Do as I Do, Not as I Say: Incentivization and the Relationship Between Cognitive Ability and Risk Aversion

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Abstract We study how the use of real and hypothetical choices to elicit risk preferences affect the statistical relationship between cognitive ability and risk aversion. Our experimental results suggest that such association is sensitive to incentive conditions of the choice problems used to elicit risk preferences. Individuals in the upper tail of the cognitive ability distribution are willing to take more risks only when choices involve hypothetical payoffs. This correlation is found insignificant when choices are real, with results being robust to alternative measures of cognitive ability. Our study suggests that if risk-elicitation tasks used in the literature capture risk preferences, then the finding that individual with higher cognitive ability are willing to take more risks should be further examined.

Keywords: cognitive ability, risk-elicitation, risk taking behavior, incentivization.
JEL: D12, D81.

Resumo Esse paper investiga como o uso de tarefas reais e hipotéticas na mensuração das atitudes dos indivíduos com relação a risco afeta a relação entre aversão a risco e habilidade cognitiva. Os resultados dos nossos experimentos sugerem que tal relação é sensível às condições de incentivização das tarefas utilizadas para medir aversão a risco. Observamos que os indivíduos com níveis maiores de habilidade cognitiva estão dispostos a correr mais riscos quando as tarefas de mensuração de risco são hipotéticas. Esta correlação, entretanto, é estatisticamente insiginifcante quando as escolhas nas tarefas são reais, sendo este resultado robusto ao uso de medidas alternativas de habilidade congnitiva. Nosso estudo sugere que a recente literatura experimental sugerindo que os indivíduos com maior habilidade conigtiva essão relativamente mais dispostos a tomar risco merece ser melhor examinada antes de ser acreditada.

Palavras-Chave: habilidade cognitiva, aversão a risco, incentivização.
Área Anpec: 7 - Microeconomia, Métodos Quantitativos e Finanças.

*We are grateful to Robin Cubitt, Martin Sefton, Simon Gächter, and Hörst Zank for helpful comments. Bruno Campos and Bruno Siqueira provided able research assistance. Sousa is thankful to CAPES, FAPESP and University of Nottingham for financial support. Rangel gratefully acknowledges support from the Brazilian Ministry of Science and Technology's (CNPq) Research Productivity Fellowship. The usual disclaimer applies. Contact the authors with comments: Rangel at `rangelm@usp.br` and Sousa at `ssousa@usp.br`.

1 Introduction

That individuals differ in their ability to reason and think is a well established fact in the psychology literature. Economists have more recently turned their attention to this issue, and a considerable number of recent studies have documented empirically how differences in cognitive ability affect behavior in domains that are of central importance for economic theory and policy.[1] Studies focusing on the relationship between cognitive ability and attitudes towards risk are of particular interest due to their policy implications.[2] Their empirical findings, however, are mixed. While some studies have found that individuals with higher cognitive ability are willing to take more risks relative to those in the lower tail of the cognitive ability distribution, others have found no relationship at all.[3] This is not surprising considering the heterogeneity in risk preferences and cognitive ability measurement procedures, subject pools and other aspects of experimental design in these studies.[4]

In the present article we focus on measurement procedures and ask whether and to what extent the association between cognitive ability and risk aversion is sensitive to risk-elicitation tasks that have hypothetical/real incentives, as well as to different instruments to measure cognitive ability. We conduct laboratory experiments in which subjects make both real and hypothetical risky decisions from which we elicit their willingness to take risks (within-subject design). We then examine the robustness of the results to alternative measures of cognitive ability.

There is reason to believe that incentives of risk-elicitation tasks and measurement of cognitive abilities could affect the relationship between cognitive ability and risk preferences. Regarding incentives, there are differences between real and hypothetical choice decisions. Real choices have consequences, whereas hypothetical choices have none. Indeed, several studies have found a “hypothetical bias" on choices people make, i.e., a tendency to understate or overstate their preferences when compared with carefully matched real choices. This propensity to “misrepresent" choice in hypothetical problems *vis a vis* real ones has been found, for instance, in the valuation of goods and services (e.g. Cummings *et al.*, 1995; Harrison & Rutström, 2008) and risk-taking behavior (e.g. Harrison, 2006)[5]. If choice problems with hypothetical consequences are solved in rapid, mindless, and thus less cognitively demanding ways (Kang *et al.*, 2011), the observed associations between measures of risk aversion (elicited through tasks with hypothetical outcomes) and cognitive ability would be biased. Regarding cognitive tests, it is well known that scores can differ between different tests. Besides the contentious issue of which cognitive domain is being assessed by these psychometric tests (for a review, see Neisser, 1996), it is well established

