

# Patience, Cognitive Abilities, and Cognitive Effort

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# Patience, Cognitive Abilities, and Cognitive Effort: Survey and Experimental Evidence From a Developing Country

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Stefania Bortolotti<sup>1,4</sup>, Thomas Dohmen<sup>2,3,4</sup>,  
Hartmut Lehmann<sup>1,4,5</sup>, Frauke Meyer<sup>6</sup>,  
Norberto Pignatti<sup>4,7</sup>, and Karine Torosyan<sup>7</sup>

## Abstract

This study sheds light on the relationship between cognition and patience by documenting that the correlation between cognitive abilities and delay discounting is weaker for the same group of individuals if choices are incentivized. This study conjectures that higher cognitive effort, which induces higher involvement of the cognitive system, moderates the relationship between patience and cognition. For 107 participants drawn from the adult population in Tbilisi, this study examines the relationship between various measures of cognitive ability and that of patience. Specifically, we consider the relationship between the Cognitive Reflection Test, a numeracy test, self-reported math ability measure, enumerators' assessments, and incentivized and hypothetical trade-offs between smaller-sooner and larger-later payments.

## Keywords

behavioral economics, cognition, patience, experimental evidence, developing country

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<sup>1</sup>University of Bologna, Bologna, Italy

<sup>2</sup>University of Bonn, Bonn, Germany

<sup>3</sup>Maastricht University, Maastricht, Netherlands

<sup>4</sup>IZA Institute of Labor Economics, Bonn, Germany

<sup>5</sup>National Research University Higher School of Economics, Russian Federation

<sup>6</sup>Forschungszentrum Jülich GmbH, Institute of Energy and Climate Research – Systems Analysis and Technology Evaluation (IEK-STE), Jülich, Germany

<sup>7</sup>Tbilisi State University, Tbilisi, Georgia

## Corresponding Author:

Thomas Dohmen, University of Bonn, Adenauerallee 24-42, Bonn 53113, Germany.

Email: tdohmen@uni-bonn.de

## Introduction

Decisions involving trade-offs between immediate gratification and delayed benefits are important for life outcomes. Patience drives success in life. People with more patience accumulate more skills, enjoy higher incomes, and greater health (Borghans & Golsteyn, 2006; Golsteyn et al., 2014; Sutter et al., 2013), and GDP is higher in countries with more patient populations (Dohmen et al., 2017; Falk et al., 2018). Several studies in psychology and economics indicate a relationship between cognition and delay discounting. Evidence from the studies of psychology on the relationship between intelligence and the ability to delay gratification has focused on children and typically used hypothetical measures of delay discounting (see Shamosh & Gray, 2008, for a metastudy). Funder and Block (1989), Shoda et al. (1990), Kirby et al. (2005), and Parker and Fischhoff (2005) suggested that individuals with higher cognitive ability make choices more patiently. Experimental studies in economics have used student samples (e.g., Benjamin et al., 2013; Frederick, 2005) and representative samples of the adult population (e.g., Dohmen et al., 2010) to examine incentivized choices between smaller-sooner monetary rewards and larger-later payments to reveal a positive correlation between measures of cognitive ability and patient behavior in these intertemporal trade-offs.

Several studies have proposed mechanisms that reveal the link between cognitive ability and patience, including self-control (e.g., Kirby et al., 2005; Shoda et al., 1990), working memory (WM; e.g., Benjamin et al., 2013; Hinson et al., 2003), or competing separate neural systems in the brain (Benhabib & Bisin, 2005; Bernheim & Rangel, 2004; Fudenberg & Levine, 2006). These mechanisms all indicate that the involvement of the cognitive system affects the relationship between patience and cognitive ability, because either the cognitive system helps encode and value future rewards or it suppresses more spontaneous and emotional responses (e.g., the urge for immediate gratifications).

