Remembering Past Present Biases

A Replication and Extension

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1 Introduction

This project aims to replicate and extend the research conducted by Bakó et al. (2026). Their study examines the association between present bias and lower memory accuracy in intertemporal decision-making.

Originating from psychology, present bias is seen as a natural way to represent how animal and human respond to time delays, and was introduced to economics by Laibson (1994) (O'Donoghue & Rabin, 2015). More specifically in economics, agent's preference for earlier and later rewards depends on the time interval separating them; however, experimental evidence indicates that people frequently favour smaller rewards available immediately over larger rewards delivered later (Chakraborty, 2021).

The negative outcomes resulting from this bias are well discussed in the literature. Bakó et al. (2026) make their contribution to this topic by linking memory accuracy with the existence and intensity of the present bias. In their paper, the key hypothesis is that present-biased individuals may misremember their decisions as more positively biased, particularly in situations involving immediate rewards, as they are motivated to maintain a positive self-image. To test the hypothesis, the authors designed and conducted an experiment with university students. Each participant were asked to complete 12 binary choices between a fixed smaller-sooner monetary reward and a larger future reward that increased across choices and the choices are presented under two temporal settings. Such designs typically produce an initial preference for the smaller-sooner option, followed by a switch to the later option as its amount grows.

Using the original dataset, we successfully replicate the main findings of Bakó et al. (2026). Consistent with their results, present-biased participants are more likely to exhibit misremembering, especially when an immediate reward is available. In addition, our tests also reveal significant differences in the distribution of correctly remembered choices across difference biased and time-consistent groups, which complements the regression-based evidence in the original study.

2 Design of Experiment and Hypotheses

In the experiment conducted by Bakó et al. (2026), they made three visits in six weeks to the classroom to collect data using question sheets. The participants were students from a Macroeconomics course at Corvinus University of Budapest.

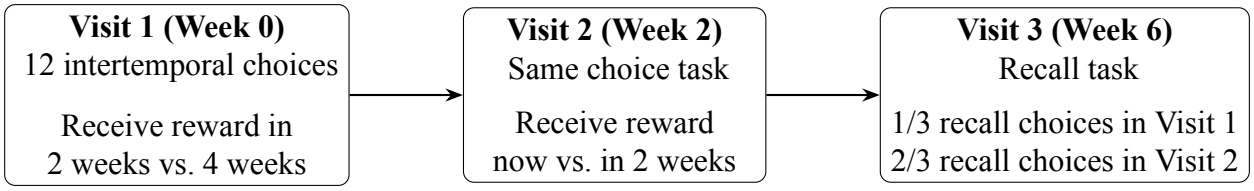

Figure 1: Experimental Workflow

In the first visit, participants were asked to make 12 decisions between receiving HUF $10,000$ in

two weeks or a larger amount in four weeks, with the latter amount increasing in each choice from HUF $10,000$ to HUF $13,500$. An example of these choices is provided in Appendix A. In addition to the intertemporal choice tasks, participants were also asked to report demographic characteristics, including gender, mother's highest level of education, and maths grade, trust, and risk attitude (see Appendix B for details). Two weeks later in the second visit, participants were given the opportunity to reconsider their decisions to choose to receive HUF $10,000$ now or to wait two more weeks to receive a larger amount. The second question sheet is the same as the third one except for the timing of receiving money. In the last visit, which was six weeks later after the first visit, the participants were randomly separated into two groups. The control group was asked to recall their decisions in the first visit, and the treatment group was asked to recall their decisions in the second visit. The workflow of the experiment is provided in Table 1.

The paper tests the hypothesis that present-biased individuals are more likely to misremember their past decisions and that such misremembering is directional due to self-image concerns. The authors further hypothesise that this pattern cannot be fully explained by time preference or demographic characteristics and is more pronounced when an immediate reward is involved.

Table 1: Example of Variables of Main Interest

	Alex	Bobby	Charlie
First-visit switch	2	4	6
Second-visit switch	2	5	12
Remembered switch	2	4	7
Present-bias dummy	0	1	1
Intensity of present bias	0	1	6
Misremembering dummy	0	1	1
Misremembering intensity	0	1	5

These hypotheses are tested by assessing participants' *switching point*, which is the row in the intertemporal choice list (see Table 9) where a participant switches from choosing the smaller-earlier reward to choosing the larger-later reward. More specifically, the authors construct variable Y indicating the recalled switching point and X indicating the actual switching point. The *existence of present bias* is defined as $Y < X$ using a dummy variable, which means the recalled switching point is earlier than the actual chosen switching point. In other words, participants exhibit (positive) *directional misremembering*. The *intensity of the present bias* is defined as $X - Y$, which is the distance between the recalled switching point and the actual chosen switching point.

