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Stefania Bortolotti Thomas Dohmen Hartmut Lehmann

Frauke Meyer Norberto Pignatti Karine Torosyan

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Patience, Cognitive Abilities, and Cognitive Effort: Survey and Experimental Evidence from a Developing Country *

Stefania Bortolotti
University of Bologna, IZA

Thomas Dohmen†
University of Bonn, IZA, Maastricht University, ROA, DIW

Hartmut Lehmann
National Research University Higher School of Economics, Russia, IZA, University of Bologna

Frauke Meyer
Forschungszentrum Jülich

Norberto Pignatti
International School of Economics at Tbilisi State University (ISET), IZA

Karine Torosyan
International School of Economics at Tbilisi State University (ISET)

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Abstract

We shed new light on the relationship between cognition and patience, by providing documenting that the correlation between cognitive abilities and delay discounting is weaker for the same group of individuals if choices are incentivized. We conjecture that the exertion of higher cognitive effort, which induces higher involvement of the cognitive system, moderates the relationship between patience and cognition. To test this hypothesis, we analyze the relationship between various measures of cognitive ability, including the cognitive reflection test (CRT), a symbol-correspondence test, a numeracy test, as well as self-reported math ability and the interviewer's assessment of the respondent's sharpness and understanding, and different measures of patience, including incentivized choices between smaller sooner and larger later monetary payments and hypothetical inter-temporal trade-offs, for 107 subjects drawn from the adult population in Tbilisi (Georgia).

1 Introduction

Decisions involving trade-offs between immediate gratification and delayed benefits are of fundamental importance for life outcomes. Patience has been identified as a major driver of success in life. More

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†Corresponding author: tdohmen@uni-bonn.de

patient populations have been shown to be richer (Dohmen et al., 2017, Falk et al., 2018, and more patient individuals have been shown to accumulate more skills, to enjoy higher incomes and greater health (Borghans and Golsteyn, 2006; Sutter et al., 2013, Golsteyn et al., 2014). A large literature in psychology and economics indicates that cognition and delay discounting are related. Evidence from the psychology literature on the relationship between intelligence and the ability to delay gratification has focused on children and typically has used hypothetical measures of delay discounting (see Shamosh and Gray, 2008 for a meta study). Prominent studies by Funder and Block (1989), Shoda et al. (1990), Kirby et al. (2005), and Parker and Fischoff (2005) suggest that individuals with higher cognitive ability make more patient choices. Experimental studies in the economics literature have typically analyzed incentivized choices between smaller sooner monetary rewards and larger later payments, using student samples (e.g., Frederick, 2005; Benjamin et al., 2013) and samples representative of the adult population (e.g., Dohmen et al., 2010) to document a positive correlation between measures of cognitive ability and patient behavior in these inter-temporal trade-offs.

Several mechanisms have been proposed through which the link between cognitive ability and patience might manifest, including self-control (e.g. Shoda et al., 1990 and Kirby et al., 2005), working memory (e.g., Hinson et al., 2003 and Benjamin et al., 2013), or competing separate neural systems in the brain (Bernheim and Rangel, 2004; Benhabib and Bisin, 2005; Fudenberg and Levine, 2006). All these explanations suggest that the observed relationship between patience and cognitive ability is affected by the involvement of the cognitive system, either because the cognitive system helps encoding and valuing future rewards or because it contributes to suppressing more spontaneous and emotional responses (e.g., the urge for immediate gratifications).

We therefore conjecture that the exertion of higher cognitive effort, which induces higher involvement of the cognitive system, moderates the relationship between patience and cognition. We provide findings that indicate a role for *cognitive effort* to affect this relationship. We show that, for the same group of individuals, the correlation between cognitive abilities and patience is weaker if actual monetary rewards are involved, i.e., choices are incentivized.[1] A simple cost-benefit model would suggest that when stakes are large enough even low ability individuals have a reason to exert sufficient cognitive effort to imagine utility in the future state and suppress their emotional system that longs for

[1]Our findings differ from the results reported in Shamosh and Gray (2008). This might not be surprising as most of the studies included in the meta-analysis were run with children/adolescents or with subjects with psychological disturbances/addictions, while our sample was drawn from the general population and included only adults. More importantly, we provided very strong monetary incentives – the maximum earnings were roughly 40% of the median household monthly income in our sample – a feature which is not present in the studies with a student/general sample considered by Shamosh and Gray (2008).

immediate gratification and, as a result, make a more deliberate and patient choice. To corroborate our findings, we extend the analysis to include trade-offs between two delayed hypothetical rewards where deliberation and cognition is always required. Being able to compare in a within-subjects design situations where an impulsive choice can be made (immediate payment) with situations in which all options are equally difficult to imagine (as they are both in the future) allows us to test if the link between cognition and patient behavior is mediated by the timing of the trade-off. As predicted, in situations where one must choose between two payments in the future, we find weaker or no association between cognition and patience.