This study hypothesizes that a higher cognitive effort, which induces higher involvement of the cognitive system, moderates the relationship between patience and cognition. The study findings indicate a role for *cognitive effort* to affect this relationship. It further shows that, for the same group of individuals, the correlation between cognitive abilities and patience is weaker if actual monetary rewards are involved, that is, choices are incentivized.<sup>1</sup> A simple cost–benefit model suggests that when the stakes are large enough, even individuals with a low ability make sufficient cognitive effort to imagine utility in the future state and suppress their emotions that desire immediate gratification and, consequently, make a more deliberate and patient choice. To corroborate the findings, this study extends the analysis to include trade-offs between two delayed hypothetical rewards where deliberation and cognition are always required. Being able to compare 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 confirmation whether 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, a weaker or no association between cognition and patience is found.

This study is presented as follows. Section 2 outlines the conceptual framework and derives a set of testable hypotheses. Section 3 describes the methodology and subject pool. Section 4 reports the results on the link between cognition, cognitive effort, and patience. Section 5 discusses the potential applications of the findings and limitations of this study.

## **Hypotheses**

Patient behavior is reflected by individuals' trade-off between early and delayed consumption. Individuals having more patience are eager to forego present gratification for higher levels of gratification at a specific future date. In economics, time preferences describe how people make intertemporal trade-offs of consumption. A simplifying assumption, which is at the core of standard economic models, holds that individuals perfectly grasp utility in the present and future.

However, this assumption presupposes that individuals are readily able to imagine the future and to value their utility in future states. Yet evidence from psychology, neuroscience, and economics suggests that future rewards are harder to conceptualize and imagine than immediate ones (e.g., Carpenter et al., 1990; Gottfredson, 1997).

Such debate involves WM. Accordingly, some studies have tested the role of WM in delay discounting tasks, where participants should remember several pieces of information and try to imagine future scenarios. Particularly, "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) showed that under higher WM load conditions, participants prefer more impulsive or temporally myopic courses of action. If thinking about the future requires more WM, this results in the observed correlation between patience and intelligence, given that intelligence and WM are highly correlated (Conway et al., 2003; Ackerman et al., 2005). While Benjamin et al. (2013) found no clear-cut evidence of cognitive load on impatience, they documented in their experiments that participants make more patient choices when asked to reflect on their choices and report their reasoning, which arguably induce deeper thinking. Their evidence therefore suggests that even if WM does not cause patient behavior, deliberation does.

Similarly, a two-systems model (Kahneman, 2011) predicts that the emotional system (System 1) favors immediate rewards, while the conscious system (System 2) inhibits 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 additional cognitive resources to be activated. McClure et al. (2004) supported this theory and showed that stronger activation in cognitive systems relative to emotional systems predicts being more patient.

If individuals struggle to imagine the future, they may find it too costly—in terms of either WM or System 2—to think about future states.<sup>2</sup> To avoid such costs associated with cognitive effort, they would not stress on future states when facing intertemporal trade-offs and, thus, behave impatiently. Following Westbrook and Braver (2015), this study defines *the cost of cognitive effort* as the opportunity cost of allocating scarce cognitive resources, such as WM, to a given task. By adopting a simple cost–benefit framework, it can be hypothesized that an individual with high cognitive effort costs will choose an immediate reward because the cost of processing future gains is larger than the benefits.<sup>3</sup> Depending on the observation that individuals with higher cognitive ability have more WM and thus make less cognitive effort to complete a cognitively demanding task, this study conjectures that the correlation between patience and cognition partly works through the channel of cognitive effort.

However, if individuals with low cognitive abilities are motivated to make higher cognitive effort, they are expected to consider future states more seriously, which in turn may result in more patient behavior. Increase in the size of the rewards can induce higher cognitive effort. Apascaritei et al. (this issue), for example, show that material incentives offered to children in the form of toys, boost cognitive effort. When the incentives are large, even individuals with very high opportunity costs of cognitive effort would allocate more resources to think about future states. Similarly, reduced costs of cognitive effort can induce patient behavior, for example, by helping individuals imagine the future.<sup>4</sup> Therefore, this study holds that cognitive effort affects patient behavior.