The rest of the key variables and terminologies are explained with the help of the example in Table 1. Alex, Bobby, and Charlie switched at choice 2, 4, and 6 in the first visit and switched at choice 2, 5, and 12 in the second visit. Then Alex is *time-consistent*, while Charlie and Bobby are *present-biased* as they require higher compensation for waiting to receive a later reward when an immediate reward is available in the second visit. In addition, as Charlie requires higher compensation (intensity of present bias equal to 6), he has a stronger present bias than Bobby (intensity of present bias equal to 1). Furthermore, in the third visit, if they were all required to recall their switching point from the second visit and they gave 2, 4, and 7 as their answers, then Alex recalled his decision accurately, while Bobby and Charlie would be considered having directional misremembering as they reported an earlier switching point than they actually had. Moreover, Charlie

has a stronger directional misremembering (misremembering intensity equal to 5) than Bobby (misremembering intensity equal to 1).

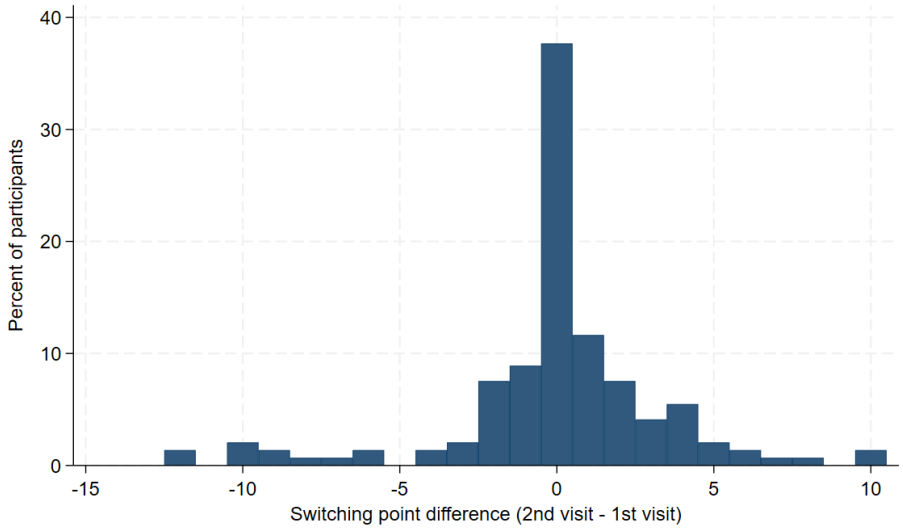

Figure 2: Distribution of Difference in Switching Points Among All Participants (N=146)

3 Data

The data is provided by Bakó et al. (2026) and accessible via the link in their paper. We start from their raw data[1] which contains 72 variables and 158 observations. Due to the nature of the experimental data, we are unable to obtain further data on the same topic. We cleaned and manipulated the data with the following steps.

First, we construct a binary variable as an indicator of gender, as there are only two types of gender (male and female) in our data. We also construct a binary variable for mother's highest level of education, separating data by whether participants' mothers received higher education.

Second, we focus on the data from the first two visits. We drop out 12 observations with more than one switching point in the two visits, reducing the sample size to 146. Participants are classified into three time preference groups based on the difference in switching points between the two visits: time-consistent if the switching points are the same in both visits, present-biased if the second switching point is later, and future-biased if the second switching point is earlier. The distribution of each type of time-preference is presented in Table 2. We also calculate difference in switching points between the two visits as as a measure of intensity of present bias when positive and intensity of future bias when negative. The distribution of bias intensity is present in Table 3 and a visual distribution of the switching point difference is presented in Figure 2.

Third, we manage to construct an indicator of the existence of misremembering by comparing whether the recalled choices are identical to the actual choices. We also compute the difference

[1] This data set has already been processed from answers in the question sheets and is ready for cleaning and further analysis.