[1] On the relationship between cognitive ability and risk preferences, see, e.g., Benjamin *et al.* (2012), Burks *et al.* (2009), Sunde *et al.* (2010), Oechssler *et al.* (2009), Huysentruyt & Read (2010), Campitelli & Labollita (2010), Bergman *et al.* (2010) and Eckel *et al.* (2011); on the relationship between cognitive ability and a set of labor-market outcomes, see, e.g., Heckman *et al.* (2006); on cognitive ability and wealth accumulation, see Cawley *et al.* (2001) and Smith *et al.* (2010); on cognitive ability and choice behavior on dominance-solvable games, see Rydval *et al.* (2009) and Burnham *et al.* (2009); on cognitive ability and time preferences, see Bettinger & Slonim (2007) and Sunde *et al.* (2010); on cognitive ability and biases in judgement, see Bergman *et al.* (2010), Oechssler *et al.* (2009), and Campitelli & Labollita (2010); finally, on cognitive ability and stock market participation, see Christelis *et al.* (2010).

[2] If cognitive ability affects risk-taking behavior and cognitive ability is shaped to some extent by schooling, then changing educational and training investments could help improve individuals' saving and investment habits.For a related view regarding financial literacy see, for example, Lusardi (2012). See also Hryshko *et al.* (2011) for a discussion on the impact of education over the intergenerational transmission of risk aversion.

[3] For studies that find a negative correlation between cognitive ability and risk aversion, see Frederick (2005), Benjamin *et al.* (2012), Burks *et al.* (2009), Oechssler *et al.* (2009), and Sunde *et al.* (2010). For studies that find no association between cognitive ability and risk aversion, see Brañas-Garza *et al.* (2008), Eckel *et al.* (2011), and Epper *et al.* (2011).

[4] Risk aversion has been measured through hypothetical choices (e.g. Frederick, 2005), real choices (Sunde *et al.*, 2010, e.g.), single-task (e.g. Benjamin *et al.*, 2012) and multiple-task individual choices (e.g. Burks *et al.*, 2009). Similar heterogeneity is also observed in the measurement of cognitive ability: some use standardized achievement tests and school grades (Benjamin *et al.*, 2012), while others have used existing psychometric tests (Burks *et al.*, 2009; Sunde *et al.*, 2010) and even developed their own test to measure their subjects' cognitive ability (Frederick, 2005).

[5] For a literature review of settings in which hypothetical/real rewards affect choices and, more importantly, validity tests of theories of decision making, see Camerer & Hogarth (1999).

that they can yield different results depending on format, length and timing conditions.[6] Despite the importance of these issues, to the best of our knowledge, the role of incentivized and hypothetical risk-elicitation mechanisms on the relationship between cognitive ability and risk preferences has not been investigated. Nor has any study examined the sensitivity of these results to different cognitive tests. Our paper fills this gap.

There are two main empirical results derived from our analysis. First, we find evidence that there are differences in the association between cognitive ability and risk aversion between real and hypothetical decisions. We confirm Frederick's (2005) findings that individuals in the upper tail of the cognitive ability distribution, as measured by Cognitive Reflection Test scores, are significantly less risk averse than others. We find that subjects are 17.5% more likely to opt for the risky option than their counterparts in the lower end of the cognitive ability distribution. Yet, we find that this association completely vanishes when risk preferences are elicited through a risky choice with real money at stake. Second, we show evidence that the association between cognitive ability and risk aversion (or the lack thereof) is robust to different measures of cognitive ability, reflecting several reasoning skills and, arguably, types of intelligence. In particular, we provide an indicator of fluid intelligence that can serve as an alternative to tests that only measure reasoning skills which are significantly aided by acquired knowledge (capturing only a crystallized type of intelligence).[7] Our results suggest that if risk-elicitation tasks used in the literature capture attitudes towards risk, the finding that individuals with relatively high cognitive ability are willing to take more risks should be examined in more detail. Our study should therefore be viewed as a first step toward a deeper understanding of how the relationship between cognitive ability and given economic behaviors may be affected by variation in measurement.

The remainder of the paper is organized into five sections. Section 2 describes the design of the main experiment and its descriptive statistics. Section 3 presents, as a robustness exercise, a second laboratory experiment that also investigates whether cognitive ability is related to risk preference applied to a different pool of subjects. Section 4 presents the econometric methodology and results. Section 5 discusses overall findings and provides concluding remarks. Tables are collected at the end of the paper.