This study tests this conjecture by considering the relationship between various measures of patience, that is intertemporal choices, and cognitive abilities. The intertemporal choices considered in this study differ by the timing of payments and monetary incentives. Particularly, our experimental measures of patience involve payments that, with some probability, are actually received by respondents, while our survey measures of patience include hypothetical payments only. We hypothesize that the correlation between patience and cognitive abilities is stronger the lower incentives to exert cognitive effort are. Specifically, when large monetary amounts are involved, individuals are willing to exert higher levels of costly cognitive effort, which is required to think about the future. Therefore, even participants with low ability, who would have to incur high costs of cognitive effort to imagine utility in future states, deliberate more on the future and the value of delayed payments, and hence make more patient choices. Consequently, 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.

The study framework has another important implication: the link between patient behavior and cognitive ability is weaker when individuals must choose between two payments at different future dates. Here, imagining utility in both future states is similarly costly, and hence there is less incentive to focus on the early payment. Consequently, individuals with a low ability are not more inclined to opt for earlier payment than those with high ability, even if both of them make little cognitive effort on the task. A comparison of both types of scenarios (now-later vs. later-later) helps test the general framework. No studies have focused on these aspects so far. Understanding if the timing of decisions produces different results in low-stakes decisions 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.

## Data and Methods

The study data were gathered as part of a larger project that investigated the link between preferences and labor market outcomes in Tbilisi, Georgia. This study focuses on a subsample of the participants in both an experiment on time preferences and an individual survey.<sup>5</sup> This section first describes the experimental and survey measures of patience and then the proxies for cognitive ability. It concludes with a description of the recruitment process, subject pool, and 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 at a later date. For both experimental and survey measures, we collected decisions about two types of trade-off: one involving decisions between an immediate and a later amount and the other involving decisions between two later dates. Decisions in the experiment involved actual monetary consequences; we used hypothetical earnings in the survey.

*Trade-off Between Immediate and Delayed outcomes.* This study used a Multiple Price List (MPL) format in the experiment to elicit a measure of patience. Participants 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 by a check, which could be cashed the coming Monday.<sup>6</sup> The delayed outcome (Option B) started at 100 GEL and grew in increments 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, the transaction costs and trust about payments are maintained for the early and delayed payoff. The following Monday was chosen for early payment because the sessions

**Table 1.** MPL 2: Immediate Versus 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

Note. MPL = Multiple Price List.

were conducted during weekends such that the following Monday was the earliest date at which participants could cash their 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.<sup>7</sup> These choices were incentivized as follows: At the end of the experiment, one of five participants 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 participants were paid according to their choice in this decision. Participants were informed about these procedures before commencing the experiment. The financial incentives were ample; 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).

This study used a quantitative survey question developed in Falk et al. (2016, 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, the 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 maintained in the subsequent four questions, but the delayed payment  $y$  varied. It was set at 154 GEL in the first question and then increased or decreased, depending on the 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 premise as the MPL, but allows economizing on the number of questions asked to the participants. By adjusting the

**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

Note. MPL = Multiple Price List.

delayed payment according to previous choices, the questions “zoom in” around the respondent’s point of indifference between the smaller-immediate and larger-delayed payment. The sequence of questions has 32 possible ordered outcomes, such that a measure of patience ranging from 1 to 32 can be derived, where 1 indicates the lowest level of patience and 32 the highest.

*Trade-Off Between Two Delayed Outcomes.* Both the experiment and survey comprised a series of decisions involving two amounts to be paid in the future, hence offsetting any immediacy effect. Decisions and procedures were identical to those presented earlier, but the time horizon of Options A and B varied. In the experiment, the payment of both options was shifted by 8 weeks (MPL 2 in Table 2). The two options in the survey involved a trade-off between a hypothetical amount in 12 and 1 in 24 months.

### Cognitive Measures

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

*Numeracy Test.* A six-item questionnaire taken from the English Longitudinal Study of Aging questionnaire was used. It tested adults’ numeracy proficiency (see the appendix for a complete list of questions). Unlike in the English Longitudinal Study of Aging questionnaire, participants had to respond to all items, regardless of the accuracy of their earlier answers.

