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An experimental study

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Time Inconsistency, Sophistication, and Commitment
An Experimental Study*

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Abstract

We experimentally study the relationship between time inconsistency, sophistication about time inconsistency, and self-commitment. Previous research has interpreted demand for commitment devices as evidence for the sophistication of a time-inconsistent decision-maker. In our laboratory experiment, we attempt to measure sophistication directly by way of a cognitive test. We then test the hypothesis that people who are both time-inconsistent and show high cognitive capacity take up commitment devices when offered in the strategic game between their current and their future self. For experimental laboratory commitment choices, we cannot detect a moderating effect of cognition on commitment demand of time-inconsistent subjects. However, we find that the existence of time-inconsistent preferences and sophistication (proxied by cognitive performance) can predict the demand for savings commitment in our hypothetical survey vignette question.

Keywords: time-inconsistency, sophistication, present bias, future bias

JEL Classification: C90, C91, D91

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I Introduction

Time-inconsistent preferences, i.e. that people exhibit different levels of patience over time, have been used to model and explain a wide range of behaviors, including addiction (Gruber and Köszegi, 2001), excessive credit-card borrowing (Meier and Sprenger, 2010), or that people save and borrow at the same time (Laibson et al., 2000, 2007). Importantly, an inconsistency in time-preferences implies exploitability, for present-bias in the sense of Laibson (1997)'s golden eggs.

To counter her bias, a person may be willing to exert self-control and show demand for commitment devices in the strategic game between her current and her later self (Fudenberg and Levine, 2006; Gul and Pesendorfer, 2001; Strotz, 1955, see also Bryan et al., 2010 for a review). Commitment devices have been shown to be helpful to increase savings (e.g. Ashraf et al., 2006; Beshears et al., forthcoming; Gugerty, 2007; Thaler and Benartzi, 2004), stop smoking (e.g. Giné et al., 2010), reduce alcohol consumption (e.g. Schilbach, 2019; Trope and Fishbach, 2000), or reduce procrastination and increase work/study output (e.g. Ariely and Wertenbroch, 2002; Augenblick et al., 2015; Kaur et al., 2015).

However, it is important to note that only *sophisticated* decision-makers, i.e. people who are aware of their own time-inconsistency, should show demand for commitment devices (Eliaz and Spiegler, 2006; O'Donoghue and Rabin, 1999). In the studies cited above, the fact that a (biased) decision-maker takes up a commitment option is usually interpreted as evidence that the decision-maker is sophisticated, while a decision-maker who refuses an advantageous commitment device is labeled as naïve.

Such indirect inference of sophistication may be problematic for several reasons. On the one hand, uncertainty about the future may give rise to preferences for retaining flexibility for sophisticated decision-makers, letting them reject commitment devices (see Laibson, 2015 for the theoretical argument and Andreoni et al., forthcoming; Casari and Dragone, 2015 for experimental evidence). On the other hand, even naïve decision-makers may adopt commitment contracts when they base their decision on historical data and experienced utility (Laibson, 2018). Additionally, the take-up of commitment devices has been found to be often inconsistent, both with concurrent and future choices, or subject to more than individual decision factors.[1]

More recently, some papers aimed to assess the decision-maker's sophistication about time inconsistency directly by asking them to predict their own future behavior. Acland and Levy (2015), Augenblick and Rabin (2019), and Carrera et al. (2019) all find wide-spread naivety

[1] E.g., DellaVigna and Malmendier (2006) find that consumers choose sub-optimal gym commitment contracts that are not consistent with their eventual attendance frequency. Carrera et al. (2019) report that demand for commitment contracts for going to the gym more and for going to the gym less is positively correlated. Exley and Naecker (2017) find more take-up of commitment devices when the commitment choice is public rather than private.

about time-inconsistency in work and gym attendance contexts (i.e. a similarity between present and predicted future choices while both are different to actual future choices), with people on average predicting only one third or less of the extent of their present bias. The former two studies do not directly assess how sophistication relates to the take-up of commitment. Carrera et al. (2019) use an information treatment to increase awareness of bias and thus sophistication, but find that such increased sophistication *reduces* rather than increases take-up of commitment contracts. John (forthcoming) takes a different approach and identifies sophistication through survey measure of self-perceived temptation, but similarly finds an unpredicted *negative* correlation between that measure and commitment take-up for biased subjects.

We complement this literature by attempting to measure (potential for) sophistication by way of cognitive ability, and verifying whether such cognitive ability is related to the take-up of commitment contracts offered to time-inconsistent people. Cognitive ability is the ability of processing mental information in the context of perception, attention, memory, problem solving, reasoning, and decision making (e.g. Anderson, 2005). In our experiment, we employ the "Automated Operation Span" (AOS) test introduced by Unsworth et al. (2005), measuring working memory, which has been found to be correlated with many higher-order cognitive capabilities and has thus been interpreted as a measure of general cognitive ability (see Engle and Kane, 2004, for a review). Recent experimental studies have shown that working memory contributes to explaining suboptimal decisions in guessing games (Rydval et al., 2009) and performance in forecasting tasks (Rydval, 2007), which seem related to the prediction of own time-inconsistency.

In our experiment, we detect present-bias or future-bias using Attema et al. (2010)'s time-tradeoff sequences (TTO), and loosely follow Casari (2009)'s experimental design in offering commitment contracts to subjects which are tailored to their time-inconsistency. The main hypothesis we test is that cognitive ability of time-inconsistent subjects is positively correlated with the take-up of commitment devices.

In our data, we find no relation between our proxy for sophistication (potential) and the take-up of commitment devices. Regression analysis does not find an effect of time-inconsistency (measured over similar experimental choices) or cognitive performance and the demand for commitment, neither directly nor in interaction. That said, the joint existence of present-bias and a high cognitive level are correlated with the (self-stated) take-up of a commitment contract in a hypothetical savings survey question. Thus, our paper contributes mixed evidence to the literature on commitment devices and why people pick them up. While measured time preferences and cognitive performance as a proxy for sophistication are not helpful in explaining real commitment choices in the laboratory, they seem to be correlated with related

(hypothetical) real-world behavior. As a result, whether a cognitive measure is a good proxy for sophistication in the context of time preferences and commitment remains an unsolved question.