Table 2: Distribution of Time Consistency and Biases

Variable	**Frequency**	**Percent**
Time consistency		
Time-consistent	55	37.67
Time-inconsistent	91	62.33
Present bias		
Not present-biased	95	65.07
Present-biased	51	34.93
Future bias		
Not future-biased	106	72.60
Future-biased	40	27.40
Total observations	146	100.00

Table 3: Distribution of Bias Intensity Measures

Bias intensity	**Present bias ($N = 51$)**		**Future bias ($N = 40$)**	
	Freq.	**Percent**	**Freq.**	**Percent**
1	17	33.33	13	32.50
2	11	21.57	11	27.50
3	6	11.76	3	7.50
4	8	15.69	2	5.00
5	3	5.88	–	–
6	2	3.92	2	5.00
7	1	1.96	1	2.50
8	1	1.96	1	2.50
9	–	–	2	5.00
10	2	3.92	3	7.50
12	–	–	2	5.00

between the recalled switching point and the actual switching point to measure the intensity of the misremembering. Table 4 shows the distribution of the existence and intensity of misremembering.

Table 4: Existence and Intensity of Misremembering

Category	**Frequency**	**Percent**
Existence of misremembering		
No misremembering	75	51.37
Misremembering	71	48.63
Misremembering intensity		
Negative (recalled later)	28	19.18
Zero (accurate recall)	75	51.37
Positive (recalled earlier)	43	29.45
Total observations	146	100.00

After all the steps stated above, we have our working data which are ready for further analysis.

Table 5 presents a summary of the average number of correctly remembered choices from the first two visits. We can see that the average number of correctly remembering in the first visit is higher than that in the second visit for all groups except the future-biased group. However, the 95% confidence intervals overlap across groups within each visit with the only outlier of the case between the future-biased group and the time consistent group. Bakó et al. (2026) conducted Wilcoxon rank-sum tests between the average numbers of correctly remembering which provide evidence that the distribution of correctly remembered choices differs significantly between present-biased and time-consistent group in the first visit, and between present-biased and non-present-biased groups as well as between present-biased and future-biased groups in the second visit.

Table 5: Average Correctly Remembered Choices and Group Comparisons

	First visit	**Second visit**
Mean number of correctly remembered choices		
Present-biased	11.06 [10.32, 11.80] (17)	10.58 [9.94, 11.22] (31)
Time-consistent	11.84 [11.66, 12.02] (19)	11.20 [10.67, 11.73] (30)
Not present-biased	11.52 [11.20, 11.84] (27)	11.18 [10.83, 11.53] (50)
Future-biased	10.75 [9.88, 11.62] (8)	11.15 [10.71, 11.59] (20)
Wilcoxon rank-sum test		
Present-biased vs Time-consistent	0.006	0.027
Present-biased vs Not present-biased	0.145	0.042
Future-biased vs Present-biased	0.235	0.280

Notes: The upper panel reports the mean number of correctly remembered choices. Numbers in brackets are 95% confidence intervals, and numbers in parentheses are sample sizes. The lower panel reports p-values from two-sample Wilcoxon rank-sum tests comparing the distributions across groups.

4 Methods

We use data visualisation to identify patterns that are consistent or inconsistent with our hypotheses. To have a concrete test of our hypotheses, we perform several regression models. The hypothesis and its corresponding models are described in Table 6.

Table 6: Hypotheses, Dependent Variables, and Independent Variables by Visit

	Hypothesis	**Dependent Variable**	**Independent Variable**
Visit 1 Visit 2	Present-biased participants are more likely to misremember their past decisions	Misremembering dummy variable	Present-biased dummy variable
Visit 1 Visit 2	Present-biased participants exhibit stronger motivated misremembering	Misremembering intensity	Present-biased dummy variable
Visit 1 Visit 2	Present-biased participants with stronger intensity are more likely to misremember their past decisions	Misremembering dummy variable	Present bias intensity
Visit 1 Visit 2	Present-biased participants with stronger intensity exhibit stronger motivated misremembering	Misremembering intensity	Present bias intensity

Furthermore, I regress both the dummy of misremembering and the intensity of misremembering separately on intensity of present-bias, an indicator for the visit (first vs second), their interaction term, and the set of demographic controls. These regression results would be helpful in testing whether other potential variables contribute significantly to the existence and intensity of directional misremembering. The corresponding regression model is:

$$\begin{aligned}\text{MisremDummy}_i/\text{MisremIntensity}_i = \alpha + \beta_1\,\text{PBIntensity}_i + \beta_2\,\text{SecondVisit}_i \\ +\beta_3\,(\text{PBIntensity}_i \times \text{SecondVisit}_i) + \beta_4\,\text{Female}_i + \beta_5\,\text{MotherDiploma}_i \\ +\beta_6\,\text{SocialRank}_i + \beta_7\,\text{Math}_i + \beta_8\,\text{Trust}_i + \beta_9\,\text{Risk}_i + \varepsilon_i\end{aligned}$$

where i represents each observation; α represents a constant intercept; β_{1-9} are the coefficients of each explanatory variable; ϵ_i represents the disturbance term of observation i.