*Cognitive Reflection Test.* The second test captured the ability to suppress an intuitive wrong answer in favor 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 answer is GEL 0.05.

*Self-Reported Math Ability.* Participants were asked to self-assess how well the following statement described 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 respondents' understanding (on a scale from 1 to 3) and sharpness (on a scale from 1 to 4).

### **Subject Pool, Recruitment, and Procedures**

Overall, 486 participants drawn from the adult population in Tbilisi participated in the study on the informal labor market. Those participants who lived in the capital, could read and speak Georgian, and were 18 years or older were included in the study. They were recruited from two different samples of the general population in Tbilisi. The first sample comprised respondents of a previous survey who were recruited through a random walk method in 2013. Overall, 787 invitations were sent for the first wave for 269 participants in the study. The second sample consisted of participants directly recruited by the Georgian team of enumerators. The latter group registered a lower no-response rate, with 217 responses from 409 invitations. Participants from the second wave were significantly wealthier and less likely to be unemployed than their peers from the first wave. Other demographic characteristics were consistent across the two waves (e.g., gender, marital status, and children).

Participants were recruited in the following steps. First, in a presurvey, enumerators asked the participants about their monthly disposable household income, number of (adult) family members, among others. Second, respondents were invited to participate in the study. On consent, their intention to participate in both the survey and experiment or the survey alone was noted. They would then be contacted over a phone call and invited for a specific date. All consenting family members were invited on the same date to reduce transportation costs. Third, all participants who appeared at the specified date at the study location completed a survey in a personal interview lasting between 30 and 90 minutes.<sup>8</sup> A subset of participants participated in an incentivized additional experiment (including the two MPLs) before taking the individual survey. If multiple members of the same family were willing to participate in the survey and experiment, only one randomly chosen person in the family was allowed to participate in the experiment. This study relied on the data of the 107 participants for whom measures of patience were elicited in the experiment and survey and for whom the survey data on cognitive abilities were available.

Table 3 reports the summary statistics for the subject pool ( $N = 107$ ). The study sample is diverse in many aspects. The age of our participants varied between 18 and 85 years (an average age of 44 years).

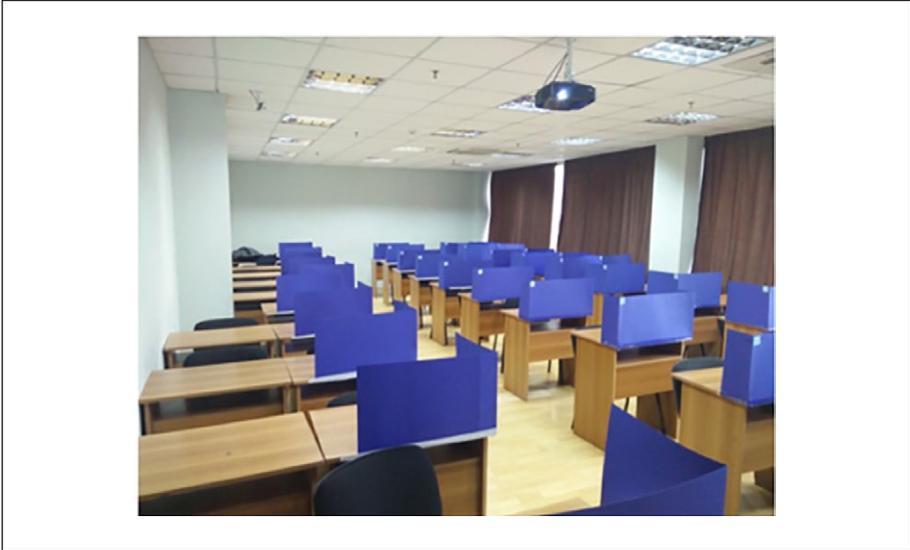
**Table 3.** Description of the Subject Pool.

Variable	<i>M</i>	<i>SD</i>	Median	Min	Max
Age (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

Note. HH = household; GEL = Georgian Lari; CRT = Cognitive Reflection Test.