II Experimental design and procedures

Time preferences. Our laboratory experiment consisted of four parts. Using a shortened two-step version of Attema et al. (2010)'s Time Trade-Off sequences, we elicited 4 sequences, each consisting of 2 chained questions.[2] In the first question of a sequence, a participant stated her willingness-to-wait t in weeks for a larger-later payment \$L which makes her indifferent to a smaller-sooner payment \$S in FED weeks (FED stands for "front-end delay").

$$(\$S, FED) \sim (\$L, FED + t)$$

In the second question, the participant stated her willingness-to-wait t' (in weeks) for a larger-later payment \$L which makes her indifferent to a smaller-sooner payment \$S in $FED+t$ weeks.

$$(\$S, FED + t) \sim (\$L, FED + t + t')$$

An increasing willingness to wait over time ($t' > t$) indicates present-bias, while a decreasing willingness-to-wait ($t' < t$) represents future bias. Across the four sequences we vary the base stake size (\$S=\$100, \$L=\$130 vs. \$S= \$200, \$L= \$240) and the initial front-end delay (1 week vs. 5 weeks). We elicited each question using a multiple price list of 26 binary choices between $\$S$ in FED weeks and $\$L$ in $FED + t$, with the willingness-to-wait t ranging from 1 to 26 weeks. We enforced consistency through a unique (or no) switching point between $\$S$ and $\$L$.[3]

Commitment choices. In the second part of the experiment, adapting from Casari (2009), we created situations in which, given (time-inconsistent) elicited t and t', a subject should show a choice reversal. Assume the subject has a decision to make in the future, at time t, between a smaller-sooner payment that is paid at time t plus a front-end delay FED, (\$S, $t + FED$), and a larger-later payment that is paid with some further delay d, (\$L, $t + FED + d$). The subject's future self, who's "now" is at time t, will have a willingness to wait t for the larger

[2] To examine a different research question, the first part featured additional choices that allowed to compare time inconsistency classifications based on three different methods: TTO, equivalent delay functions, and a traditional intertemporal choice reversal task. We report these results in our paper Greiner and Zhang (2020).

[3] Table 4 in the Online Appendix summarizes the 8 intertemporal choice questions presented to subjects, and Figure 2 ibid. displays a screenshot of the multiple price list.

payment. The subject's current self, who thinks now about that future choice at time t, will have a willingness to wait of t'. If t and t' differ, and if $t \leq d \leq t' - 1$ (in case of present bias) or $t' \leq d \leq t - 1$ (in case of future bias), then we should observe a choice reversal, in that the current self would decide differently than the future self.

Thus, we design binary choices between (\$S, $t + FED$) and (\$L, $t + FED + d$), and in order to maximize the differences between preferences of current and future self, we choose a delay d at the midpoint of the range of predicted choice reversals, $d = \frac{t+t'-1}{2}$.[4] Given these two options, we offered subjects (that is: their current self) the possibility to commit their future self to one of these options. In particular, subjects could decide between leaving the choice to their future self, or committing their future self to one of the options.[5]

We based the commitment offers on TTO sequences 1 (\$S=\$100, FED=1 week) and 4 (\$S=\$200, FED=5 weeks). For each of these situations, we designed 8 commitment options that varied whether commitment was soft (costs added to the action that is supposed to be avoided) or strict (restricting the future choice set), and in the cost/benefit of the commitment contract (in time or money).[6] Table 1 summarizes the altogether 16 commitment questions, and Online Appendix B exemplarily lists the full text of all commitment questions, assuming a present-biased decision-maker.

While sophisticated biased subjects should accept an commitment option (if its direct cost are sufficiently low or its implicit costs sufficiently high), naïve biased subjects believe to be time-consistent and thus should accept a commitment option only if it comes with a benefit, just as truly time-consistent subjects.

Measurement of cognitive ability. We used an automated version of the operation span test (Turner and Engle, 1989; Unsworth et al., 2005), implemented in zTree (Fischbacher, 2007), to measure subjects working memory. After a practice trial, 75 math problems and 75 letter recalling questions are randomly ordered and organized into 12 task sets of 3 to 7 pairs each. Each task set repeatedly asks the subjects to solve math problems and at the same time remember letters displayed on the screen under time pressure. At the end of a task set, a recall screen asks for the sequence of letters in the correct order. We calculate a subjects cognitive score as the sum of the number of correctly answered math and correctly recalled letters. Subjects were paid according to their performance in the test.

[4] If the mid-point was not an integer number, we rounded down for present-biased and up for future-biased people.

[5] If a subject exhibited present-bias, she was assigned questions where commitment options lead to the choice of the larger-later payment at a future date; if future-bias was detected, the subject was assigned questions where choosing the smaller-sooner payment is induced by commitment.

[6] Commitment contract features such as strict vs. soft commitment options or monetary vs. time costs have also been examined by Augenblick et al. (2015), Beshears et al. (forthcoming), Casari (2009), and Houser et al. (2018).

Survey and vignette questions. A questionnaire collected subject's demographic information and information on their real-world financial situation. We incentivized proper attention to the questions by including four control questions with obvious answers, where wrong answers (due to inattention) would attract a financial penalty.[7] The questionnaire contained three binary questions in small vignette scenarios on real-life commitment behavior. One asked about the willingness to accept a commitment savings product, another about accepting a mutual bet to quit smoking, and a third one about a mutual bet to go to the gym regularly.[8]

Experimental procedures. The experiment was conducted in August 2012 at the BizLab of the University of New South Wales with 87 subjects in 6 sessions, each lasting about 90 minutes. Subjects were recruited using ORSEE (Greiner, 2015). All parts of the experiment were programmed in zTree (Fischbacher, 2007) except for the questionnaire that was implemented in Qualtrics.[9] Experimental payoffs had three components. First, all subjects received a show-up fee of AU$5 and questionnaire fee of AU$5 (less any penalties for wrong answers to attention checks). Second, subjects received cash conditional on their performance in the cognitive test, on average AU$12.94. And third, 6 subjects were randomly selected for payoff of their time preference and commitment choices (they received AU$220 in 1 week, 2 x AU$200 in 7 and 12 weeks, and 3 x AU$240 in 11, 25, and 58 weeks, respectively).

Gift cards were chosen for the latter component in order to prevent potential arbitrage behaviors through investment of earned payoffs outside of the experiment (thus replacing endogenous waiting options). The gift cards from the Coles and Myer group, which run thousands of supermarkets and department stores in Australia, could also be partially used and thus functioned like cash earmarked for consumption. At the beginning of each session, we displayed the gift cards to all subjects, and declared that the Business School of the University of New South Wales guaranteed their experimental income, in particular delayed payments. The gift card payments were sent by Australian Express Post Platinum service to ensure arrival on the promised date.

[7]Seven subjects answered 1 out of 4 control questions wrongly, no subject made more mistakes. We report below when excluding these six subjects would affect the results of our analysis.

[8]The three questions are contained in Online Appendix C.

[9]Appendix F includes the experimental instructions, and Appendix G displays some screenshots.