The remainder of the paper is organized as follows. In section 2, we outline our conceptual framework and derive a set of testable hypotheses. In section 3 we describe our methodology and subject pool. Section 4 reports results on the link between cognition, cognitive effort, and patience. Section 5 discusses potential applications of our findings and the limitations of this study.

2 Hypotheses

Patient behavior captures individuals' trade-off between early and delayed consumption. More patient individuals are more willing to forgo gratification in the present for higher levels of gratification at a specific future date. In economics, time preferences describe how people make inter-temporal trade-offs of consumption. A simplistic view of the world, which is at the heart of standard economic models, holds that individuals perfectly grasp utility in the present and in the future.

However, this would require that individuals can readily imagine the future and hence the utility derived from future payments. Yet, evidence from psychology, neuroscience, and economics suggest that future rewards are harder to conceptualize and imagine than immediate ones, as one has to focus on goal-relevant information and integrate abstract information (e.g., Carpenter, Just, & Shell, 1990; Gottfredson, 1997).

Such deliberation involves working memory. In this vein, some studies have tested the role of working memory (WM) in delay discounting tasks, where subjects have to hold in memory several pieces of information and have to try to imagine scenarios that will realize in the future. In particular, "under conditions of high WM load, an immediately available reward might be overvalued because it is too difficult or time consuming to properly weight the value of a larger reward over an extended period of time" (Hinson et al., 2003: p. 299). In a series of experiments, Hinson et al., (2003) have shown that under higher WM load conditions, participants tend to prefer more impulsive or temporally myopic courses of action. If thinking about the future likely requires more WM, this might be one reason for the observed correlation between patience and intelligence, since intelligence and WM are highly correlated (Conway et al., 2003; Ackerman et al., 2005). While Benjamin et al. (2013) find no clear cut evidence of cognitive load on impatience, they document that participants in their experiments make more patient choices when asked to reflect on their choices and report their reasoning, which arguably induces deeper thinking. Their evidence therefore suggests that even if working memory does not cause patient behavior, deliberation does.

Similarly, a two-systems model (Kahneman, 2011) would predict that the emotional system (system 1) favors immediate rewards while the conscious system (system 2) contributes to inhibiting those impulses and is required to assess more complex trade-offs such as future streams of rewards. While system 1 is automatic, effortless, and unconscious, system 2 requires more cognitive resources to be activated. Corroborating evidence for this theory is provided by McClure et al. (2004) who show that stronger activation in cognitive systems relative to emotional systems predicts being more patient.

If individuals find it hard to imagine the future, they may find it too costly – either in terms of WM or system 2 – to think about future states.[2] Avoiding such costs associated with cognitive effort, they would not put weight on future states when facing inter-temporal trade-offs and as a result behave impatiently. Following Westbrook and Braver (2015), we define *the cost of cognitive effort* as the opportunity cost of allocating scarce cognitive resources – such as working memory – to a given task. By adopting a simple cost-benefit framework, one can hypothesize that an individual with high cognitive effort costs will choose an immediate reward, as the cost of processing future gains is too large compared to the benefits.[3] Hinging on the observation that individuals with higher cognitive ability have more WM and thus exert less cognitive effort to complete a cognitively demanding task, we conjecture that the correlation between patience and cognition partly works through the channel of cognitive effort.

However, if individuals with low cognitive abilities could be induced to exert higher cognitive effort, they are expected to consider future states more seriously, which we expect to result in more patient behavior. One simple way to induce higher cognitive effort is to increase the size of the rewards. When

[2]Notice that costs could be associated with cognitive costs but also with one's willingness to perform a task diligently. We are agnostic about the nature of those costs, and both could explain our results.

[3]In line with this approach, Garbarino and Edell (1997) find that effort adversely affects choice of the more difficult to process alternatives.

the incentives at stake are large, even individuals with very high opportunity costs of cognitive effort might find it worthwhile to allocate more resources to think about future states. Likewise, patient behavior could be induced if costs of cognitive effort are lowered, e.g. by helping individuals to imagine the future.[4] We therefore hold that cognitive effort affects patient behavior.