5 Results

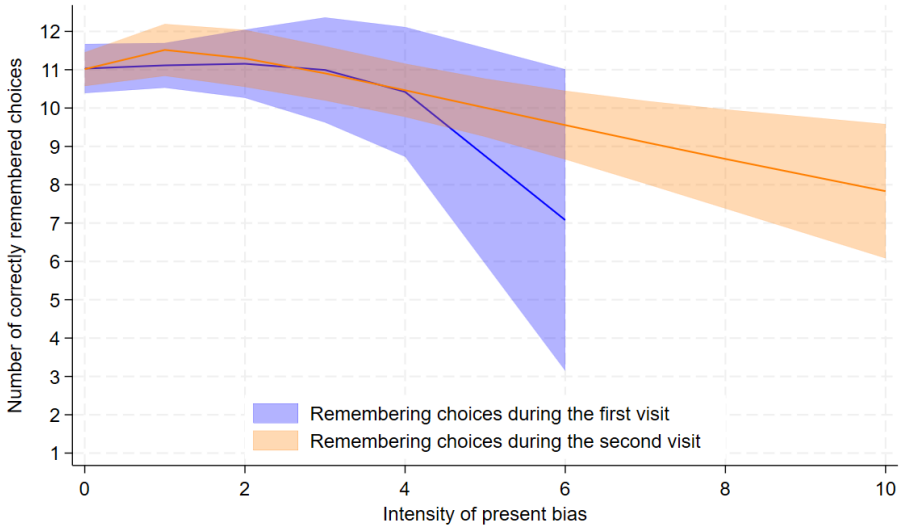

Figure 3: Fractional Polynomial Plot. It depicts the relationship between the average number of correctly recalled choices and the intensity of present bias, with 95% confidence interval (N=146)

In Figure 3, it suggests a negative association between the intensity of the present bias and the number of correctly remembered choices. This aligns with our expectation that stronger present bias is associated with lower memory accuracy. The overlap area before intensity of present bias equal to six indicates that the participants with lower level of present bias in the first and second visits do not differ from each other in terms of misremembering.