Our participants vary with respect to their wealth; the mean household adjusted income is 764 GEL and the distribution highly dispersed ( $SD = 951$ ). The median income is 459 GEL, slightly higher than the 330 GEL median for Tbilisi city. Despite the heterogeneity regarding age and income, the study sample is highly educated with 37% holding a secondary degree and 63% a tertiary degree.<sup>9</sup> Approximately 50% were employed, while 36% were unemployed. Table 3 (bottom panel) reports summary statistics for the measures of cognition. Some variability was observed in our sample, as one would expect from a subject pool drawn from the general population and not a specific convenience sample.

The study was conducted at the University of Georgia and International School of Economics in Tbilisi between November 2015 and May 2016.<sup>10</sup> Participants were registered on arrival to the venue and escorted to the experimental room. Participants drew a number and seated at the corresponding desk (Figure 1). Participants were not allowed to communicate with each other during the paper-and-pencil test. Written instructions were distributed, and control questions were asked to ensure understanding for some parts of the study. The average session lasted about 60 minutes. To avoid any spillover effect, feedback was provided only at the end of the session. The experiment was followed by an individual survey administered by trained enumerators, who read the questions and recorded the responses. To limit peer pressure, participants received a printed copy of both the CRT and numeracy tests and they were allowed to answer privately. At the end of the individual survey, participants were paid in private and via checks by a financial officer not involved in the study.



**Figure 1.** Experimental location.

## Results

We first test whether hypothetical choices between (rather) immediate 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 as follows:

- 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 the other in 8 weeks (Delayed);
- 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 as follows:
  - *Cognition objective*: To reduce the measurement error, we construct a composite index by taking the average of the standardized score in the numeracy test and CRT.
  - *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 shows the results from linear regressions, where the dependent variable is the hypothetical (Models 1 and 2) or incentivized (Models 3 and 4) intertemporal

**Table 4.** Immediate Versus Delayed.

	Hypothetical choice		Incentivized choice	
	Immediate-delayed		Immediate-delayed	
	Model 1	Model 2	Model 3	Model 4
Cognition (objective)	0.238 (0.113)**		-0.160 (0.107)	
Cognition (subjective)		0.347 (0.147)**		0.074 (0.141)
Age (in years)	-0.006 (0.006)	-0.006 (0.006)	-0.006 (0.006)	-0.005 (0.006)
1 If female	0.053 (0.219)	0.077 (0.219)	0.005 (0.207)	0.013 (0.210)
Constant	0.354 (0.338)	0.328 (0.338)	0.279 (0.320)	0.213 (0.324)
Number of observations	107	107	107	107
R <sup>2</sup>	.054	.064	.028	.009

Note. Ordinary least squares regressions.

\* $p < .1$ . \*\* $p < .05$ . \*\*\* $p < .01$ .

trade-off between a smaller-immediate and 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 the models, we find that the survey measures of patience are positively and significantly correlated with cognitive abilities, even when the sample is restricted to the 107 participants who participated in both the experiment and survey (Hypothesis 1). This result confirms the findings in the psychology literature and economics literature discussed in Section 1. Models 3 and 4 replicate the analysis for the same subject, but using the incentivized measure of patience. Consistent with Hypothesis 2, a weaker association is found between cognition and patience. In fact, in the study sample, the relationship between delay discounting and our measures of patience is not statistically significant. To find whether high- or low-cognition types are those who changed their behavior, we split the sample based on a median split and tested their choices.<sup>11</sup> When moving from the incentivized to hypothetical scenario, we find that both high- and low-cognition types make less patient choices. However, the difference is significant for the low-cognition types, hence suggesting that the effect of incentives is more important for this group and confirmed by our framework. While the measures in the incentivized and hypothetical task are not directly comparable, the difference between the tasks is comparable across high- and low-cognition types.<sup>12</sup>

Consider Hypothesis 3 that suggests 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, as discussed earlier, we hypothesize that this relationship weakens when the early reward is shifted into the future; because 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 with the difference in cognitive effort required to evaluate an