2 Experiment 1: Real and Hypothetical Risky Choices

Our first experiment uses a within-subject design to investigate whether the relationship between cognitive ability and risk aversion is affected by risk-elicitation tasks being hypothetical or real. In the remainder of this section, we describe the design, summarize its implementation, and present descriptive statistics.

2.1 The Experimental Design

The experiment consists of a set of tasks designed to elicit subjects' cognitive ability and risk aversion. It was implemented sequentially in a three-part procedure, each part completed independently.

Part one elicited measures of cognitive ability. Subjects were asked to complete a timed cognitive test. The test consisted of figures with symbolic patterns presented in the form of a 3×3 matrix with one symbol missing. Test-takers' task in each question was to identify among a set of symbols which one represents the missing element required to complete the pattern in the figure. Our test consists of twelve such questions and is identical to the one applied in the context of the Mexican Family Life Survey.[8] MxFLS describe these test as a reduced version of Raven's *Advanced Progressive Matrices*

[6] See, e.g., Norris (1995) and Ackerman & Kanfer (2009).

[7] This fluid type of intelligence is viewed as one of the factors of general intelligence. It is regarded as the ability to solve problems in novel situations, identify patterns, and make meaning out of confusion. For more on crystallized *versus* fluid intelligence, see Carrol (1993).

[8] MxFLS documentation can be found at http://www.ennvih-mxfls.org.

Test (APMT).[9] In our version, subjects were given three minutes to fill out the test. We computed two scores for each individual: a raw one, which is just the number of questions she answered correctly, and a difficulty-corrected score, which is the weighted sum of correct answers. Weights applied to each question are given by the inverse of the proportion of correct answers considering results among MxFLS adult test takers. These scores are used as two of the three measures of cognitive ability we have in this experiment.

Part two elicited subjects' risk aversion by asking subjects to choose between bets with real money at stakes. In this part, we presented subjects with a discrete choice involving two bet options. Option A was a safe bet that paid 20 tokens with certainty, whereas option B was a risky bet that yielded a higher outcome of 45 tokens with probability p and a lower outcome of 10 tokens with probability $1-p$. Each token was worth 1 Brazilian Real (at the time, BRL\$1,00=US\$ 0,64). Subjects made their choices with the understanding that the actual value p would be defined only at the end of the experiment.[10] Payment for their choice was also done only at the end of the experiment.

Part three was implemented after subjects made their choices. They were asked to fill out a brief questionnaire containing information regarding their socio-economic statuses. In the questionnaire, we also presented subjects with a hypothetical risk-elicitation task. In this task, a subject has to choose one of six $50-50$ lotteries. Table 1 presents the hypothetical money prize entries in these lotteries, with negative entries meaning losses. Note that lottery $L1$ is a degenerate lottery that would pay 20 with certainty, lottery $L4$ is a simple one with one nonzero outcome and the remaining lotteries are all binary prospects with nonzero outcomes. While the expected value is maximized by choosing the lottery $L6$, turning down the sure 20 ($L1$) for any of the other options clearly involves some degree of risk. The "downside" and "upside" risks of choosing the other lotteries are all increasing as one move from lottery $L2$ to $L6$. In the spirit of Frederick (2005), we characterize risk-taking behavior in this task in a binary way defining risk-averse behavior as a choice for the safe gamble ($L1$) and risk-seeking behavior as a willingness to take risks at all (from $L2$ to $L6$).

Table 1: Hypothetical $50-50$ Lotteries

Lottery	Prize 1	Prize 2
$L1$	20	20
$L2$	10	40
$L3$	5	50
$L4$	0	60
$L5$	-10	80
$L6$	-30	100

In the same questionnaire subjects were also asked to undertake Frederick's (2005) Cognitive Reflection Test. The test consisted of three questions designed to measure impulsive thinking, one's ability to suppress an erroneous answer to a problem that springs "impulsively" to mind (Frederick, 2005, p.27). Subjects' scores in this test are used as the third measure of cognitive ability. Since performance in this test is clearly aided by acquired knowledge, the scores provide a measure of a reasoning skill that is likely distinct from the one captured by the test implemented in part one.

[9] The Raven's *Advanced Progressive Matrices Test* is a 48 question, untimed test that seeks to measure one component of the Spearman's g measure of general intelligence, namely *eductive* ability, also known as fluid intelligence (J. Raven, 1998). Eductive ability involves a great deal of problem-solving skills and is one of the best single measures of g as reported by several studies. For a survey, see Carrol (1993). On fluid intelligence, see Cattell & Horn (1978).

[10] As part of a larger study, we implemented two treatments that varied the source of p. Our data analysis controls for potential treatment effects interacting with the degree of risk aversion observed among subjects.

