

Supplementary material: Another experiment

This supplementary material belongs to the paper “Measuring Decreasing and Increasing Impatience” by Rohde, and describes the first experiment I ran, which implements the DI-index. This experiment was ran before the experiment ran in the main text, with different subjects.

Design

Subjects

For this experiment 115 students from Erasmus University Rotterdam were recruited. They were distributed over 9 experimental sessions. The experiment consisted of two parts: Part I was an unrelated small experiment on risky choice (Li, Rohde and Wakker, 2016), and Part II is the experiment relevant for this paper. Subjects received a fixed fee of €5 for participating. In addition, we implemented real incentives as will be explained later.

Task

Subjects were asked to choose between receiving €20 at a specified point in time or €35 at a later point in time. They were asked to fill out choice lists to determine t_0, t_2 , and t_4 in the following three indifferences:

$$\text{€20 in 0 weeks + 1 day} \sim \text{€35 in } t_0 \text{ weeks + 1 day}$$

$$\text{€20 in 2 weeks + 1 day} \sim \text{€35 in } t_2 \text{ weeks + 1 day}$$

$$\text{€20 in 4 weeks + 1 day} \sim \text{€35 in } t_4 \text{ weeks + 1 day}$$

Time t_0 was varied between 0 weeks and 25 weeks, t_2 between 2 weeks and 27 weeks, and t_4 between 4 weeks and 29 weeks, each with steps of one week per row in the choice list. Thus, subjects were presented with 3 choice lists with 26 rows each. We offered the choice lists in 2 different orders: $t_0 - t_2 - t_4$ and $t_4 - t_2 - t_0$, where half of the subjects were presented with the first order and the other half with its reverse. The instructions are at the end of this supplementary material.

At the end of the experiment subjects were asked demographic and behavioral questions. The demographic questions ask for age and gender. The behavioral questions ask for the number of hours per week the subjects do sports, whether they smoke (yes/no), the

number of days per week they drink alcohol, the number of glasses drank on such days, their length and weight, and whether they live in the same house as their parents. Weight and length were converted into the body-mass index bmi, which equals weight (kg) divided by length (m) squared. We finally asked for their fields of studies, and their nationalities.

Implementation and incentives

The experiment was carried out using paper and pencil. Subjects were told that at the end of the experiment one of the choices (out of Part I or Part II) of one of the subjects in the session would be selected to be paid with real money. If a choice of Part II would be selected, one of the choice lists would be selected at random and one of the rows of this choice list would subsequently be chosen randomly. The subject was paid according to his/her choice in this row. The money was transferred to his/her bankaccount at the specified date.

Results

A few subjects violated basic assumptions: 2 subjects switched more than once in at least one of the choice lists, and 8 violated impatience in an indirect manner by having $t_0 > t_2$ or $t_2 > t_4$. We exclude these 10 subjects from our dataset, leaving us with 105 subjects in total (42 female, 63 male, average age 21.1, 100 studying economics or business). Table 1 gives summary statistics.

Table 1: Summary statistics of demographic and behavioral variables

variable	mean
gender	60% male
age	21.1
sports (nr of hours per week)	4.3
smoke	16% smokes
days of alcohol	1.4
glasses of alcohol	3.0
bmi	21.7
does not live with parents	72 %

In the choice list for t_0 29 subjects always choose the €35, meaning that for them $t_0 > 25$ weeks. Similarly, $t_2 > 27$ weeks for 31 subjects and $t_4 > 29$ for 34 subjects. For the subjects who did switch t_0 , t_2 , and t_4 are computed as the midpoint between the two delays where the subject switched from the timed outcome with €35 to the timed outcome with €20. Figure 1 shows the histograms of t_0 , t_2 , and t_4 .