**Table 5.** Varying the Timing: Delay-Delay Versus Immediate-Delay.

	Hypothetical		Hypothetical	
	Delayed-delayed		Immediate-delayed	
	Model 1	Model 2	Model 3	Model 4
Cognition (objective)	0.155 (0.104)		0.238 (0.113)**	
Cognition (subjective)		0.249 (0.134)*		0.347 (0.147)**
Age (in years)	-0.024 (0.006)***	-0.024 (0.006)***	-0.006 (0.006)	-0.006 (0.006)
1 if female	-0.241 (0.201)	-0.224 (0.200)	0.053 (0.219)	0.077 (0.219)
Constant	1.338 (0.310)***	1.307 (0.309)***	0.354 (0.338)	0.318 (0.338)
Number of observations	107	107	107	107
R <sup>2</sup>	.184	.193	.054	.064

Note. Ordinary least squares regressions.  
\*p < .1. \*\*p < .05. \*\*\*p < .01.

immediate versus a future situation. Consequently, 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. This hypothesis is tested 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 the following:

**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);

The study sample is limited to participants for whom data for all the aforementioned measures are available and for the control variables used in the regressions. A new series of linear regressions are run, where the dependent variable is the hypothetical choice between the two delayed payment options and reported in columns 1 and 2 of Table 5.

For the purpose of comparison, we report in columns 3 and 4 of that table again the coefficient estimates of columns 1 and 2 of Table 4. The coefficients for cognitive abilities are much smaller and less significant in columns 1 and 2 than in columns 3 and 4. This finding supports our hypothesis.<sup>13</sup>

The estimated effect of cognition on patient behavior also weakens when we move from an incentivized choice between an immediate versus delayed payment (as in columns 3 and 4 of Table 4 to an incentivized choice between two delayed payments). Overall, the study findings support the hypotheses that incentives and payment delay moderate the relationship between cognition and patience. These findings are consistent with the conjecture that cognitive effort mediates the correlation between cognitive ability and delay discounting.

## Discussion and Conclusion

Studies in economics and psychology have reported a link between cognitive abilities and patience, with low-ability participants being less patient. This study examines whether the introduction of sizable financial incentives affects this link through the channel of cognitive effort. If imagining the future were especially demanding for low-ability participants, the participants would need proper incentives to exert enough cognitive effort to take future states seriously. Consistent with this reasoning, this study replicated the usual positive association between cognition and impatience in a nonincentivized survey but found no statistically significant correlation when financial incentives are introduced.

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

This study has a few methodological limitations. First, there is no proxy for cognitive effort and the effort is not directly manipulated. Measuring decision time, using some tracking device (e.g., eye tracking machines) or recording hormonal response as in as in De Dreu et al. (this issue) helps understand the decision process. One could also exogenously vary the cognitive resources available to the participants. Second, the sample size of this study is limited, and a larger sample could confirm the robustness of the results. Finally, owing to logistic constraints, the time horizon used in the experiment is shorter than the one used in the survey. The limited sample size and logistic constraints did not allow controlling for the order effect for both the sequence experiment-survey and time horizon. Nevertheless, it is important to stress that this lack of control does not affect the results related to Hypothesis 3.

While more evidence is needed, it is important for policy reasons to better understand the role of cognitive effort in shaping the relationship between cognition and patience. The study data suggest that impatience is a concern especially when immediate gains are present and financial incentives are too small to examine 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 certainly some crucial choices to make, such as 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.<sup>14</sup> Similarly, individual actions to reduce global warming often involve small stakes that accumulate, for example, reducing the consumption of water or electricity, are the result of many daily actions that might appear to be insignificant and not worth the effort.