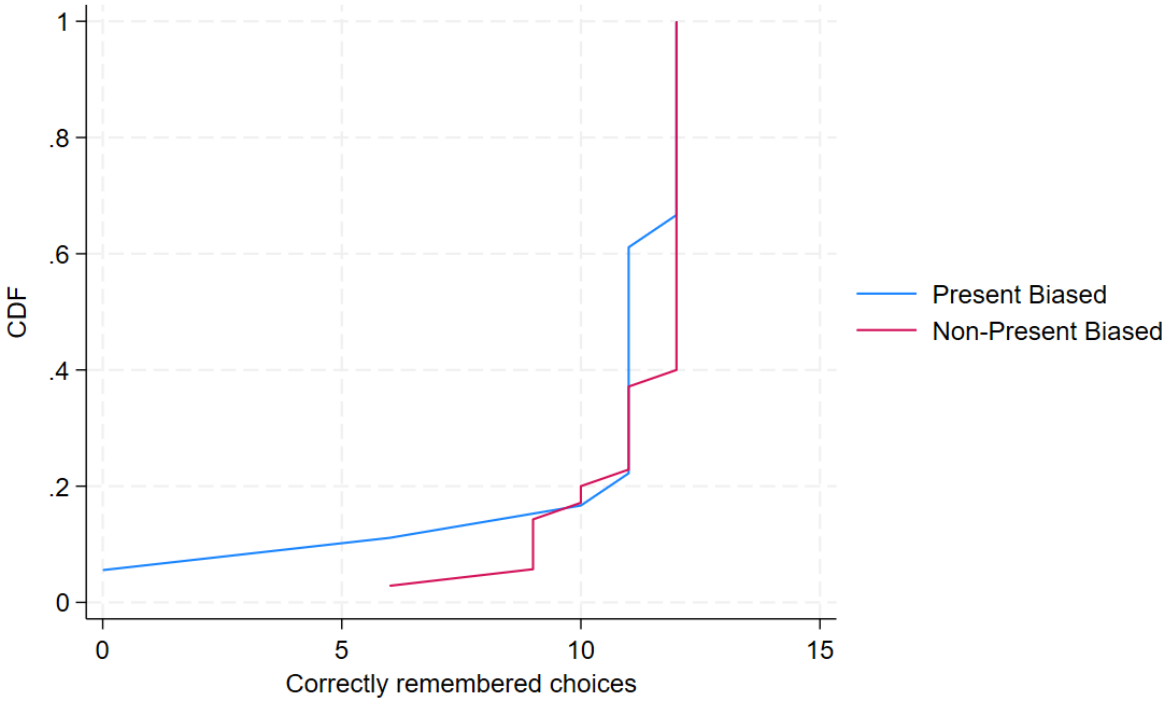

Figure 4: Cumulative Distribution Function of Correct Recall (Visit 1)

Figure 4 and Figure 5 are empirical cumulative functions of correct recall in the first and second visits respectively. In the first visit, we can clearly see that there are crossings between the red line and blue line. Together with numbers in Table 5, we can better argue that the present-biased participants do not differ from non-present-biased participants in terms of correctly remember past choices. In the second visit, the CDF of the present bias (blue line) is almost always higher than the CDF of the non-present bias (red line). This suggests that present biased participants have remembered fewer correct choices than the participants without present bias. This is another evidence of connection between lower memory accuracy and existence of present bias.

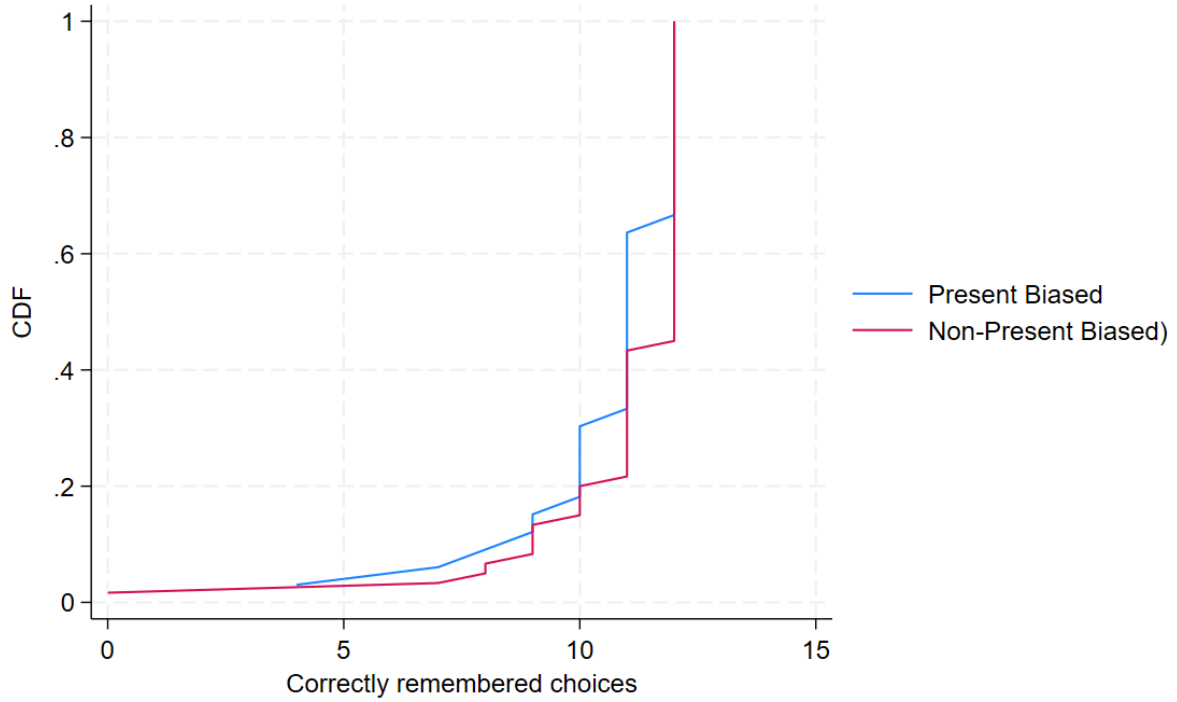

Figure 5: Cumulative Distribution Function of Correct Recall (Visit 2)

Tabel 7 reports the effect of the existence of present bias on misremembering. Under 5% level of significance, the dummy of present bias only has significant effect on the existence of the misremembering in the second visit. This suggests that participants with present bias are more likely to exhibit misremembering but they have no significant influence on the intensity of motivated misremembering on average comparing with the time-consistent participants.