In our study, we shed some light on this conjecture by considering the relationship between various measures of patience and cognitive abilities. These measures of patience are tasks in which individuals make choices about the timing of payments or, more generally, gratification. The choices that we consider differ by the timing of payments and by monetary incentives. In particular, our experimental measures of patience involve payments that, with some probability, are actually received by respondents, while our survey measures of patience involve hypothetical payments only. We hypothesize that the correlation between patience and cognitive abilities is stronger the lower are incentives to exert cognitive effort. Specifically, when large monetary amounts are at stake, individuals are willing to exert higher levels of costly cognitive effort, which is needed to think about the future. Therefore, even low-ability participants who would have to incur high costs of cognitive effort to imagine utility in future states, might find it worthwhile to pay more attention to delayed payments, weigh the future more, and hence make more patient choices. As a result, the correlation between patient behavior and cognitive ability is expected to weaken as incentives rise and cognitive effort of low-ability types increases.

Hypothesis 1: When incentives are absent or low, we expect a significant (positive) association between cognition and impatience.
Hypothesis 2: When large monetary incentives are at stake, we expect a weaker association between cognition and impatience as even low-ability types have proper incentives to exert more cognitive effort to imagine utility in future states.

Our framework has another important implication: the link between patient behavior and cognitive ability should be is weaker when individuals have to choose between two payments at different future dates. In this case, imagining utility in both future states is similarly costly, and hence there is less of a reason to put more weight on the earlier payment. As a result, low ability types might not be more inclined to opt for the earlier payment than high ability types, even if both of them spend little cognitive effort on the task. Being able to compare both types of scenarios (now-later vs. later-later) is key to test our general framework and we are not aware of any previous paper focusing on these

[4]For example, sellers of private pension savings plans often visualize the consumption gap that potential buyers would experience at later age without pension savings.

aspects. Understanding if the timing of decisions produces different results in low stakes decisions can have important implications for the choice architecture of such problems.

Hypothesis 3: When both payments are in the future, we expect a weaker association between cognition and impatience as the two future prospects are equally costly to imagine.

3 Data and methods

The data that we analyze in this article was collected as part of a larger project aimed at investigating the link between preferences and labor market outcomes in Tbilisi, Georgia. Here we focus on a subsample of the participants who took part in both an experiment on time preferences and an individual survey.[5] In this section we first describe the experimental and survey measures of patience and then move to the proxies for cognitive abilities. We conclude with a description of the recruitment process, the subject pool and the experimental procedures.

Patience measures. To measure time preferences, participants were asked to make a series of decisions involving a trade-off between a smaller amount paid on an earlier date and a larger amount paid on a later date. For both experimental and survey measures, we collected decisions about two types of trade-off: (i) one involving decisions between an immediate and a later amount; and (ii) one involving decisions between two later dates. While in the experiments decisions entailed actual monetary consequences, we used hypothetical earnings in the survey.

Trade-off between immediate and delayed outcomes. In the experiment, we used a Multiple Price List (MPL) format to elicit a measure of patience. Subjects made a series of 20 choices between an earlier and a later payoff (Table 1). The earlier payoff (Option A) was fixed at 100 Georgian Lari (GEL) and would be paid with a check which could be cashed the coming Monday.[6] The delayed outcome (Option B) started at 100 GEL and increased in steps of 5 GEL and would be paid out in 8 weeks, again by a check. By introducing a front-end delay and choosing the same payment mode, we keep transaction costs and trust about payments constant for the early and the delayed payoff. We chose the coming Monday as the date for the early payment because the sessions took place during weekends, so that the coming Monday was the earliest date at which participants could cash their

[5]The experiment on time preferences was followed by other tasks on trust and risk taking. Instructions are available upon request.

[6]The Georgian Lari (GEL) is the local currency in Georgia; in the period when the survey and the experiments took place (November 2015 to May 2016) the GEL/USD rate vacillated between a maximum of 2.49 and a minimum of 2.19.

check. The switching point from Option A to Option B is our proxy for patience, with earlier switches being associated with higher levels of patience.[7] These choices were incentivized in the following way: At the end of the experiment one of five subjects was selected at random for payment. If a participant was selected for payment, one of the choices made in the experiment was selected randomly, and subjects were paid according to their choice in this decision. Subjects were informed about these procedures before the experiment started. It is worth stressing that the financial incentives were sizable; in fact, the median adjusted monthly household income for the city of Tbilisi at the time of the experiment was 330 GEL (earnings in our experiment ranged between 100 and 195 GEL).