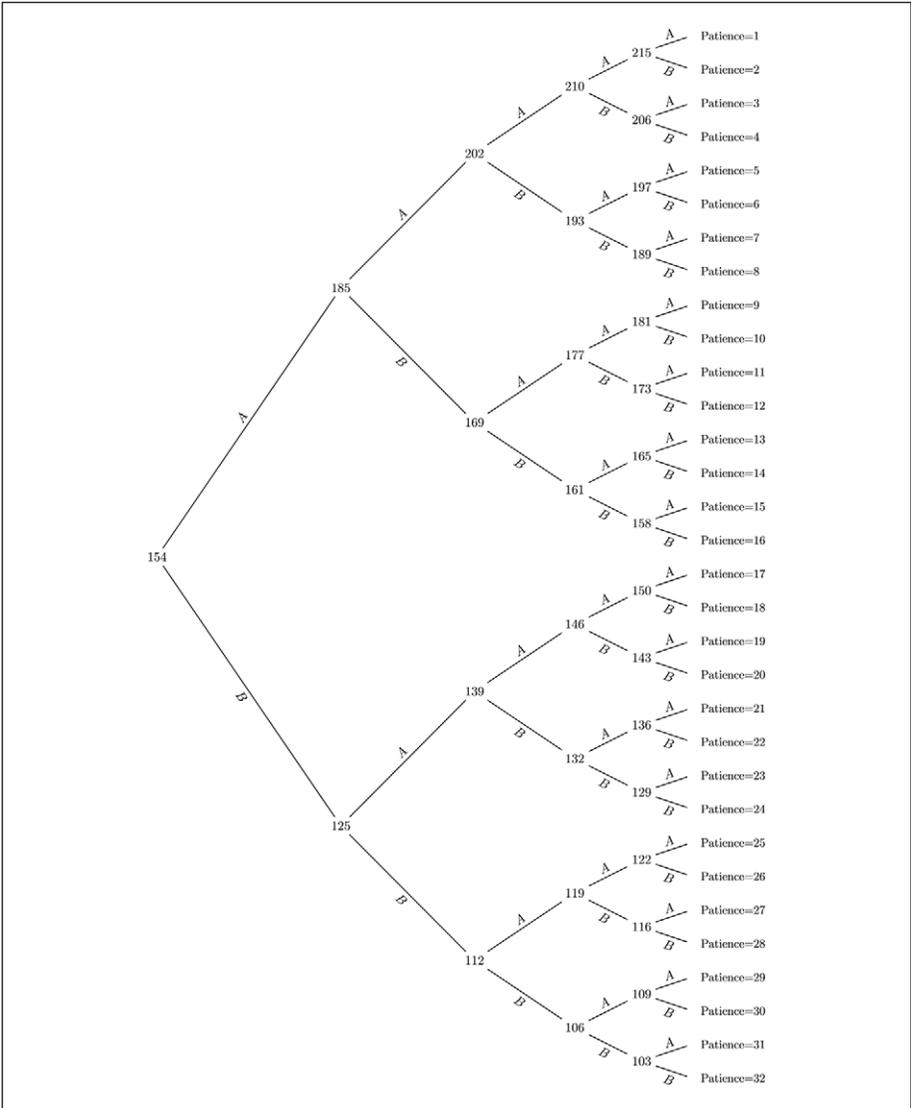
## Appendix

The numeracy test administered in the individual survey included the following questions:

1. If you buy a drink for 85 Tetri and pay with a 1 Lari coin, how much change should you receive?
2. During a sale, a shop is selling all items at half price. Before the sale, a sofa costs GEL 300. What is the price during the sale?
3. If the chance of acquiring a disease is 10%, how many people out of 1,000 would be expected to acquire the disease?
4. A secondhand car dealer is selling a car for GEL 6,000, which is two thirds the cost price of a new car. How much did the new car cost?
5. If all five people have the winning numbers in a lottery and the prize is GEL 2 million, how much will each receive?
6. Suppose you have GEL 200 in a savings account. If the account earns 10% interest per year, how much will you have in the account at the end of 2 years?

The CRT 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.

Note. 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 works as follows. First, each respondent was asked his or her preference to receive 100 GEL today or 154 GEL in 12 months from now (leftmost decision node). If the respondent opted for the payment today (“A”), in the second question the payment in 12 months was adjusted upward 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.”