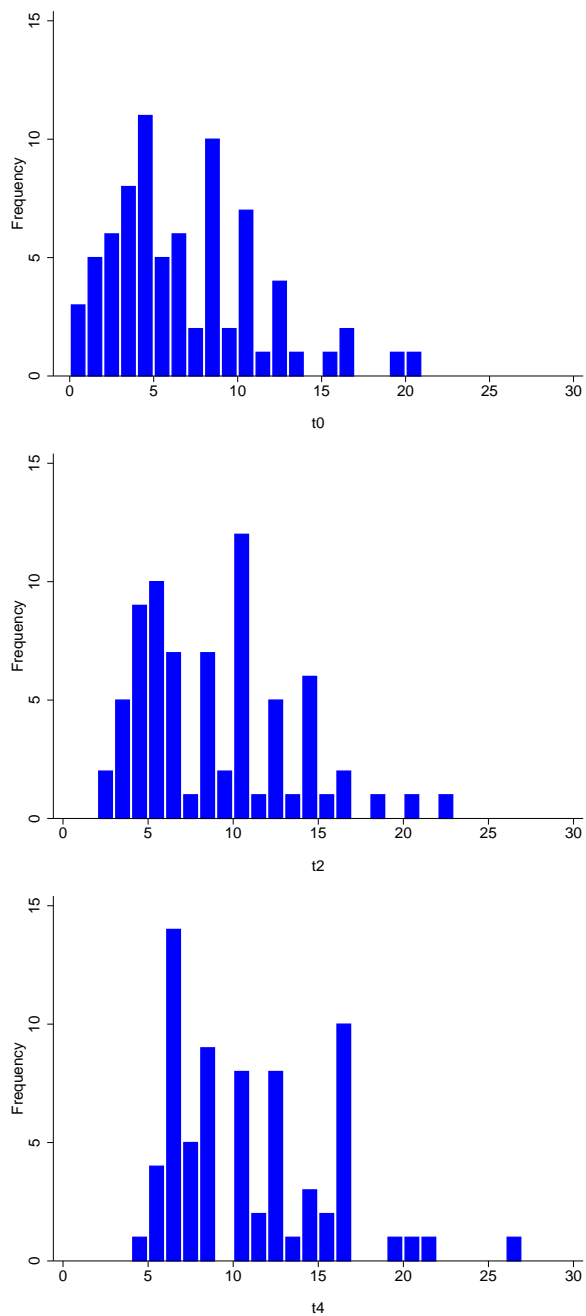


Figure 1: Histograms of t_0 , t_2 , and t_4

For subjects with $t_0 > 25$ or $t_2 > 27$ we could not compute DI_{02} . Similarly, for subjects with $t_2 > 27$ or $t_4 > 29$ we could not compute DI_{24} . For the computation of the DI indices we used days as the unit of time. We could compute DI_{02} for 74 subjects, and DI_{24} for 71 subjects. Figure 2 plots the DI indices for each of the 71 subjects for whom we could compute both indices.

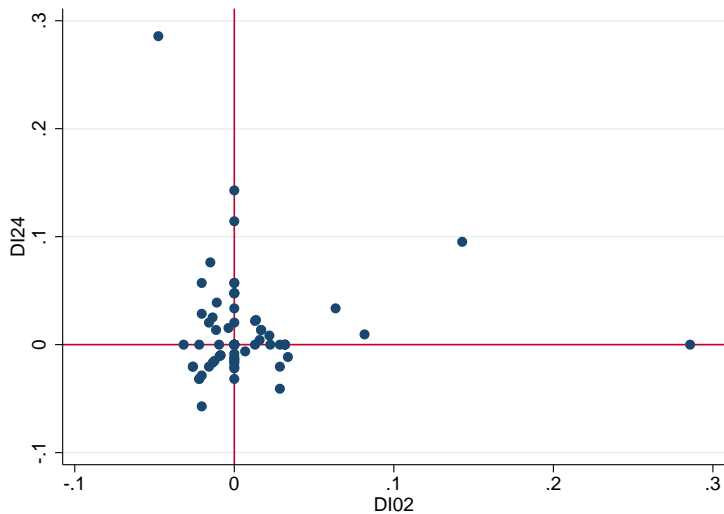


Figure 2: Distributions of DI_{02} and DI_{24}

Deviations from constant discounting

Table 2 summarizes the signs of the DI indices. For some subjects we cannot compute a DI-index, but can still conclude whether they have decreasing impatience. This is the case for DI_{02} when there is an indifference value for t_0 , but none for t_2 , as the subject always chooses the €35 in the choice list to determine t_2 . Similarly, this is the case for DI_{24} if there is a value for t_2 but none for t_4 .

We first analyze whether there is more decreasing than increasing impatience from t_0 to t_2 , by using the three categories of Table 2 as inputs and including the subjects for whom t_0 is non-missing and t_2 is missing. This analysis shows no deviation from constant discounting ($p = 1.000$ for signtest). A similar test for the change in impatience from t_2 to t_4 also shows no deviation from constant discounting ($p = 0.590$ for signtest).

Table 2: Deviations from constant discounting

	DI_{02}	DI_{24}
Decreasing impatience ($DI > 0$)	22 (24) ^a	27 (30)
Constant impatience ($DI = 0$)	28	19
Increasing impatience ($DI < 0$)	24	25

^aThe numbers between brackets are if we include the subjects for whom we cannot compute a DI index, but can conclude that they are decreasingly impatient.

We also analyze whether the DI-indices deviate significantly from zero, thereby including only the subjects for whom we could compute the indices. From t_0 to t_2 we find no deviation from constant discounting ($p = 0.883$ for signtest, $p = 0.710$ for Wilcoxon signed rank test). From t_2 to t_4 we also find no deviation from constant discounting ($p = 0.890$ for signtest and $p = 0.266$ for Wilcoxon signed rank test).