III Results

Preliminaries. Based on the first part of the experiment, for the sequence with \$L=\$100 and FED=1 week (\$L=\$200 and FED=5 weeks), 37% (33%) of subjects were classified as present-biased, 33% (29%) as future-biased, as 30% (38%) of subjects were either consistent or could not be classified. In part 2, present-biased (future-biased) subjects were offered commitment options that corrected present bias (future bias), while all other subjects were randomly assigned to either a present-bias or a future-bias correcting commitment option. Cognitive scores ranged from 81 to 149, with a mean of 129.4 and a standard deviation of 13.3 (see Figure 3 in Online Appendix A for the distribution).

Laboratory commitment decisions. Table 1 reports for all 16 commitment questions, how many of present or future biased subjects took up the commitment options designed for them. We also list the predictions for sophisticated and nave biased subjects, as discussed in Section 2. Between 16% and 31% of biased subjects accept an option that restricts their future choice and does not come at any costs, with present-biased and future-biased subjects showing quite some similarity.[10] If strict commitment is costly, acceptance rates decrease significantly, more so when the costs is monetary (2/4) than when it represents waiting time (3 days). On the other hand, acceptance rates increase to 44% to 55% when a strict commitment option comes with an additional benefit of 3 days less waiting time. Soft commitment, which features no direct but only implicit costs (that only need to be paid if the temptation is given in) seems to be much less popular than strict commitment options. Only between 0% and 7% of subjects choose to commit themselves by applying penalties of \$2, \$4, or 1 week on choosing the tempting option in the future. Only when such a commitment is sweetened with an additional benefit of 3 days for choosing the (now) preferred option in the future, between 32% and 52% of subjects opt for commitment.

We ran Probit regression models, reported in Table 2, that explore drivers of accepting a commitment option based on a subject's time-preferences and cognitive performance and features of the commitment device. The independent "Time Inconsistency" indicates whether the subject was (present- or future-) biased. "Cognitive Score" is the normalized score achieved in the Automated Operation Span test. Our main interest is on the interaction effect "TI x CogScore" which estimates how the likelihood to commit changes for time-inconsistent people when cognitive performance is higher. As controls we include the "Patience level" of the subject equaling the average willingness to wait in the two related time preference questions, "Soft commitment" indicating whether this was a soft commitment (rather than a strict commitment)

[10] We note that in his experiment, Casari (2009) finds up to 60 percent of present-biased subjects to accept commitment options.

TABLE 1: Take-up rates of commitment options

Commitment question	Q	Pred for sophisticated biased subjects	Pred for naïve biased subjects	Take-up present-biased subjects	Take-up future-biased subjects
$100 stakes, 1 week FED					
Strict commitment					
No cost for C	1	100%	indiff.	28.1%	31.0%
$2 cost for C	2	dep. on tradeoff	0%	6.3%	6.9%
3 days cost for C	3	dep. on tradeoff	0%	18.8%	17.2%
3 days benefit for C	4	100%	100%	53.1%	55.2%
Soft commitment					
$2 penalty on T	5	dep. on tradeoff	indiff.	0.0%	0.0%
$6 penalty on T	6	dep. on tradeoff	indiff.	0.0%	0.0%
1 week penalty on T	7	dep. on tradeoff	indiff.	3.1%	0.0%
1 week penalty on T +3 days benefit for P	8	dep. on tradeoff	100%	50.0%	48.3%
$200 stakes, 5 weeks FED					
Strict commitment					
No cost for C	9	100%	indiff.	31.0%	16.0%
$2 cost for C	10	dep. on tradeoff	0%	3.4%	4.0%
3 days cost for C	11	dep. on tradeoff	0%	17.2%	8.0%
3 days benefit for C	12	100%	100%	51.7%	44.0%
Soft commitment					
$2 penalty on T	13	dep. on tradeoff	indiff.	6.9%	4.0%
$6 penalty on T	14	dep. on tradeoff	indiff.	3.4%	4.0%
1 week penalty on T	15	dep. on tradeoff	indiff.	3.4%	4.0%
1 week penalty on T +3 days benefit for P	16	dep. on tradeoff	100%	51.7%	32.0%

Notes: "C" stands for "deciding for the commitment option now", "T" refers to "choosing the tempting option in the future", and "P" to "choosing the (now) preferred option in the future." "Q" refers to the commitment question number.

question, and the commitment devices actual costs and implicit costs, the calculation of which are detailed in Online Appendix D. We report separate estimations for whether the commitment option corrected present bias or future bias, and whether the questions addressed $100 stakes with a one-week FED or $200 stakes with a 5 weeks FED.[11]

TABLE 2: PROBIT ESTIMATIONS OF COMMITMENT OPTION ACCEPTANCE

	Correcting present-bias		Correcting future-bias	
	$100, 1w	$200, 5w	$100, 1w	$200, 5w
Model	(1)	(2)	(3)	(4)
Time-inconsistent	0.014	0.019	0.016	-0.018
	(0.060)	(0.056)	(0.055)	(0.048)
Cognitive Score	0.002	0.019	0.049*	0.057*
	(0.023)	(0.023)	(0.026)	(0.034)
TI × CogScore	0.036	-0.072	-0.031	0.046
	(0.040)	(0.054)	(0.048)	(0.067)
Patience level	0.001	-0.005	-0.001	-0.001
	(0.004)	(0.003)	(0.003)	(0.003)
Soft commitment	-0.125**	-0.105***	-0.127**	-0.040
	(0.063)	(0.041)	(0.063)	(0.054)
Actual cost	-7.146***	-8.704***	-6.031***	-11.194***
	(1.350)	(1.644)	(1.252)	(1.816)
Implicit cost	-1.198	-2.132**	0.519	-1.22
	(0.781)	(0.911)	(1.439)	(1.362)
N	368	400	328	296
Log-Likelihood	-157.23	-168.26	-136.92	-94.97

Notes: We report average marginal effects. Robust standard errors are clustered at the subject level and given in parentheses. Partial effects for the interaction term are calculated following Norton et al. (2004).

Table 2 reports the results of our Probit estimations of commitment choices. We obtain a similar pattern of estimates for commitment decisions that correct either direction of bias. With respect to our main variables of interest, we do not find support for the hypothesis that commitment demand would be mainly driven by time-inconsistent but sophisticated people. As a matter of fact, neither time-consistency nor the cognitive score nor their interaction have a significant impact on the likelihood of taking up a commitment device. (The only exception are weakly positive effects of a higher cognitive score on the take-up rate for commitment devices that correct future-biased, but this effect seems to exist independently of whether the subject is indeed time-consistent or not and disappears when we include other demographic controls.)