Table 7: Effect of Existence of Present Bias on Misremembering

VARIABLES	(1) Dummy of Misremembering	(2) Intensity of Misremembering	(3) Dummy of Misremembering	(4) Intensity of Misremembering
Present_bias_dummy	-0.158*	-0.158*	0.392***	0.491
	(0.0871)	(0.0871)	(0.122)	(0.499)
Constant	0.158*	0.158*	0.286***	0.929**
	(0.0871)	(0.0871)	(0.0869)	(0.388)
Observations	26	26	59	59
R^2	0.048	0.048	0.153	0.017

Notes: Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(1) (2) are visit 1; (3) (4) are visit 2

Table 8 provides the regression results of regressing misremembering variables on the intensity

of present bias. In column (1) and (2), which represent the first visit, neither estimated coefficient are statistically significant. In the second visit (column (3) and (4)), both estimated coefficient are positive and statistically significant. This result matches with our hypothesis that higher intensity of present bias is associated with higher probability of misremembering and higher intensity of misremembering.

Table 8: Effect of Intensity of Present Bias on Misremembering

VARIABLES	(1) Dummy of Misremembering	(2) Intensity of Misremembering	(3) Dummy of Misremembering	(4) Intensity of Misremembering
Intensity of Present Bias	-0.0456*	-0.0456*	0.0981***	0.418***
	(0.0255)	(0.0255)	(0.0198)	(0.125)
Constant	0.150*	0.150*	0.337***	0.527*
	(0.0831)	(0.0831)	(0.0747)	(0.306)
Observations	26	26	59	59
R^2	0.040	0.040	0.188	0.242

Notes: Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(1) (2) are visit 1; (3) (4) are visit 2

6 Conclusion

Our project replicates and refines the key empirical findings of Bakó et al. (2026), who connect memory of past behaviour with present bias and conduct experiment to test the hypothesis that present-biased individuals may misremember their decisions as more positively biased, particularly in situations involving immediate rewards. Our replicated work answers the main research question about the association of present bias and reduced memory. However, we do not show how the incentive to maintain a positive self-image is connected to directional misremembering or exclude alternative explanations for such association.

Consistent with the original study, we find that participants with present bias are more likely to misremember their past choices, particularly when an immediate reward is available. We also find higher level of present bias is positively related to stronger intensity of misremembering. These relationships are further confirmed through regression analyses using both dummy and continuous measures of misremembering.

Future research on motivated misremembering could go beyond intertemporal choices to contexts that involve more measurable self-image concerning behaviours. The current experiment relies only on numeric choices. Since Graeber et al. (2024) show that different types of information shape selective memory, further studies could compare how misremembering differs between story-based and statistical settings.

Data Availability

Stata codes and data of this project are available at https://github.com/zd31/BEEM136_Empirical-Project_Ziteng-Dong.git

Appendix

A Intertemporal Choice Task

During the first visit, participants were presented with the following 12 binary choices. For each row, they had to select between receiving a fixed amount sooner (in 2 weeks) or a larger amount later (in 4 weeks). The latter amount increased incrementally to identify their switching point.

Table 9: Example of intertemporal choice list shown to participants (1st visit)

Choice #	Option A (Sooner)	Option B (Later)
1	HUF 10,000 in 2 weeks	HUF 10,000 in 4 weeks
2	HUF 10,000 in 2 weeks	HUF 10,200 in 4 weeks
3	HUF 10,000 in 2 weeks	HUF 10,400 in 4 weeks
4	HUF 10,000 in 2 weeks	HUF 10,600 in 4 weeks
5	HUF 10,000 in 2 weeks	HUF 10,800 in 4 weeks
6	HUF 10,000 in 2 weeks	HUF 11,000 in 4 weeks
7	HUF 10,000 in 2 weeks	HUF 11,300 in 4 weeks
8	HUF 10,000 in 2 weeks	HUF 11,600 in 4 weeks
9	HUF 10,000 in 2 weeks	HUF 11,900 in 4 weeks
10	HUF 10,000 in 2 weeks	HUF 12,400 in 4 weeks
11	HUF 10,000 in 2 weeks	HUF 12,800 in 4 weeks
12	HUF 10,000 in 2 weeks	HUF 13,500 in 4 weeks

In the second visit, conducted two weeks later after the first visit, the participants were presented with the same intertemporal choice list with the only difference that the money in earlier option was available immediately and the latter option would be received two weeks later.