Table 1: MPL 2: Immediate vs. delayed outcomes

Decision No.	**Option A** [Monday]		**Option B** [8 weeks]	Switch to Option B	Patience proxy
1	100	or	100	1	*21*
2	100	or	105	2	*20*
3	100	or	110	3	*19*
	...		...	...	...
19	100	or	190	19	*3*
20	100	or	195	20	*2*
–	–	–	–	never	*1*

In the survey, we used a quantitative measure developed in Falk et al. (2016) and Falk et al. (2018) that consists of a series of five interdependent hypothetical binary choices between immediate and delayed financial rewards, a format commonly referred to as "staircase" (or "unfolding brackets") procedure (Cornsweet, 1962). In each of the five questions, participants had to decide between receiving a payment today or larger payments in 12 months. Enumerators asked:

> *Suppose you were given the choice between receiving a payment today or a payment in 12 months. We will now present to you five situations. The payment today is the same in each of these situations. The payment in 12 months is different in every situation. For each of these situations we would like to know which one you would choose. Please assume there is no inflation, i.e., future prices are the same as today's prices. Please consider the following: Would you rather receive amount x today or y in 12 months?*

The immediate payment x was set at 100 GEL and remained constant in all subsequent four questions, but the delayed payment y varied. It was set at 154 GEL in the first question and then was increased or decreased depending on previous choices (see Figure A1 in the Appendix for an exposition of the entire sequence of binary decisions). The staircase measure builds on the same basic idea as the

[7] We observe only 13 participants switching more than once from Option A to Option B. For these subjects, we consider the first switch.

Multiple Price List, but it allows to economize on the number of questions asked to the participants. By adjusting the delayed payment according to previous choices, the questions "zoom in" around the respondent's point of indifference between the smaller immediate and the larger delayed payment. The sequence of questions has 32 possible ordered outcomes, such that we can derive a measure of patience ranging from 1 to 32 – where 1 indicates the lowest level of patience and 32 the highest level.

Trade-off between two delayed outcomes. Both the experiment and the survey comprised a series of decisions involving two amounts paid in the future, hence offsetting any immediacy effect. Decisions and procedures were identical to the one presented before, but the time horizon of Option A and B varied. In the experiment, the payment of both options was shifted by 8 weeks (MPL 2 in Table 2). In the survey, the two options involved a trade-off between a hypothetical amount in 12 and one in 24 months.

Table 2: MPL2 : two delayed outcomes

Decision No.	**Option A** [8 weeks]		**Option B** [16 weeks]	Switch to Option B	Patience proxy
1	100	or	100	1	*21*
2	100	or	105	2	*20*
3	100	or	110	3	*19*
	...		...	...	...
19	100	or	190	19	*3*
20	100	or	195	20	*2*
–	–	–	–	never	*1*

Cognitive measures. During the individual survey, we administered two different standardized cognitive tests: (i) numeracy test; and (ii) cognitive reflection test (CRT). These two measures are combined to obtain an objective assessment of cognitive abilities. In addition, we asked participants to self-assess their math ability, and enumerators to evaluate the sharpness and understanding level of the respondents. The latter measures are used to construct a subjective proxy for cognitive ability.

Numeracy Test. We used a 6-item questionnaires taken from the English Longitudinal Study of Aging (ELSA) questionnaire and aimed at testing the numeracy proficiency of adults (see the Appendix for a complete list of questions). Unlike in the ELSA questionnaire, subjects had to reply to all items, regardless of the accuracy of their earlier answers.

Cognitive Reflection Test (CRT). The second test was aimed at capturing the ability to suppress an intuitive wrong answer in favour of a reflective and deliberative right answer (Frederick, 2005). For instance, one of the three items was: "A bat and a ball cost GEL 1.10 in total. The bat costs GEL 1.00 more than the ball. How much does the ball cost?" The intuitive answer in this case is GEL 0.10

while the correct one is GEL 0.05.

Self-reported math ability. Subjects were asked to self-assess how well the following statement describes them as a person: *I am good at math.* We used a scale from 0 (does not describe me at all) to 10 (describes me perfectly).

Enumerators' evaluation. In private and at the end of the individual survey, each enumerator had to rate the understanding (on a scale from 1 to 3) and sharpness (on a scale from 1 to 4) of the respondent.

Figure 1: Experimental location

Subject pool, recruitment, and procedures. In total, 486 subjects drawn from the adult population in Tbilisi took part in the study on the informal labour market. Potential participants had to live in the capital, being able to read and speak Georgian, and being 18 years or older. Subjects in the study were recruited from two different samples of the general population in Tbilisi. The first sample comprises respondents of a previous survey who had been recruited via the random walk method in 2013. A total of 787 invitations were sent for the first wave for a total of 269 participants in the study. The second sample consists of subjects directly recruited by the Georgian team of enumerators. In this latter group we registered a lower no-response rate with 217 participants who showed up out of 409 invitations. Participants from the second wave were significantly more wealthy and less likely to be non-employed than their peers from the first wave. Other demographic characteristics were instead fairly in line across the two waves (gender, marital status, children, etc).