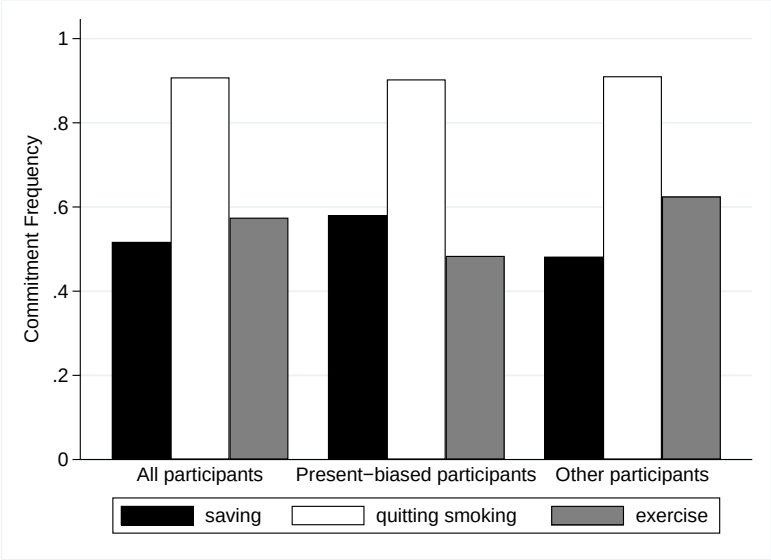
The main drivers of whether commitment is accepted or not seem to be the properties

[11] We did a number of robustness checks, including controlling for subjects' demographic characteristics, which are reported in Online Appendix E. None of them would change our conclusions here.

of the specific commitment option. Consistent with our observations above, soft commitment options (which impose penalties on giving in to temptation) are less preferred than strict commitment options (where future choice is restricted). The size of direct costs or benefits of commitment has a significant negative effect on whether the commitment is accepted or not. The effect of implicit costs is also negative in most cases, but not significantly so.

Vignette commitment questions. In the survey part of the experiment, 52% of subjects expressed interest towards the saving product, 57% would commit to do regular exercise, and 91% agreed to commit to quit smoking. Since the three commitment devices are targeted towards present-biased people, Figure 1 compares the commitment rates for the three questions between subjects identified to have present bias and other people.[12] We do not observe differences in commitment rates between present-biased and other people (Fishers exact tests; $p = 0.502$, $p = 1.000$, and $p = 0.259$ for the savings, smoking, and exercise vignette question, respectively).

FIGURE 1: Commitment rates to questions



We use Probit regression models to analyze the interaction between being present-bias and having a high cognitive performance in explaining commitment take-up in the vignette questions. The independent "Present-biased" is an indicator whether the subject was classified as present-biased, or not. The "Patience level" here is the average waiting time across all 8 timed payment choices from Part 1 of the experiment.

Table 3 presents the results, separately for each of the three vignette questions. As before, our main interest is in the interaction effect "Present-biased × Cognitive Score". While for the

[12]To classify subjects here we use all four TTO sequences and assign the most common classification across these four sequences. See Greiner and Zhang (2020) for details on this and other classification approaches.

contexts of quitting smoking and exercising the detected bias and measured cognitive performance cannot explain the take-up of a commitment device, for the decision to take-up a savings commitment product, our results are in line with the theoretical prediction. The interaction effect between present bias and cognitive score is positive and statistically significant while the two main effects are not different from zero.[13]

TABLE 3: Probit regression results on likelihood to take up commitment in the three vignette questions

Commitment context	Savings	Quitting smoking	Exercising
Present-biased	0.098	-0.049	-0.177
	(0.108)	(0.072)	(0.108)
Cognitive Score	-0.010	0.016	-0.033
	(0.051)	(0.028)	(0.054)
Present-biased × Cognitive Score	0.259***	-0.067	0.018
	(0.105)	(0.082)	(0.113)
Patience level	-0.006	-0.007**	-0.011*
	(0.006)	(0.003)	(0.006)
N	87	87	87
LL	-56.75	-22.93	-56.74

Note: Standard errors are given in parentheses. Partial effects of interaction terms are calculated following Norton et al. (2004).

IV Conclusion

In this paper we aimed to measure (potential for) sophistication of time-inconsistent decision-makers via a cognitive test, in order to explore the relation between sophistication and demand for commitment devices. In our experiment, we first measure time-preferences and detect time-inconsistencies, then present participants with new sets of questions that offer tailor-made commitment devices, and finally measure participants' performance in an automated operation span test testing working memory. Contrary to the theoretical prediction, we find no relation between cognitive performance and take-up of commitment devices for time-inconsistent people. Interestingly, while cognitive ability is of little help in explaining laboratory commitment

[13] In robustness tests, demographic characteristics only played a role for exercise commitment choices. In none of the three models their inclusion affected the estimates of the interaction effect. In addition, we explored the correlation between laboratory commitment behavior and answers to the vignette questions, and found no relation. When we exclude 7 subjects who made errors in control questions from the analysis, we find no changes for smoking and exercise commitment questions (other than the coefficient for *Patience level* for Exercising shifting significance level from 10% to 5%). For saving commitment decisions, the interaction term stays significant at the 1% level, but additionally the estimated marginal effect of *Present-biased* is positive and significant at the 10% level.

choices, it has predictive power for subjects' self-stated demand for a savings commitment product. We thus contribute to a growing literature that finds individual commitment choices to be noisy and often inconsistent. However, we also document and replicate reasonable reactions to features of commitment devices, such as preference for strict vs. soft commitment options, and sensitivity to direct and – less so – to implicit costs.

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Online Appendix

A Additional Figures and Tables

TABLE 4: Intertemporal choice questions in time preference elicitation

Seq	Question Nb. q	Smaller-sooner payment $\$Sq$	Front-end delay FED_q	Larger-later payment $\$L_q$	Elicited willingness to wait t_q
1	1	\$100	1 week	\$130	t_1
	5	\$100	1 week+t_1	\$130	t_5
2	2	\$100	5 weeks	\$130	t_2
	6	\$100	5 weeks+t_2	\$130	t_6
3	3	\$200	1 week	\$240	t_3
	7	\$200	1 week+t_3	\$240	t_7
4	4	\$200	5 weeks	\$240	t_4
	8	\$200	5 weeks+t_4	\$240	t_8

