of the two groups preferred performing the task on the first day, the removal of start up costs showed a statistically significant difference between the groups in terms of percentage of the subjects performing the task on the first day. In 99 out of 100 cases the difference between the groups would lie between 13%-53% thus inferring that the removal of start up costs had a significant effect on the test groups ability to complete the task on the first day. Hence the hypothesis could be rejected.

While the only difference between the two groups is the removal of start up cost leading the test group to a more immediate exposure to the task at hand, this difference isn't explained by either of the discounted utility model or the hyperbolic discount model. As a potential explanation to the difference a parameter of stationarity ϖ was introduced. The parameter suggests that while being in a working modus (that is, after one has paid the start up cost) it is preferred to finish the task at hand even when the option of completing the task later (after having paid the start up cost an obligatory second time) is available.

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Appendix

1:a BREVET TILL KONTROLLGRUPP

Hej!

Vi är två masterstudenter som håller på att skriva vår D-uppsats och söker nu deltagare till det experiment som skall ligga till grund för vår studie. Experimentet tar i sin helhet c:a 30 min och alla deltagare är **garanterade 200 kr**, förutsatt att man slutför uppgiften.

Beskrivning av experimentet:
För att kunna tillgodogöra dig de 200 kr som utlovats kommer du ges möjligheten att utföra en uppgift på antingen måndag den 26:e eller torsdag den 29:e (alltså mån eller tors nästa vecka!). Uppgiften kommer att bestå av 15 uppgifter där du kommer att räkna bokstäver eller ord i ett antal texter. Uppgiften kan lösas närsomhelst under måndags eller torsdagsdygnet* och kan utföras vartsomhelst där det finns tillgång till internet.

För att anmäla dig till experimentet ber vi dig att svara på detta mail senast *24:00 onsdagen den 21:e* med ditt namn och inskrivningsnr.

Med vänliga hälsningar
Erik Jontell & Viktor Schönning

*Vi har här valt att **räkna ett dygn som 03:00 och 24 timmar framåt** (istället från 00:00 som är brukligt). Det är alltså exempelvis tillåtet att lämna in torsdagens uppgift under fredagnatt fram

till och med 02:59.

1:a BREVET TILL TESTGRUPPEN

Hej!

Vi är två masterstudenter som håller på att skriva vår D-uppsats och söker nu deltagare till det experiment som skall ligga till grund för vår studie. Experimentet tar i sin helhet c:a 30 min och alla deltagare är **garanterade 200 kr**, förutsatt att man slutför uppgiften.

Beskrivning av experimentet:
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När av de två tillfällena du vill göra klart uppgiften är alltså helt upp till dig. Ett krav är dock att du på **både måndag och torsdag** fyller i dina kontaktuppgifter på undersökningens första sida, samt svarar på en kontrollfråga om uppgiften.

För att anmäla dig till experimentet ber vi dig att svara på detta mail senast *24:00 onsdagen den 21:e* med ditt namn, och inskrivningsnr!

Med vänliga hälsningar
Erik Jontell & Viktor Schönning

*Vi har här valt att **räkna ett dygn som 03:00 och 24 timmar framåt** (istället från 00:00 som är brukligt). Det är alltså exempelvis tillåtet att lämna in torsdagens uppgift under fredagnatt fram

till och med 02:59.

PÅMINNELSEMAIL TILL TESTGRUPP

Hej!

Du har väl inte glömt av att du kan tjäna 200 kr nästa vecka på totalt 20-30 minuters arbete? Anmäl dig till vårt Experiment innan **23:59 ikväll**.

Uppgiften kan alltså utföras när som helst, var som helst (där det finns internet) under hela måndag och torsdagsdygnet!

Ta chansen!
Erik Jontell och Viktor Schönning

INFORMATIONSBREV KONTROLLGRUPP

Hej och tack för din anmälan!

Du är en av de utvalda att få delta i experimentet och är nu registrerad. Experimentet innehåller alltså ett antal uppgifter som går ut på att du så exakt som möjligt ska uppge hur många bokstäver av en viss typ som ingår i ett textstycke. En exempeluppgift finns bifogad i pdf-format.

På måndag nästa vecka (den 26:e) kommer du få en länk skickad till dig med vårt experiment som beräknas ta 20-30 minuter att utföra. Du kommer sedan kunna utföra experimentet när som helst under måndag eller torsdagsdygnet.

Dina 200 kr kommer du sedan att kunna hämta på fredag på skolan. Mer information om när och var på skolan kommer du tillhandahållas vid ett senare tillfälle. (Skulle du inte ha möjlighet att ta dig till skolan på fredag så löser vi givetvis detta).

Tack för din medverkan!
Erik Jontell & Viktor Schönning

INFORMATIONSBREV TESTGRUPP

Hej och tack för din anmälan!

Du är en av de utvalda att få delta i experimentet och är nu registrerad. Experimentet innehåller alltså ett antal uppgifter som går ut på att du så exakt som möjligt ska uppge hur många bokstäver av en viss typ som ingår i ett textstycke. En exempeluppgift finns bifogad i pdf-format.