2.2 Administration

This experiment was conducted in Sao Paulo, Brazil, with students of the University of Sao Paulo, the largest superior education institution in Latin America. Approximately 200 subjects took part in the experiment. We conducted 20 sessions with an even number of 10 participants in each session.[11] The experiment was conducted in paper-and-pencil format with sessions lasting no more than 80 minutes.

Upon their arrival, subjects sat at visually isolated desks. Instructions to each part of the experiment were distributed separately and read aloud by the experimenter as subjects read them along on paper. After the entire experiment was completed, we resolved the uncertainty about p in the lottery choice problem, played out the lottery for those who chose it, and paid the subject based on the outcome. At the end each token earned in the experiment was converted to money. A show-up fee of BRL$5 was added to the earnings in the experiment yielding an average payment of BRL$ 29.09 (US$ 18.62) per participant.

2.3 Descriptive Statistics

Table 2 presents overall statistics for the subjects in Experiment 1. Most are male and white with an average age of 22.3 years. Socio-economic background corresponds to what is expected in this population at the University of Sao Paulo, with slightly more than 70% of parents having at least a college degree and 43.5% of households having per-capita income above four minimum-wages.

The majority of the students attending the sessions were enrolled in social sciences and humanities degree programs, less than half of whom were from economics. On average our subjects responded correctly two out of the three questions in the Cognitive Reflection Test. In the timed fluid-intelligence test, slightly more than 50% of the answers were correct.

Finally, Table 2 also indicates that subjects were way more likely to choose the risky option both in both the incentivized and hypothetical choice conditions. Notice, however, that conservative choices are seen more frequently on the incentivized than in the hypothetical setup.

3 Experiment 2: Sensitivity to Alternative Measures of Cognitive Ability

We report in this section a second experiment that examines the relationship between risk aversion and cognitive ability in an incentivized setting. Before we introduce the experimental design, procedures and descriptive statistics, a caveat is in order. The experiment has the advantage of using a set of risk-elicitation tasks rather than just one, but was not primarily designed to examine the issue of hypothetical and real incentives as attitudes toward risk. We explore its results for two reasons. First, because it adds weight to results from Experiment 1, in that it replicates the finding that cognitive ability does not appear to be related to risk aversion with a different pool of subjects. Second, because besides eliciting risk aversion, subjects were requested to complete two different cognitive tests: Frederick's (2005) Cognitive Reflection Test and a test that assess quantitative and sequential reasoning (logical), so we can analyze whether the relationship between cognitive ability and risk aversion is robust to the use of different cognitive tests.

3.1 Experimental Design

This experiment consists of a set of risk-elicitation tasks and a cognitive test. First, subjects face a sequence of twelve choice tasks designed to elicit their risk attitudes. Then, they are asked to complete a timed cognitive test.

[11] Except for one of the sessions that had 7 participants, leaving us with a sample of 197 subjects.

Table 2: Summary Statistics for Subjects in Experiment 1

	Mean	(se)	Standard-deviation
Demographics			
Male	0,599	(0,035)	0,491
White	0,705	(0,032)	0,457
Black	0,170	(0,027)	0,377
Age (in years)	22,249	(0,256)	3,599
Socio-economic background			
Head of household has college degree or more	0,716	(0,032)	0,452
Household per-capita income above 4 minimum-wages	0,435	(0,035)	0,497
Household with 4 or 5 members	0,533	(0,036)	0,500
Household more than 5 members	0,086	(0,020)	0,282
Field of study			
Social Sciences	0,574	(0,035)	0,496
Exact and Biological Sciences	0,066	(0,018)	0,249
Economics major	0,203	(0,029)	0,403
Cognitive ability			
Cognitive Reflection Test scores (0-3)	1,954	(0,075)	1,051
Fluid Intelligence Test raw scores (0-12)	7,827	(0,117)	1,635
Fluid Intelligence Test difficulty-weighted scores (0-12)	5,932	(0,138)	1,936
Choices			
Risky option (incentivized choice)	0,751	(0,031)	0,432
Risky option (hypothetical choice)	0,858	(0,025)	0,349
Observations		197	

Note: Difficulty-corrected score are weighted sum of correct answers, where the weights are given by the inverse of the proportion of correct answers considering results among adult test takers in the Mexican Family Life Survey (http://www.ennvih-mxfls.org), from where we borrow the test.