FIGURE 2: Screenshot of example intertemporal choice question

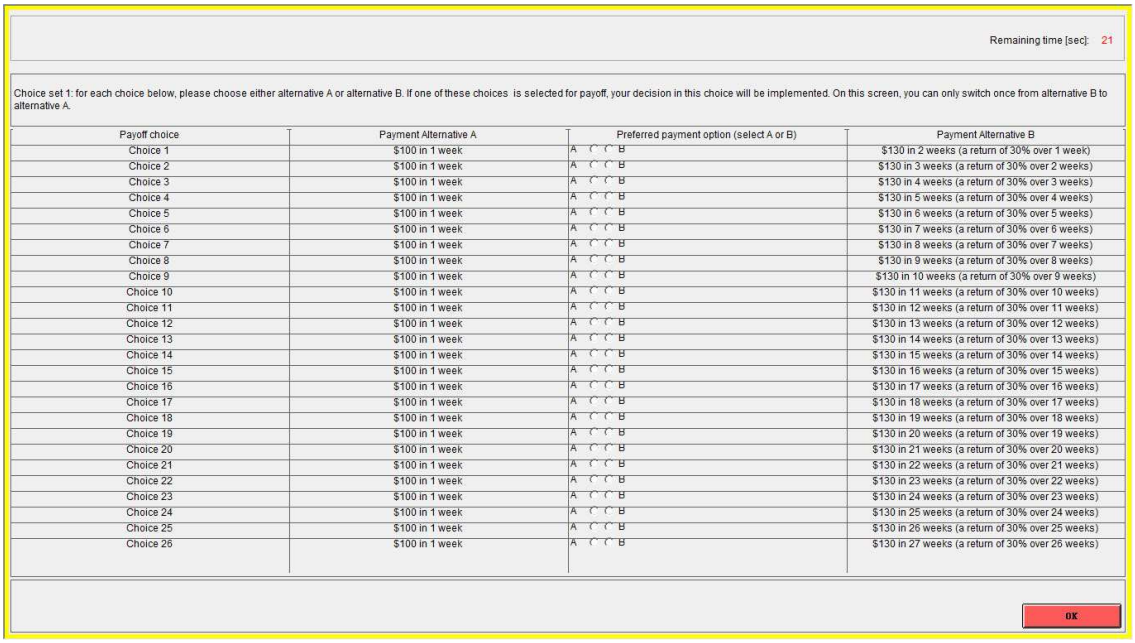
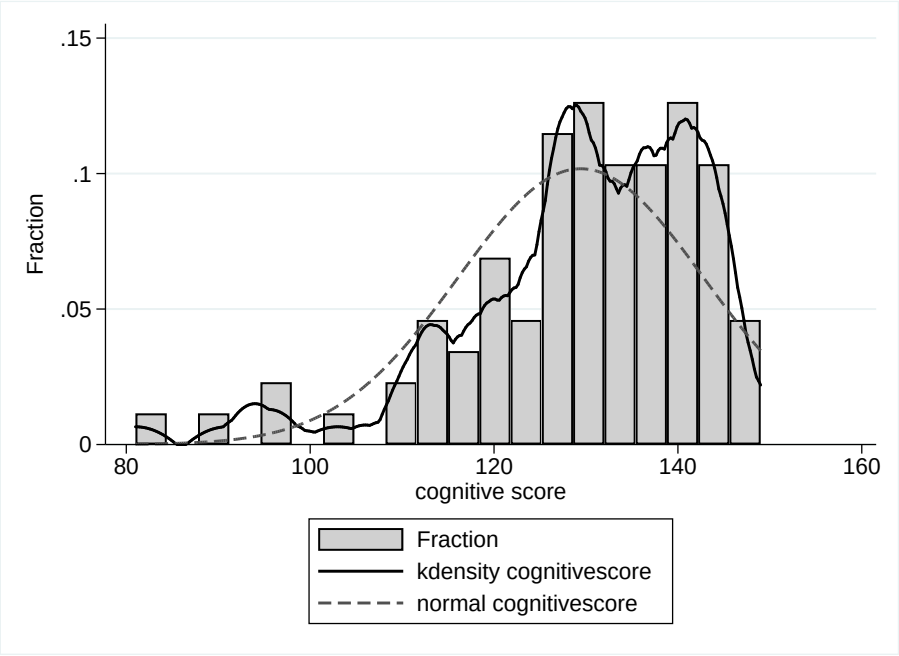


FIGURE 3: Distribution of cognitive scores



B Commitment questions used in the experiment

Across each set of 8 questions we altered the design and cost of commitment. Four commitment questions C1, C2, C3, and C4 imposed a **strict commitment**, by limiting future choices to the now preferred alternative (based on elicited preferences), so there is no chance for temptation later. This option could be chosen for free (C1), come at a cost of \$2 (C2) or a (further) time cost of 3 days (C3), or could even carry a time benefit of 3 days (C4). A typical strict question (with a cost of \$2) would read:

> You are asked to choose between Option A and Option B today.
>
> Option A: *In 10 weeks you will have to decide between*
>
> *Sub-option A1: 1 week later you receive \$100 or*
>
> *Sub-option A2: 6 weeks later you receive \$130*
>
> Option B: *In 10 weeks you will have no choice, 6 weeks later your will receive* ***\$128****.*

To equalize transaction costs between options A and B, subjects who chose option B were also asked to send a confirmation message (no choice could be made) via email on the designated date.

The other four commitment questions C5, C6, C7, and C8 offered a form of **soft commitment**, which retained the choice flexibility but imposed a penalty on the tempting sub-option for the future self, making it less attractive. The costs are implicit, since they do not have to be incurred if commitment is successful and the current selfs option is chosen in the future. The penalty imposed on choosing the tempting sub-option could be monetary costs of \$2 (C5) or \$6 (C6), a time cost of one week (C7), or the time cost of one week for choosing the tempting option combined with a reward of 3 days for choosing the option preferred by the current self (C8). A typical soft commitment option with a \$6 implicit cost would read:

> You are asked to choose between Option A and Option B today.
>
> Option A: *In 10 weeks you will have to decide between*
>
> *Sub-option A1: 1 week later you receive \$100 or*
>
> *Sub-option A2: 6 weeks later you receive \$130*
>
> Option B: *In 10 weeks you will have to decide between*
>
> *Sub-option B1: 1 week later you receive* ***\$94*** *or*
>
> *Sub-option B2: 6 weeks later you receive \$130.*

Assume a present-biased decision-maker who answered, when asked about her willingness to wait for \$130 vs. \$100 with a 1 week initial front-end delay, "7 weeks" for t and then "11 weeks" for t'. Then, we would use a $d = \lfloor \frac{t+t'-1}{2} \rfloor = \lfloor \frac{7+11-1}{2} \rfloor = 8$ weeks, such that the decision situation for which the participant is offered commitment contracts takes place in 7 weeks and is between \$100 in 7+1 weeks and \$130 in 7+1+8 weeks. The 8 different commitment questions presented to the participant were then:

C1 (strict commitment, no cost):
You are asked to choose between Option A and Option B today.
Option A: *In 7 weeks you will have to decide between*
Sub-option A1: 1 week later you receive \$100 or
Sub-option A2: 9 weeks later you receive \$130
Option B: *In 7 weeks you will have no choice, 9 weeks later your will receive \$130.*

C2 (strict commitment, \$2 cost):
You are asked to choose between Option A and Option B today.
Option A: *In 7 weeks you will have to decide between*
Sub-option A1: 1 week later you receive \$100 or
Sub-option A2: 9 weeks later you receive \$130
Option B: *In 7 weeks you will have no choice, 9 weeks later your will receive \$128.*

C3 (strict commitment, 3 days cost):
You are asked to choose between Option A and Option B today.
Option A: *In 7 weeks you will have to decide between*
Sub-option A1: 1 week later you receive \$100 or
Sub-option A2: 9 weeks later you receive \$130
Option B: *In 7 weeks you will have no choice, 9 weeks and 3 days later your will receive \$130.*

C4 (strict commitment, 3 days benefit):
You are asked to choose between Option A and Option B today.
Option A: *In 7 weeks you will have to decide between*
Sub-option A1: 1 week later you receive \$100 or
Sub-option A2: 9 weeks later you receive \$130
Option B: *In 7 weeks you will have no choice, 8 weeks and 4 days later your will receive \$130.*

C5 (soft commitment, \$2 implicit costs):

You are asked to choose between Option A and Option B today.
Option A: *In 7 weeks you will have to decide between*
Sub-option A1: 1 week later you receive $100 or
Sub-option A2: 9 weeks later you receive $130
Option B: *In 7 weeks you will have to decide between*
Sub-option B1: 1 week later you receive $98 or
Sub-option B2: 9 weeks later you receive $130.

C6 (soft commitment, $6 implicit costs):
You are asked to choose between Option A and Option B today.
Option A: *In 7 weeks you will have to decide between*
Sub-option A1: 1 week later you receive $100 or
Sub-option A2: 9 weeks later you receive $130
Option B: *In 7 weeks you will have to decide between*
Sub-option B1: 1 week later you receive $94 or
Sub-option B2: 9 weeks later you receive $130.

C7 (soft commitment, 1 week implicit costs):
You are asked to choose between Option A and Option B today.
Option A: *In 7 weeks you will have to decide between*
Sub-option A1: 1 week later you receive $100 or
Sub-option A2: 9 weeks later you receive $130
Option B: *In 7 weeks you will have to decide between*
Sub-option B1: 2 weeks later you receive $100 or
Sub-option B2: 9 weeks later you receive $130.

C8 (soft commitment, 1 week implicit costs and 3 days benefit):
You are asked to choose between Option A and Option B today.
Option A: *In 7 weeks you will have to decide between*
Sub-option A1: 1 week later you receive $100 or
Sub-option A2: 9 weeks later you receive $130
Option B: *In 7 weeks you will have to decide between*
Sub-option B1: 2 weeks later you receive $100 or
Sub-option B2: 8 weeks and 4 days later you receive $130.

C Survey vignette questions on real-life commitment behavior

The first vignette question referred to the finance domain and was motivated by the field study conducted by Ashraf et al. (2006). It asks:

> If you were offered a saving product which does not allow you to withdraw funds until the funds on your account reach a goal date or target amount. Would you sign up for this?

The other two vignette questions address behavior in the health domain. One of them asks:

> Assume you are a smoker. You desperately want to quit smoking for better health. At the same time, a friend of yours also wants to quit smoking. Both of you plan to reduce nicotine intake over time and believe that in 10 weeks (a date agreed on by both of you) you will be smoke-free. Now, your friend offers you a bet: whoever is still smoking after the designated time will have to pay the other party $200. Would you take this bet?

The other question asks:

> Assume you intend to attend gym sessions regularly, but fail to do so due to discomfort after exercising. A friend of yours, experiencing the same situation, is willing to work out 3 times a week with you for the next month (on a date agreed on by both of you). S/He offers you a bet: whoever fails to stick to the plan will have to pay the other party $20 upon each time s/he does not go to the gym. Would you take this bet?

D Calculation of direct and implicit commitment costs

We calculate the size of direct and implicit costs of a (strict or soft) commitment option following Casari (2009)'s approach. We employ the simple interest rule under the assumption that utility is linear in money to compute the net present value of a commitment cost.

The "actual cost" of a (strict or soft) commitment option is the amount directly paid for being able to commit the future choice according to current preferences (i.e. to the larger-later payment for present-biased people or to the smaller-sooner payment for future-biased people, respectively). We express it as the relative loss in option B compared to option A in terms of net present value (NPV) on the preferred payment, calculated based on the observed impatience level in the relevant time preference sequence,

$\frac{NPV(L_A)-NPV(L_B)}{NPV(L_A)}$ for correcting present-bias, and

$\frac{NPV(S_A)-NPV(S_B)}{NPV(S_A)}$ for correcting future-bias.

The "implicit cost" of a (soft) commitment option is the penalty which is only imposed when the tempting choice is chosen in the future. That is, "implicit cost" does not have to be paid if the commitment device works properly. We express it as the relative loss for the tempting payment alternative in option B compared to the tempting payment alternative in option A in terms of net present values, calculated based on the observed impatience level in the relevant time preference sequence,

$\frac{NPV(S_A)-NPV(S_B)}{NPV(S_A)}$ for correcting present-bias, and

$\frac{NPV(L_A)-NPV(L_B)}{NPV(L_A)}$ for correcting future-bias.

E Robustness checks for the main regressions

Table 6 reports results from regressions similar to the ones reported in Table 2 in the main text, but which additionally control for subjects' demographic information.

As demographics controls we use "Liquidity constrained" and "Has credit card" as dummies indicating whether the subject would have difficulty to borrow $1000 within two weeks and uses a credit card, respectively, a gender indicator Male and a variable for Age, whether the subject was born as "Australian" or not, whether they have achieved a "Bachelor degree" or a "Master degree" (baseline is a High School degree), whether they study in a "Business/Economics major" or not, whether they are currently "Employed" or not, and a standardized score from a self-control assessment in the questionnaire (original scores range from 77 to 147, with a mean of 112.6 and a standard deviation of 15.5). Table 5 gives an overview over these variables.