På måndag nästa vecka (den 26:e) kommer du få en länk skickad till dig med vårt experiment som beräknas ta 20-30 minuter att utföra. Du kommer sedan kunna utföra experimentet när som helst under måndag eller torsdagsdygnet. Beroende på vilken dag du väljer kommer du även att få logga in och svara på en snabb kontrollfråga på den överblivande dagen. Alltså, utför du experimentet på måndag kommer du få svara på en snabb kontrollfråga på torsdag och tvärt om.

	Alternativ1	Alternativ2
måndag	Experiment	Kontrollfråga
torsdag	Kontrollfråga	Experiment

Dina 200 kr kommer du sedan att kunna hämta på fredag på skolan. Mer information om när och var på skolan kommer du tillhandahållas vid ett senare tillfälle. (Skulle du inte ha möjlighet att ta dig till skolan på fredag så löser vi givetvis detta).

Tack för din medverkan!

Erik Jontell & Viktor Schönning

EXPERIMENT 1 KONTROLL GRUPP

Hej!

Nedanstående länk tar dig till en sida där du kan utföra det c:a 30 minuter långa testet. Försök att vara så noggrann som möjligt vid varje fråga och låt det ta tid. Att slentrianmässigt bara chansa på uppgifterna kommer inte att godkännas. Vid ett sådant tillfälle kommer inga 200 kr utdelas till personen i fråga. Uppgifterna är menade att göras enskilt, det är alltså inte tillåtet att samarbeta.

Andra tillfället att utföra uppgiften är på torsdag. Vi kommer då att skicka ut en ny länk till experimentet med samma uppgift. Det spelar ingen roll vilket av de två tillfällena du väljer.

Glöm inte att du har fram till 03:00 att skicka in dina svar!

Länk
https://www.surveymonkey.com/s/GMDMHSK

Lycka till!
Erik Jontell & Viktor Schönning

EXPERIMENT 1 TESTGRUPP

Hej!

Nedanstående länk tar dig till en sida där du kan utföra det c:a 30 minuter långa testet. Försök att vara så noggrann som möjligt vid varje fråga och låt det ta tid. Att slentrianmässigt bara chansa på uppgifterna kommer inte att godkännas. Vid ett sådant tillfälle kommer inga 200 kr utdelas till personen i fråga. Uppgifterna är menade att göras enskilt, det är alltså inte tillåtet att samarbeta.

Glöm inte att du minst måste ha **loggat in och registrerat dig** senast 03:00 inatt (tisdag den 27:e) om du vill ha möjlighet att utföra testet överhuvudtaget!

Länk
https://www.surveymonkey.com/s/89CGPZ2

Lycka till!
Erik Jontell & Viktor Schönning

EXPERIMENT 2 KONTROLL GRUPP XT (de som inte utfört)

Hej!

Detta är ett meddelande till er som anmält er, men ännu inte utfört vårt experiment. Idag är andra/sista chansen att fullfölja ditt åtagande! Tänk på att du har fram till 03:00 i natt (fredag 30 september) på dig!

Nedanstående länk tar dig till en sida där du kan utföra det c:a 30 minuter långa testet. Försök att vara så noggrann som möjligt vid varje fråga och låt det ta tid. Att slentrianmässigt bara chansa på uppgifterna kommer inte att godkännas. Vid ett sådant tillfälle kommer inga 200 kr utdelas till personen i fråga. Uppgifterna är menade att göras enskilt, det är alltså inte tillåtet att samarbeta.

Länk
https://www.surveymonkey.com/s/N2HLW6Z

Lycka till!
Erik Jontell & Viktor Schönning

EXPERIMENT 2 TESTGRUPP YM (de som ska svara på kontrollfråga på tors)

Hej!

Du tillhör gruppen som i måndags valde att utföra vårt experiment under måndagsdygnet! Det är nu dags att svara på en kort fråga för att slutföra ditt åtagande! Att svara på kontrollfrågan är alltså en obligatorisk del av experimentet och tar c:a 2 minuter!

Länk
https://www.surveymonkey.com/s/GT7YLLJ

Tack för att du varit med i studien!
Erik Jontell & Viktor Schönning

EXPERIMENT 2 - TESTGRUPP YT (de som ska utföra uppgiften på tors)
Hej!

Du tillhör gruppen som i måndags valde att utföra vårt experiment under torsdagsdygnet! Det är nu hög tid att fullgöra ditt åtagande!

Vi vill återigen påminna dig om att försöka vara så noggrann som möjligt vid varje fråga och låta det ta tid. Att slentrianmässigt bara chansa på uppgifterna kommer inte att godkännas. Vid ett sådant tillfälle kommer inga 200 kr utdelas till personen i fråga. Uppgifterna är menade att göras enskilt, det är alltså inte tillåtet att samarbeta.

Länk
https://www.surveymonkey.com/s/89MK2HX

Lycka till!
Erik Jontell & Viktor Schönning