Participants were recruited in a step-wise procedure. First, they were approached by enumerators that conducted a pre-survey in which they asked respondents - among other things - about their

Table 3: Description of the subject pool

Variable	mean	sd	median	min	max
Age (in years)	44.39	16.49	44	18	85
Female	0.69			0	1
HH adjusted income (GEL)	764	951	459	0	5760
Education level					
secondary	0.37			0	1
tertiary	0.63			0	1
Employment status					
unemployed	0.36			0	1
employee	0.46	0		0	1
Cognitive (objective)					
numeracy score	3.88	1.44	4	0	6
CRT score	0.47	0.76	0	0	3
Cognitive (subjective)					
math ability (self-reported)	6.21	2.93	7	0	10
understanding	2.85	0.40	3	1	3
sharpness	3.17	0.59	3	1	4

monthly disposable household income and the number of (adult) family members. Second, respondents were invited to take part in the study. If they agreed, they were asked if they intended to participate in both the survey and the experiment or just in the survey and were then told that they would be contacted again via phone to be invited for a specific date. We always invited all family members willing to take part in the study on the same date in order to reduce transportation costs. Third, all participants who showed up at the specified date at the study location completed a survey in a personal interview. This survey lasted between 30 and 90 minutes.[8] A subset of subjects took part in an incentivized additional experiment (including the two MPLs) before taking the individual survey. In case multiple members of the same family showed up and declared to be willing to participate in the survey and the experiment, only one randomly chosen person in the family was allowed to take part in the experiment. In case multiple members of the same family showed up, only one person was allowed to take part in the experiment. In this paper, we rely on data of the 107 participants for whom we elicited measures of patience in the experiment and in the survey and for whom we have the survey data on cognitive abilities.

Table 3 reports summary statistics for our subject pool (N=107). Our sample is diverse under many respects. The age of our participants vary between 18 and 85 years, with an average age of 44. Our participants greatly vary with respect with their wealth; the mean household adjusted income is 764 GEL and the distribution is very dispersed (standard deviation of 951). The median income is

[8]One member of each household was also asked to take part in a household survey. The data from that survey are not discussed here.

459 GEL, slightly higher than the 330 GEL median for the Tbilisi city. Despite the heterogeneity with respect to age and income, our subject pool is highly educated with 37% of the participants owning a secondary degree and 63% a tertiary degree.[9] A large fraction of our sample (36%) is unemployed while about half of the participants report to work as employees. The bottom part of the table reports summary statistics for our measures of cognition. Once more, we observe quite some variability in our sample, as one would expect from a subject pool drawn from the general population and not a specific convenience sample.

The study took place at the University of Georgia and at the International School of Economics in Tbilisi between November 2015 and May 2016.[10] Upon arrival, participants were registered and those who were assigned to take part in the experiment were escorted to the experimental room. Subjects drew a number and were seated at the corresponding desk (Figure 1). No form of communication among participants was allowed. The experiment was conducted by paper and pencil. Written instructions were distributed and control questions were asked to ensure understanding for some parts of the study. The average experimental session lasted about 60 minutes. To avoid any spill-over effect, feedback was only provided at the end of the session. The experiment was followed by the individual survey administered by trained enumerators who read the questions and recorded the answers of the participants. To limit peer pressure, participants received a printed paper copy of both the CRT and the numeracy tests and were given some time to privately answer to these questions. At the end of the individual survey, participants were paid in private and via checks by one financial officer not involved in the study.

4 Results

We will first test if hypothetical choices between (rather) immediate payments and delayed payments (I-D) induce a stronger observed relationship between cognitive ability and patient behavior (Hypothesis 1) than incentivized choices (Hypothesis 2). We relate two measures of patience to objective and subjective measures of cognition. The measures of patience are:

- *Incentivized I-D:* standardized value for patience as measured in the experimental MPL 1 where one option was paid at the earliest date possible (Immediate) and one was paid in 8 weeks (Delayed);

[9] This should not be surprising, as Georgia is a former Soviet country and education was mandatory.

[10] The study was entirely conducted in Georgian by local coordinators and enumerators. In addition, two authors of the paper were present to all the sessions to ensure all the procedures were followed.

- *Hypothetical I-D:* standardized value for patience as measured in the Staircase Method with hypothetical values (immediate vs. 12 months delay)

The measures for cognitive ability are:

- *Cognition Objective:* to reduce measurement error we construct a composite index by taking the average of the standardized score in the Numeracy Test and the Cognitive Reflection Test;

- *Cognition Subjective:* we construct a composite index by taking the average of the standardized score in the self-reported math ability question and the mean standardized score of the two measures reported by the enumerator.