TABLE 5: Means and standard deviations of demographic variables

Variable	Sample Mean	Standard Deviation
Age	21.7	2.8
Male (0/1)	0.529	
Australian (0/1)	0.299	
Employment (0/1)	0.356	
Bachelor (0/1)	0.172	
Master (0/1)	0.046	
Business major (0/1)	0.448	
Liquidity-constrained (0/1)	0.138	
Have a credit card (0/1)	0.448	
Self-control score	112.6	15.5

Including individual characteristics as independents does not change the interpretation of our main effects of interest, but demographics also contribute to explaining commitment decisions. Being liquidity-constrained is negatively related to commitment that allows to correct present-bias and positively related to commitment that allows to correct future-bias (significant only for higher stakes). Subjects who have achieved a bachelors degree, compared to those with a high school degree, are less likely to commit. Older people are more likely commit to a present-bias correction (but keep in mind that the average age of our subjects is 21.7 with a standard deviation of only 2.8). Being an Australian or having obtained a Master degree are also detected as significant influences, but these seem not to be consistent across models.

We did several further robustness checks of our results. For example, we also ran a larger model that comprises data from all four cases and adds the independents "Commitment question type" (correcting present bias or future bias) and "Stake size". The results are basically

the same, with the only difference being that the coefficient for "Implicit costs" becomes significant, and that some coefficients on demographics (where they are inconsistently estimated across the four groups) become insignificant.

When we exclude seven subjects who made errors in control questions from our estimations reported in Table 2 and Table 6, then the interaction effects "TI × CogScore" in Models 2 and 6 are -0.111 and -0.129, and significant at the 5% and the 10% level, respectively. This, however, goes even contrary to our initial hypothesis of a positive interaction effect of time-inconsistency and cognitive performance.

TABLE 6: PROBIT ESTIMATIONS OF COMMITMENT OPTION ACCEPTANCE, INCLUDING DEMOGRAPHICS

	Correcting present-bias		Correcting future-bias	
	\$100, 1w	\$200, 5w	\$100, 1w	\$200, 5w
Model	(1)	(2)	(3)	(4)
Time-inconsistent	0.057	0.053	-0.013	0.017
	(0.052)	(0.058)	(0.061)	(0.048)
Cognitive Score	-0.018	0.024	0.06	0.036
	(0.027)	(0.028)	(0.044)	(0.028)
TI × CogScore	-0.019	-0.092	-0.027	0.015
	(0.048)	(0.060)	(0.060)	(0.052)
Patience level	0.004	-0.005	-0.001	-0.002
	(0.004)	(0.004)	(0.003)	(0.005)
Soft commitment	-0.131**	-0.109***	-0.132**	-0.047
	(0.061)	(0.039)	(0.064)	(0.052)
Actual cost	-7.112***	-8.694***	-5.973***	-11.682***
	(1.359)	(1.540)	(1.200)	(1.661)
Implicit cost	-0.972	-1.948**	0.729	-1.029
	(0.807)	(0.835)	(1.379)	(1.249)
Liquidity	-0.068	-0.116**	-0.059	0.134*
constrained	(0.068)	(0.057)	(0.084)	(0.069)
Has credit card	0.038	-0.039	-0.041	-0.000
	(0.058)	(0.082)	(0.060)	(0.053)
Male	-0.046	-0.023	-0.002	-0.031
	(0.053)	(0.059)	(0.050)	(0.050)
Age	0.020**	0.019*	-0.017	-0.006
	(0.008)	(0.010)	(0.017)	(0.025)
Australian	-0.067	0.037	-0.096*	-0.001
	(0.057)	(0.087)	(0.058)	(0.089)
Bachelor degree	-0.112*	-0.103*	-0.001	-0.259*
	(0.062)	(0.057)	(0.068)	(0.142)
Master degree	-0.125***	-0.000	0.510**	omitted
	(0.046)	(0.106)	(0.231)	
Business/Ec major	0.066	0.065	-0.055	0.013
	(0.060)	(0.061)	(0.049)	(0.070)
Employed	-0.012	-0.045	0.074	0.077
	(0.053)	(0.056)	(0.051)	(0.047)
Self-control score	0.035	-0.010	-0.005	0.042
	(0.029)	(0.036)	(0.028)	(0.027)
N	368	400	328	296
Log-Likelihood	-146.83	-160.86	-127.04	-83.10

Notes: We report average marhinal effects. Robust standard errors are clustered at the subject level and given in parentheses. Partial effects for the interaction term are calculated following Norton et al. (2004).

F Experimental instructions

F.A General Instructions

Welcome and thank you for participating in this experiment.

These instructions are the same for all the participants. From now on, please do not communicate with other participants. If you have a question please raise your hand. One of the experimenters will attend to you and answer your questions. Please switch your mobile phone off now. Please use the computer only for entering your decisions. Please only use the pen and forms provided. Dont start or end any programs, and do not change any settings. If you dont conform to these rules during the experiment we will have to exclude you from the any payoffs.

To ensure privacy of choices, each participant is seated in a cubicle. The experiment will be conducted by participants entering their choices via computers that are located in those cubicles.

This experiment consists of 4 different parts.

You are paid a show-up fee of $5, a reward conditional on your performance in part 3 of the experiment, and a $5 flat-fee for filling in a questionnaire in part 4.

Additionally, at the end of this experiment one participant will be randomly drawn. This participant is paid according to one of his/her choices in either part 1 or part 2, randomly selected, with payoffs ranging from $100 to $240. If you are the selected participant, your rewards will be paid with a Myers & Coles gift certificate. The ASBLab will send the gift certificate to you by post. "A payment in 1 week" means the certificate will be sent to you in 6 days and arrive at your address in 7 days (exactly one week). "A payment in t weeks and 2 days" means the certificate will be sent to you in t weeks and 1 day and arrive at your address in t weeks and 2 days. Please note that we send the gift certificates by Australian Post "Express Post Platinum" and thereby make sure that your gift certificate(s) will arrive at your address on the exact date.

F.B Instructions for Time Preferences Elicitation

In this part of the experiment, you will be asked to make a series of choices between alternatives concerning different valued gift certificates which you will receive at different points in time.

You will encounter 16 different choice sets (computer screens), each of which consists of 26 simple choices. Each choice asks you to make a decision between "Payment Alternative A" and "Payment Alternative B". "Payment Alternative A" is always a smaller-valued gift-certificate receivable in the near future while "Payment Alternative B" is always a larger-valued gift-certificate receivable some time later. On each screen (choice set), the amounts of gift cards A and B and the payoff time of gift card A are fixed, and the only thing which changes from one row to the next row is the time when you receive gift card B.

To enforce consistency among your choices on one screen, we will assume that if you prefer gift card A over gift card B when gift card B is paid in X weeks, then you also prefer A over B in X+1 weeks. In other words: Whenever you choose A over B, we will assume that in all rows below you also prefer A over B, and whenever you choose B over A we will assume that in all rows above you prefer B over A. The computer will correct this automatically on the screen whenever you make a choice.