B Demographic Questions

Table 10: Demographic and Background Questions

Variable	**Question / Response Scale**
Gender	Female; Male; Other / Prefer not to answer
Mother's highest level of education	Elementary School; Vocational School; High School Diploma; College; University; PhD
Maths grade	Grade received in mathematics in the last term (scale: 1–5)
Social rank	Please place your family on a social ladder from 0 to 10, where 10 represents the best situation based on income, education, and job market status
Trust	In general, would you say most people can be trusted or that you cannot be too careful in dealing with people? (1 = cannot be too careful, 5 = most people can be trusted)
Risk attitude	How willing are you to take risks? (1 = not willing to take risks at all, 5 = very willing to take risks)

C Regression Results 1 with Demographic Variables

Table 11: Regression result. Dependent Variable: Dummy of Misremembering

VARIABLES	Dummy of Misremembering					
	(1)	(2)	(3)	(4)	(5)	(6)
Intensity of Present Bias				0.0766***	-0.0456*	-0.0434
				(0.0173)	(0.0251)	(0.0386)
Second Visit	0.312***	0.128	0.128	0.314***	0.186*	0.185*
	(0.0961)	(0.122)	(0.121)	(0.0963)	(0.111)	(0.109)
P. Bias Intensity x Second Visit					0.144***	0.141***
					(0.0320)	(0.0484)
Female			0.115			0.130
			(0.112)			(0.108)
Mother_has_diploma			0.0557			0.0478
			(0.145)			(0.146)
Social_rank			-0.0171			-0.00576
			(0.0323)			(0.0321)
Math			0.0228			0.0430
			(0.0521)			(0.0532)
Trust			0.0725			0.0482
			(0.0521)			(0.0561)
Risk			0.0529			0.0407
			(0.0603)			(0.0585)
Present_bias_dummy	0.250**	-0.158*	-0.130			
	(0.0989)	(0.0857)	(0.135)			
P. Bias x Second Visit		0.550***	0.523***			
		(0.150)	(0.195)			
Constant	0.0481	0.158*	-0.276	0.0564	0.150*	-0.334
	(0.0787)	(0.0857)	(0.390)	(0.0731)	(0.0818)	(0.384)
Observations	85	85	85	85	85	85
R^2	0.190	0.247	0.282	0.228	0.272	0.302

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

D Regression Results 2 with Demographic Variables

Table 12: Regression result. Dependent Variable: Dummy of Misremembering

VARIABLES	Intensity of Misremembering					
	(1)	(2)	(3)	(4)	(5)	(6)
Intensity of Present Bias				0.349***	-0.0456*	-0.0635
				(0.121)	(0.0251)	(0.0977)
Second Visit	0.988***	0.771*	0.610	0.789***	0.377	0.232
	(0.289)	(0.400)	(0.428)	(0.276)	(0.319)	(0.350)
P. Bias Intensity x Second Visit					0.464***	0.490***
					(0.128)	(0.178)
Female			0.206			0.186
			(0.354)			(0.321)
Mother_has_diploma			0.165			0.112
			(0.555)			(0.386)
Social_rank			0.0466			0.159
			(0.0972)			(0.0963)
Math			-0.362			-0.282
			(0.243)			(0.253)
Trust			0.243			0.223
			(0.244)			(0.161)
Risk			0.122			0.0827
			(0.211)			(0.170)
Present_bias_dummy	0.323	-0.158*	-0.0771			
	(0.373)	(0.0857)	(0.341)			
P. Bias x Second Visit		0.649	0.655			
		(0.510)	(0.695)			
Constant	0.0283	0.158*	0.0958	-0.153	0.150*	-0.770
	(0.126)	(0.0857)	(1.376)	(0.149)	(0.0818)	(1.271)
Observations	85	85	85	85	85	85
R^2	0.098	0.105	0.183	0.267	0.307	0.370

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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