Table 4 reports results from linear regressions where the dependent variable is the hypothetical (Models 1 and 2) or the incentivized (Models 3 and 4) inter-temporal trade-off between a smaller immediate and a larger delayed monetary payment. In Model 1, the main regressor of interest is a standardized score of cognitive abilities (objective); in Model 2, we consider a score of cognitive abilities based on subjective measures. In both models, we find that survey measures of patience are positively and significantly correlated with cognitive abilities, even when restricting our sample to the 107 subjects who took part in the experiment as well the survey (Hypothesis 1). This result confirms findings in the psychology literature and economics literature referenced above in section 1. Models 3 and 4 replicate the same analysis for the same subject, but now using the incentivized measure of patience. In line with our Hypothesis 2, we find a weaker association between cognition and patience. In fact, in our sample the relationship between delay discounting and our measures of patience is not statistically significant. To better understand if high or low cognition types are the ones who changed their behavior, we split the sample according to a median split and tested their choices.[11] When moving from the incentivized to the hypothetical scenario, we find that both high and low cognition types make less patient choices. However, the difference is much more pronounced for the low type hence suggesting that the effect of incentives is more important for this group – as suggested by or framework. While the measures in the incentivized and hypothetical task are not directly comparable, it is important to remark that the difference between the two is comparable across the two types – high and low cognition.[12]

[11] The median split is based on a compound index obtained combining objective and subjective cognition.

[12] It is unlikely that deep time preference parameters of individuals changed over the course of our study that lasted only a few hours. It is useful to bear in mind that we cannot directly observe a preference parameter but can only observe choices that reveal the preference. We conjecture that patient behavior is not only driven by a pure time preference parameter that captures how an individual would trade-off consumption at two different points in time if the person were to know for sure the levels of utility that are associated with these choices, but that it is also determined by the capacity to imagine the future and adequately grasp the consumption utility in future states. How well the future can be imagined is likely related to cognitive ability and the time and effort one is willing to spent to put oneself in a future situation. It is plausible to assume that the present is less difficult to grasp, while the future is more abstract and the benefits from future payments are more difficult to envisage than immediate payments.

Table 4: Immediate vs. delayed

	Hypothetical Choice Immediate-Delayed		Incentivized Choice Immediate-Delayed	
	Model 1	Model 2	Model 3	Model 4
Cognition (objective)	0.238**		-0.160	
	(0.113)		(0.107)	
Cognition (subjective)		0.347**		0.074
		(0.147)		(0.141)
Age (in years)	-0.006	-0.006	-0.006	-0.005
	(0.006)	(0.006)	(0.006)	(0.006)
1 if female	0.053	0.077	0.005	0.013
	(0.219)	(0.219)	(0.207)	(0.210)
Constant	0.354	0.318	0.279	0.213
	(0.338)	(0.338)	(0.320)	(0.324)
N.obs.	107	107	107	107
R squared	0.054	0.064	0.028	0.009

Notes: OLS regressions. Symbols $***$, $**$, and $*$ indicate significance at the 1%, 5% and 10% level, respectively.

We next turn to our Hypothesis 3 suggesting a weaker association between cognitive ability and impatient behavior when both prospects are in the future. If cognitive effort mediates the relationship between patient behavior and cognitive ability through the process discussed in the previous paragraph, we hypothesize that this relationship weakens when the sooner reward is shifted into the future; for it is plausible to assume that the difference in cognitive effort required to imagine the utility of payments at two different dates that are sufficiently small compared to the difference in cognitive effort required to evaluate an immediate vs. future situation. As a result, we expect less present bias in the absence of cognitive effort when early and late payments are delayed, and therefore a weaker association between cognitive ability and patient behavior. We test this hypothesis by comparing the relationship between cognitive ability and two measures of hypothetical choices that differ with respect to the timing of rewards. Specifically, we consider:

- *Hypothetical I-D:* standardized value for patience as measured in the Staircase Method with hypothetical values (immediate vs. 12 months delay);
- *Hypothetical D-D:* standardized value for patience as measured in the Staircase Method with hypothetical values (12 vs. 24 months delay);

We restrict our sample to participants for whom we have data for all the above measures and for the control variables used in the regressions. We run a new series of linear regressions where the dependent variable is the hypothetical choice between the two delayed payment options and report these in columns 1 and 2 of (Table 5). For comparison purposes, we report in columns 3 and 4 of

Table 5: Varying the timing: Delay-Delay vs. Immediate-Delay

	Hypothetical Delayed-Delayed		Hypothetical Immediate-Delayed	
	Model 1	Model 2	Model 3	Model 4
Cognition (objective)	0.155		0.238**	
	(0.104)		(0.113)	
Cognition (subjective)		0.249*		0.347**
		(0.134)		(0.147)
Age (in years)	-0.024***	-0.024***	-0.006	-0.006
	(0.006)	(0.006)	(0.006)	(0.006)
1 if female	-0.241	-0.224	0.053	0.077
	(0.201)	(0.200)	(0.219)	(0.219)
Constant	1.338***	1.307***	0.354	0.318
	(0.310)	(0.309)	(0.338)	(0.338)
N.obs.	107	107	107	107
R squared	0.184	0.193	0.054	0.064