Thus on average the data show no deviation from constant discounting. Yet, more than 50% of our subjects deviate from constant discounting. Thus, in our dataset increasing impatience is at least as prevalent as decreasing impatience.

Test of constant decreasing impatience

Of all 71 subjects for whom we could compute both DI_{02} and DI_{24} , 37 satisfied $DI_{02} > DI_{24}$ and 25 satisfied $DI_{02} < DI_{24}$. A Wilcoxon signed-rank test shows that DI_{02} does not deviate significantly from DI_{24} ($p = 0.823$, two-sided). Yet, a Spearman rank correlation test also shows that we cannot reject that DI_{02} and DI_{24} are independent ($p = 0.240$).

Correlations between DI-index and demographic variables

Of the subjects for whom we could compute DI_{02} 39 were male and 35 female and for DI_{24} these numbers were 37 and 34 respectively. A Mann-Whitney U test shows that DI_{02} and DI_{24} are not significantly different between males and females ($p = 0.612$, 0.358 respectively). The Spearman rank correlation between DI_{02} and DI_{24} and age is also not significant ($p = 0.611$, 0.575 respectively). Thus, the DI-index is unrelated to age and gender in our sample.

Correlations between DI-index and behavioral variables

I analyzed the Spearman rank correlation between each behavioral variable, such as hours of sports, and each DI-index. None of these correlations are significant at a 5% level. For the non-binary behavioral variables a linear regression was analyzed with robust variance estimators to check for the dependence of the behavioral variable on the DI-index and age and gender. For the binary behavioral variables, like smoking (yes/no), logit regressions were employed. Only the variable sports seems to be predictable by DI_{02} at a 5% significance level, yet this effect disappears when we remove one outlier with $DI_{02} > 0.25$.

Monetary discount factors

To compare the DI indices with traditional measures of time preference, daily monetary discount factors corresponding to the three elicited indifferences are computed as follows for the subjects for whom we have the required indifference points:

$$\begin{aligned} md_0 &= \frac{20^{1/(7*t_0+1-1)}}{35} \\ md_2 &= \frac{20^{1/(7*t_2+1-7*2-1)}}{35} \\ md_4 &= \frac{20^{1/(7*t_4+1-7*4-1)}}{35} \end{aligned}$$

A Mann-Whitney U test shows that md_0 , md_2 , and md_4 are significantly higher for male than for female students ($p = 0.0066$, 0.0030 , and 0.0122 respectively), indicating that males discount less. The Spearman rank correlation between md_0 , md_2 , and md_4 and age is significantly negative ($p = 0.000$, 0.000 , and 0.007 respectively), indicating that older students discount more.

For each of the monetary discount factors we analyze the Spearman rank correlation with the behavioral variables. These correlations are positive for the number of glasses of alcohol ($p = 0.034$, 0.042 , 0.069 , respectively, for t_0 , t_2 , t_4) and negative for does-not-live-with-parents ($p = 0.030$, 0.044 , 0.031 , respectively). Thus, students who no longer live with their parents have a lower discount factor. The discount factors are positively correlated with the number of glasses of alcohol, implying that a higher valuation of the future induces more alcohol consumption, which is counterintuitive.

For each of the monetary discount factors we also run similar regressions as before. Monetary discount factor md_0 has a positive impact on hours of sports ($p = 0.011$), bmi

($p = 0.008$), and number of glasses of alcohol ($p = 0.014$). The other discount factors have no significant impact on behavior. Only for sports this impact is intuitive.

The next pages show the instructions for this experiment.

Dear participant,

Welcome to this experiment.

Please read the instructions carefully.

During the experiment you are not allowed to communicate with other participants.

Instructions

In this experiment you will be asked to make choices between amounts of money to be received in a specified number of weeks.

Consider the following question:

Which option do you prefer, option A or option B?

Option A		Your Choice	Option B		
amount	timing		amount	timing	
€25	in 0 weeks + 1 day	A <input type="checkbox"/>	B <input type="checkbox"/>	€30	in 3 weeks + 1 day

The question here is whether you want to receive the €25 on your bank account tomorrow or the €30 three weeks later, i.e. in 3 weeks and one day. You can indicate your choice by checking the corresponding box.

If the question would be

Option A		Your Choice	Option B		
amount	timing		amount	timing	
€25	in 0 weeks + 1 day	A <input type="checkbox"/>	B <input type="checkbox"/>	€30	in 0 weeks + 1 day

then you would probably choose option B. The longer you would have to wait for the €30, the more likely it would be that you would choose option A.