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## Notes

1. Our findings differ from the results reported in Shamosh and Gray (2008) because most of the studies included in the meta-analysis were conducted with children/adolescents or with participants with psychological disturbances/addictions, while our sample was drawn from the general population and it included only adults. Importantly, this study provides strong monetary incentives—in our sample, the maximum earnings were approximately 40% of the median household monthly income—a feature that is not present in the studies with a student/general sample considered by Shamosh and Gray (2008).
2. The costs could be associated with cognitive costs and 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. Consistent with this approach, Garbarino and Edell (1997) found that effort adversely affects the choice of cumbersome alternatives.
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.
5. The experiment on time preferences was followed by other tasks on trust and risk taking. Instructions are available on request.
6. The GEL is the local currency in Georgia; in the period when the survey and the experiments were conducted (November 2015 to May 2016), the GEL/USD rate vacillated between a maximum of 2.49 and minimum of 2.19.

7. We observe only 13 participants switching more than once from option A to option B. For these participants, we consider the first switch.
8. One member of each household was also asked to participate in a household survey. The data from that survey are not discussed here.
9. This should not be surprising, as Georgia is a former Soviet country and education was mandatory.
10. The study was conducted entirely in Georgian by local coordinators and enumerators. In addition, two authors of the paper were present at all sessions to ensure all procedures were followed.
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 this study that lasted only a few hours. We cannot directly observe a preference parameter but can only observe choices that reveal the preference. We conjecture that patient behavior not only is driven by a pure time preference parameter that captures how an individual would trade-off consumption at two different time points if the person was certain about the levels of utility associated with these choices, but that it is also determined by the capacity to imagine the future and adequately understand 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 spend to put oneself in a future situation. It is possible to assume that the present is less difficult to understand, while the future is more abstract and the benefits from future payments are more difficult to envisage than immediate payments.
13. We rerun the same specifications for Tables 4 and 5 by including either the CRT or numeracy test as main variables of interest. Results for both proxies of objective cognition are similar, but a stronger effect is found for the CRT.
14. See also Holtman et al. (this issue) and Gil-Hernández (this issue) for studies on the effects of personality traits and behavioral traits on schooling decisions.

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## Author Biographies

**Stefania Bortolotti** is an assistant professor at the Economics Department of the University of Bologna. She specializes in the field of experimental and behavioral economics, with a focus on cross-cultural cooperation, trust, fairness views, incentives, and gender gap in science.

**Thomas Dohmen** is Professor of Applied Microeconomics and Spokesperson of the Cluster of Excellence ECONtribute: Markets & Public Policy at the University of Bonn, and Professor of Education and the Labour Market at Maastricht University. He specializes in the field of economics and psychology, focusing on the measurement, origin and formation of preferences, personality and skills over the life course and their impact on life outcomes.

**Hartmut Lehmann** is Leading Research Fellow at the Centre for Labour Market Studies at the Higher School of Economics in Moscow, Program Coordinator of the IZA research area "Labor in Post-Transition and Emerging Economies", and Alma Mater Professor of Economics at the University of Bologna. He is editor of the IZA Journal of Development and Migration and Vice-President of the European Association of Comparative Economic Studies.

**Frauke Meyer** is a postdoctoral researcher at the Institute of Energy and Climate Research – Systems Analysis and Technology Evaluation (IEK-STE) at the Forschungszentrum Jülich GmbH. She specializes in behavioral economics, focusing on prosocial motives and environmental attitudes.

**Norberto Pignatti** is Associate Professor of Policy at the International School of Economics at Tbilisi State University (ISET) and Head of the Energy and Environmental Policy Center at the ISET Policy Institute. His research interests are in labor economics (with a focus on labor markets of developing and transition countries), sustainable development and behavioral economics.

**Karine Torosyan** is an associate professor of economics at the International School of Economics at Tbilisi State University (ISET), Tbilisi, Georgia. She is actively engaged in interdisciplinary academic research in the fields of economics, populations studies, and sociology, and her main research focus is on labor market outcomes for special sub-groups of the population, including: women, informal workers, internally displaced people, families with absent or return migrants.