Notes: OLS regressions. Symbols $***$, $**$, and $*$ indicate significance at the 1%, 5% and 10% level, respectively. Dummy variables are indicated by the letter *d*.

that table again the coefficient estimates of columns 1 and 2 of Table 4. It is immediate to see that the coefficients for cognitive abilities are much smaller and less significant in columns 1 and 2 than in columns 3 and 4. This finding corroborates our hypothesis.[13]

It is also worth mentioning that the estimated effect of cognition on patient behavior also weakens when we move from an incentivized choice between an immediate vs. delayed payment (as in columns 3 and 4 of Table 4 to an incentivized choice between to delayed payments. In sum, our findings support our hypotheses that incentives and payment delay moderate the relationship between cognition and patience. These findings are in line with the conjecture that cognitive effort mediates the correlation between cognitive ability and delay discounting.

5 Discussion and conclusion

Previous studies in economics and psychology have reported a link between cognitive abilities and patience, with low-ability subjects being less patient. Here we study whether the introduction of sizable financial incentives can affect this link through the channel of cognitive effort. If imagining the future is especially demanding for low-ability types they would need proper incentives to exert enough cognitive effort to take future states seriously. In line with this reasoning, we do replicate the usual positive association between cognition and impatience in a non-incentivized survey, but find no

[13] We re-run the same specifications for Tables 4 and 5 by including either the CRT or the numeracy test as main variables of interest. Results for both proxies of objective cognition go in the same direction, but we do find a stronger effect for the CRT.

statistically significant correlation when financial incentives are introduced.

To further corroborate this reasoning, we looked into decisions which involved two delayed outcomes. Here there is less of an unbalance in the cognitive effort required to imagine the value of payments in two future states as long as thinking about some money in a few minutes is generally much easier than thinking about future payments. As a result, low-ability types, who have face high cognitive effort costs, are not naturally drawn towards the earlier payment. A similar argument was also discussed in Benjamin et al. (2013) in a two-system framework, which would also predicts that cognitive abilities are more relevant for short-term impatience rather than impatience when both rewards are delayed. Our data provide support to this framework as we do find that the association between cognitive abilities and patience is attenuated when both outcomes are delayed.

We acknowledge a few methodological limitations. First, we do not have a proxy for cognitive effort and we do not manipulate effort itself. Measuring decision time or using some tracking device (e.g., eye tracking machines) could help gaining a better understanding into the decision process. One could also vary exogenously the cognitive resources available to the participants. Second, the sample size of our study is admittedly modest and a larger sample could help shedding further light on the robustness of the results. Finally, due to logistic constraints, the time horizon used in the experiment is shorter compared to the one used in the survey. The limited sample size and the logistic constraints did not allow to control for order effect – neither for the sequence experiment-survey nor for the time horizon. Nevertheless, it is important to stress that this lack of control does not affect results related to Hypothesis 3.

While more evidence is needed, we believe it is extremely important – also for policy reasons – to better understand the role of cognitive effort in shaping the relationship between cognition and patience. Our data seems to suggest that impatience might be an issue especially when immediate gains are present and financial incentives are too small to carefully think at the problem. While this might imply that low-ability types do not suffer from an extensive present-bias when making important decisions with large stakes, it is also true that many important outcomes in life are the sum of several independent decisions that accumulate over time. Education is a good case in point; there are for sure some crucial choices to make – years of schooling and track – but there are also many daily trade-offs between studying hard for the test next day or slacking off and enjoying the afternoon. Similarly, individual actions to reduce global warming often involve small stakes which pile up – e.g., reducing the consumption of water or electricity is the results of many daily actions that might appear insignificant and not worth the effort.