This experiment consists of 3 pages of 26 questions each. It will take approximately 10 minutes to answer all questions.

Payment

If at the end of this experimental session, one of your questions of this experiment will be chosen to be “played” for real money, we will pay the money as follows:

If your choice was an amount to be received in 0 weeks + 1 day, we will electronically transfer that amount of money to your bank account tomorrow. If your choice was an amount to be received in x weeks + 1 day, we will electronically transfer that amount of money to your bank account in exactly x weeks + 1 day.

Thus, each of the questions in this experiment may determine your final payoff. Therefore, it is important to consider each question carefully.

	Option A		Your Choice		Option B	
	amount	timing	A	B	amount	timing
Q1.1	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 0 weeks + 1 day
Q1.2	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 1 week + 1 day
Q1.3	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 2 weeks + 1 day
Q1.4	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 3 weeks + 1 day
Q1.5	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 4 weeks + 1 day
Q1.6	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 5 weeks + 1 day
Q1.7	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 6 weeks + 1 day
Q1.8	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 7 weeks + 1 day
Q1.9	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 8 weeks + 1 day
Q1.10	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 9 weeks + 1 day
Q1.11	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 10 weeks + 1 day
Q1.12	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 11 weeks + 1 day
Q1.13	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 12 weeks + 1 day
Q1.14	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 13 weeks + 1 day
Q1.15	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 14 weeks + 1 day
Q1.16	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 15 weeks + 1 day
Q1.17	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 16 weeks + 1 day
Q1.18	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 17 weeks + 1 day
Q1.19	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 18 weeks + 1 day
Q1.20	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 19 weeks + 1 day
Q1.21	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 20 weeks + 1 day
Q1.22	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 21 weeks + 1 day
Q1.23	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 22 weeks + 1 day
Q1.24	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 23 weeks + 1 day
Q1.25	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 24 weeks + 1 day
Q1.26	€20	in 0 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 25 weeks + 1 day

	Option A		Your Choice		Option B	
	amount	timing	A	B	amount	timing
Q2.1	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 2 weeks + 1 day
Q2.2	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 3 weeks + 1 day
Q2.3	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 4 weeks + 1 day
Q2.4	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 5 weeks + 1 day
Q2.5	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 6 weeks + 1 day
Q2.6	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 7 weeks + 1 day
Q2.7	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 8 weeks + 1 day
Q2.8	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 9 weeks + 1 day
Q2.9	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 10 weeks + 1 day
Q2.10	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 11 weeks + 1 day
Q2.11	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 12 weeks + 1 day
Q2.12	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 13 weeks + 1 day
Q2.13	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 14 weeks + 1 day
Q2.14	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 15 weeks + 1 day
Q2.15	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 16 weeks + 1 day
Q2.16	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 17 weeks + 1 day
Q2.17	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 18 weeks + 1 day
Q2.18	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 19 weeks + 1 day
Q2.19	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 20 weeks + 1 day
Q2.20	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 21 weeks + 1 day
Q2.21	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 22 weeks + 1 day
Q2.22	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 23 weeks + 1 day
Q2.23	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 24 weeks + 1 day
Q2.24	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 25 weeks + 1 day
Q2.25	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 26 weeks + 1 day
Q2.26	€20	in 2 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 27 weeks + 1 day

	Option A		Your Choice		Option B	
	amount	timing	A	B	amount	timing
Q3.1	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 4 weeks + 1 day
Q3.2	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 5 weeks + 1 day
Q3.3	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 6 weeks + 1 day
Q3.4	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 7 weeks + 1 day
Q3.5	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 8 weeks + 1 day
Q3.6	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 9 weeks + 1 day
Q3.7	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 10 weeks + 1 day
Q3.8	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 11 weeks + 1 day
Q3.9	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 12 weeks + 1 day
Q3.10	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 13 weeks + 1 day
Q3.11	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 14 weeks + 1 day
Q3.12	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 15 weeks + 1 day
Q3.13	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 16 weeks + 1 day
Q3.14	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 17 weeks + 1 day
Q3.15	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 18 weeks + 1 day
Q3.16	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 19 weeks + 1 day
Q3.17	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 20 weeks + 1 day
Q3.18	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 21 weeks + 1 day
Q3.19	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 22 weeks + 1 day
Q3.20	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 23 weeks + 1 day
Q3.21	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 24 weeks + 1 day
Q3.22	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 25 weeks + 1 day
Q3.23	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 26 weeks + 1 day
Q3.24	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 27 weeks + 1 day
Q3.25	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 28 weeks + 1 day
Q3.26	€20	in 4 weeks + 1 day	<input type="checkbox"/>	<input type="checkbox"/>	€35	in 29 weeks + 1 day

Please raise your hand if you are done with this questionnaire, and remain silent.