At the end of the experiment one of your 16x26 choices will be selected for payoff. (We will first randomly select one out of 16 choice sets, and then randomly select one choice row out of the 26 choice rows in this set.) This choice will be implemented according to your decision. So, for example, if "choice set 8, choice row 14" is randomly selected, then we will look at your decision in set 8, choice 14. If you chose A, you will receive Payment Alternative A in that choice, if you chose B, you will receive Payment Alternative B in that choice.

As a result, each of your choices is equally likely to be selected for payoff. So you should carefully think about each choice, because it may be selected and your decision implemented exactly as described.

At the end of the experiment, one of the participants in this session will be randomly selected and paid out either for Part 1 according to the procedure described above, or for Part 2.

F.C Instructions for Commitment Questions

For this part of the experiment we will ask you to make choices on two separate days: one today during the experimental session, and the other at a specified later date.

Today you are asked to choose between Option A and Option B.

Some days later (the exact number of days will be displayed on the screen) we will contact

you by email. If you have chosen Option A today, we will later ask you to decide between Option A1 and Option A2. If you have chosen Option B today, we will later ask you to decide between Option B1 and B2 when they are available.

For example, the choice today could be:

Option A: *In 10 weeks you will have to decide between*
A1: right then you receive $100, or
A2: 13 weeks later you receive $130.

Option B: *In 10 weeks you will have no choices, 13 weeks later you will receive $130.*

Basically, choosing Option B means that you commit to getting a $130 certificate in 10 + 13 weeks. When you choose Option A you dont commit, and will choose in 10 weeks whether you take a $100 certificate right then or you wait a further 13 weeks to get a $130 certificate.

As another example, your choice today could be:

Option A: *In 3 weeks you will have to decide between*
A1: 5 weeks later you receive $200, or
A2: 20 weeks later you receive $240.

Option B: *In 3 weeks you will have to decide between*
B1: 5 weeks later you receive $196, or
B2: 20 weeks later you receive $240.

Here choosing Option B basically assigns a penalty of $4 to yourself in case in 3 weeks you choose to get the certificate of $200 in 5 weeks instead of waiting a further 20 weeks for the certificate of $240.

All your choices in this part will be similar to these two examples. Altogether you will make 16 choices.

After finishing the experiment, one of you will be randomly selected and paid out according to one of his/her choices in either Part 1 or Part 2. That is, if you are the selected participant to be paid out in Part 2, then we will check whether you chose Option A and Option B at the

selected choice. According to your choice, we will contact you in the specified number of weeks by email (asblabexperiment@gmail.com) and let you choose between Sub-options A1 and A2 (if you selected Option A today), or Sub-options B1 and B2 (if you selected Option B today).

Please note that what amount you will be rewarded and at which time point depends on what you choose in the experiment.

F.D Instruction for Test of Cognitive Ability

In this section, you need to try to remember a sequence of letters which appear on the computer screen and at the same time solve simple math problems. The better you are in this task, the more you will earn.

The specific instruction for this section will be presented on the screen. This section consists the practice part and the real trials. The practice part helps you get familiar with what to expect, and will not be paid. In the real trials, your payment will depend on your performance. Here is how you get paid in the real trials:

For the subtask of recalling letters, you will get 10 cents for each correctly remembered letter.

For the subtask of solving math problems, the benchmark is 50 percent. If you answer more than 50 percent of math questions correctly, then you will receive 20 cents for each correct answer above 50 percent. If you get less than 50 percent of math questions correctly, you will be deducted 10 cents for each wrong answer below 50 percent.

There are different versions of this section, so other participants will not be remembering the same letters and calculating the same math problems as you are.

Please complete this test quietly. You are not allowed to make any notes on paper, or to communicate with other participants.

G Screenshots of commitment questions as displayed in the experiment

FIGURE 4: Screenshot of example commitment question
($100 stakes, present bias, strict commitment)

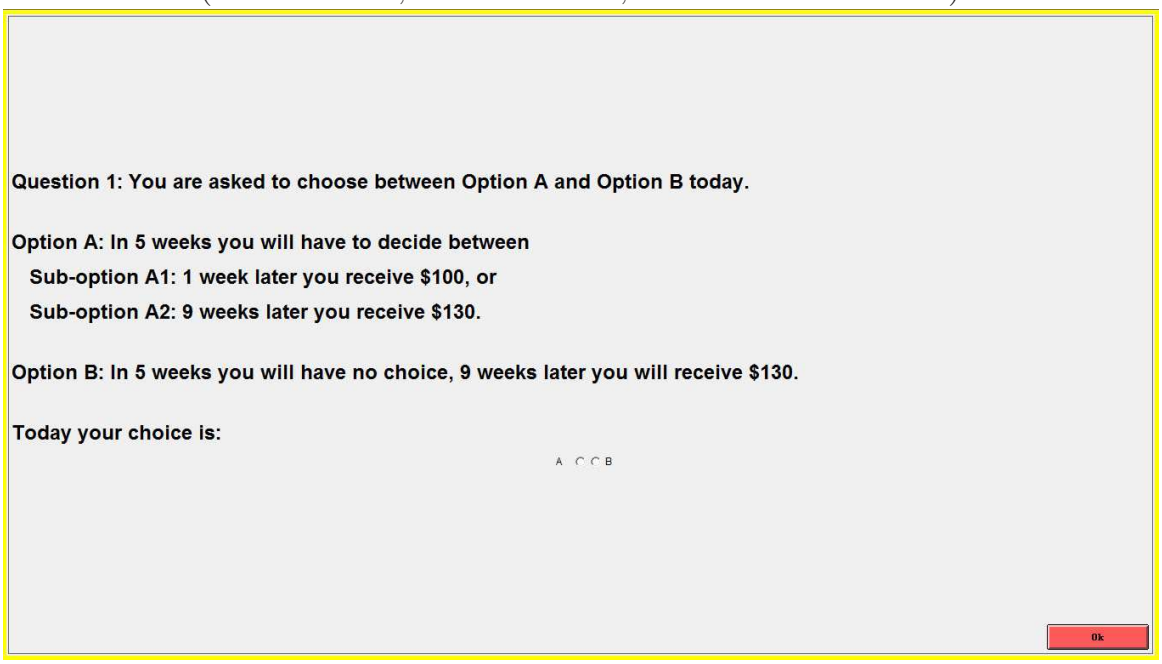


FIGURE 5: Screenshot of example commitment question
($200 stakes, future bias, soft commitment)