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Appendix

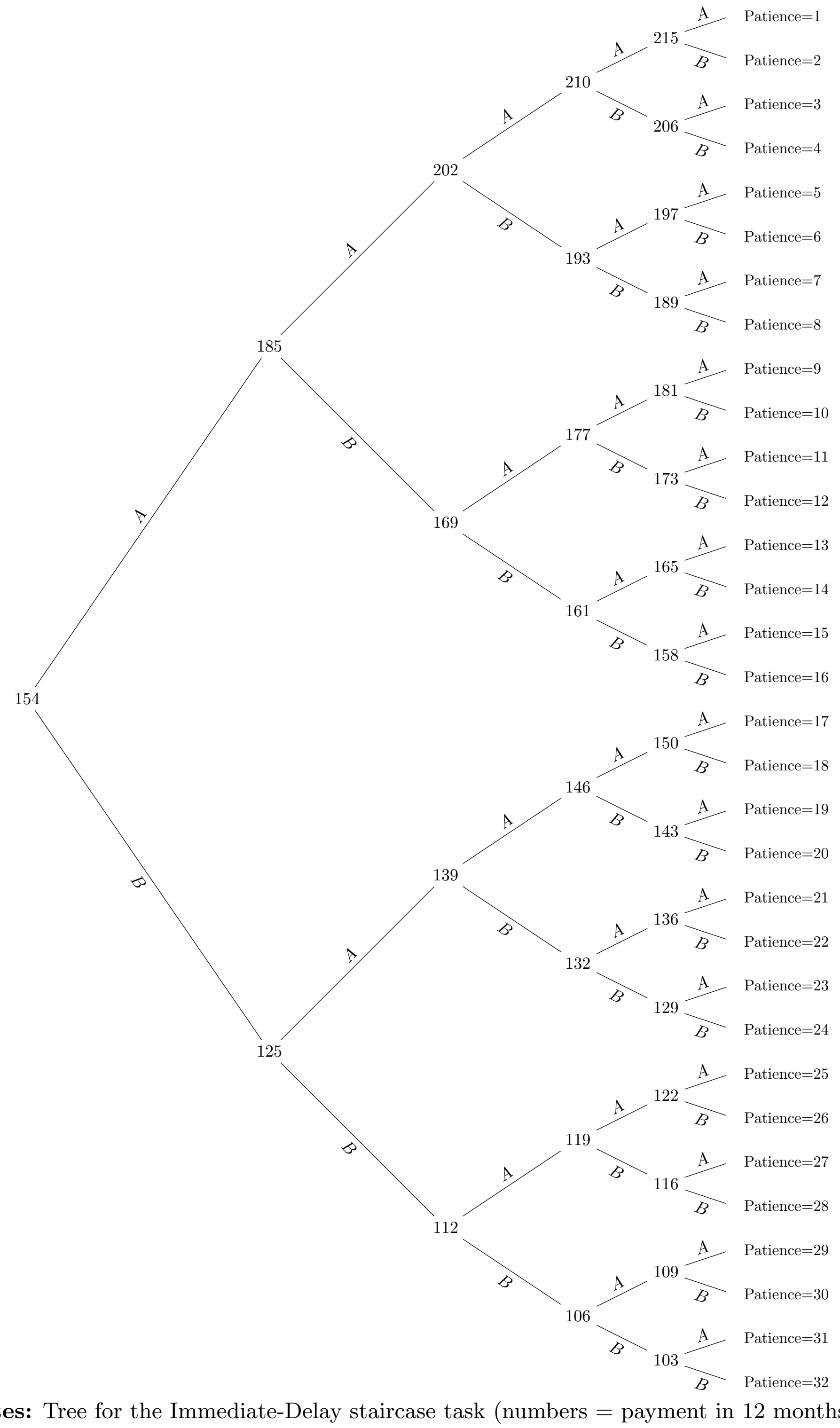
The Numeracy Test administered in the individual survey included the following six questions:

1. If you buy a drink for 85 Tetri and pay with a one Lari coin, how much change should you get?
2. In a sale, a shop is selling all items at half price. Before the sale a sofa costs GEL 300. How much will it cost in the sale?
3. If the chance of getting a disease is 10 per cent, how many people out of 1,000 would be expect to get the disease?
4. A second hand car dealer is selling a car for GEL 6,000. This is two-thirds of what it cost new. How much did the car cost new?
5. If 5 people all have the winning numbers in the lottery and the prize is GEL 2 million, how much will each of them get?
6. Let's say you have GEL 200 in a savings account. The account earns ten per cent interest per year. How much will you have in the account at the end of two years?

The Cognitive Reflection Test administered in the individual survey included three questions adapted from Frederick (2005)

1. A bat and a ball cost GEL 1.10 in total. The bat costs GEL 1.00 more than the ball. How much does the ball cost?
2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?
3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

Figure A1: Hypothetical Choices: Staircase Method



Notes: Tree for the Immediate-Delay staircase task (numbers = payment in 12 months). A = choice of "100 GEL today", B = choice of "x euros in 12 months". The staircase procedure worked as follows. First, each respondent was asked whether they would prefer to receive 100 GEL today or 154 GEL in 12 months from now (leftmost decision node). In case the respondent opted for the payment today ("A"), in the second question the payment in 12 months was adjusted upwards to 185 GEL. If, on the other hand, the respondent chose the payment in 12 months, the corresponding payment was adjusted downward to 125 GEL. The last column indicates the coding of patience based on the participant's decisions. The tree for Delay-Delay follows the same procedure with A = choice of "100 GEL in 12 months", B = choice of "x euros in 24 months".