In each risk-elicitation task we implement a subject faces a number of pairwise choice problems. Each problem is to choose between an amount of money with certainty and a given binary lottery L (a p chance to win x and $1-p$ to win y, where $x > y > 0$); the certain money option is systematically decreased from x to y by a constant amount, say δ, when proceeding down the table. The row at which an individual switches from choosing the sure money to L (if at all) can then be used to estimate a non-parametric measure of risk aversion: the subject's risk premium for that lottery. The risk premium for a lottery L is the certain amount of money an individual would forego in order to avoid the risk inherent in L. We summarize the risk aversion of a subject in the experiment by computing her *risk-propensity score*, which will simply be the number of tasks in which the subject made a risk-averse choice. In a given risk-elicitation task, this amounts to having a positive risk premium for the lottery option in that task. Table 3 shows the lottery options for each risk-elicitation task.

Table 3: Lottery Options

Lottery	Prize 1 (x)	P(x)	Prize 2 (y)	P(y)
$L1$	8	0.3	4	0.7
$L2$	16	0.2	10	0.8
$L3$	6	0.4	3	0.6
$L4$	9	0.3	4	0.7
$L5$	9	0.2	3	0.8
$L6$	6	0.3	3	0.7

Our cognitive test, like other psychometric tests, is a set of questions that seek to assess a range of reasoning skills. The test contains nine questions. Subjects were given 60 seconds per question. The test is divided into three sections: three on each of Cognitive Reflection, mathematical and sequential reasoning sections. The mathematical section is very much like the GRE-Quantitative test, requiring understanding of elementary arithmetic and algebra.[12] The sequential reasoning section, in turn, covers the analysis of patterns and deductive reasoning in arithmetic and geometric contexts. We measure cognitive ability with raw scores obtained in these tests.

3.2 Administration

This experiment was conducted at CeDEx laboratory in the University of Nottingham, England. A total of 106 subjects took part in the experiment. Most are undergraduate students from different disciplines. The experiment was computerized and used a proprietary software developed for this experiment. Sessions lasted about 60 minutes.

Upon their arrival, subjects sat at visually isolated desks. Instructions to each part of the experiment were distributed separately and read aloud by the experimenter as subjects read them along on paper. After we explained what a risk-elicitation tasks would look like, subjects started completing a series of twelve risk-elicitation tasks with the understanding that only one of their choices would be selected at random at the end of the experiment to determine their earnings. For the selected task, earnings were determined according to the option they chose in the selected choice problem. If they chose Option A, they received the amount of money it specifies, whereas if they chose Option B, the risky option, they played the lottery; risk is resolved by drawing a chip from a bag containing 10 numbered chips and receiving the payoff according to what the lottery specifies in British pounds (at the time, £ $1,00 =$ US$ 1,98). On average, subjects earned £ 6.70 (US$ 13.27).

[12] A great deal of research has been conducted to investigate the reasoning abilities measured by the GRE, see (Powers & Kaufman, 2004) and (Kuncel *et al.*, 2001), and references therein.

3.3 Descriptive Statistics

Table 4 presents overall statistics for the subjects in Experiment 2. There are slightly more female students engaging on the activities, and most are White with twenty years of age on average. Socio-economic background information indicates that approximately 30% of parents have at least a MSc degree and 17% have household income above fifteen thousand pounds a year.

Table 4: Summary Statistics for Subjects in Experiment 2

	Mean	(se)	Standard-deviation
Demographics			
Male	0,472	(0,049)	0,502
White	0,623	(0,047)	0,487
Age (in years)	19,943	(0,154)	1,585
Socio-economic background			
Head of household has MSc degree or more	0,302	(0,045)	0,461
Household income > Briths Pounds 15,000	0,170	(0,037)	0,377
Field of study			
Social Sciences	0,406	(0,048)	0,493
Exact Sciences	0,189	(0,038)	0,393
Cognitive ability			
Cognitive Reflection Test scores (0-3)	0,915	(0,096)	0,987
Quantitative reasoning raw scores (0-3)	0,915	(0,075)	0,770
Sequential reasoning raw scores (0-3)	2,500	(0,057)	0,590
Choices			
Proportion of risky options in 12 tasks (incentivized choice)	0,691	(0,025)	0,462
Observations		*106*	

Forty percent of students attending the sessions were from the University's Social Sciences division, with other 19% coming from the Exact Sciences. On average our subjects responded correctly one out of the three questions in the Cognitive Reflection Test. The same pattern is also seen on the quantitative reasoning test. Students did extremely well on the sequential reasoning test, scoring on average 2.5 out of 3 points. Table 4 also indicates that in the twelve incentivized choices they faced in the experiment, the average student picked the risky option 70% of the time.

4 Empirical Methodology and Results

4.1 Econometric Specifications

We examine the data from the experiments using simple linear regression techniques (ordinary least squares). We measure the impact of cognitive ability over the propensity to opt for the risky option computing dichotomic indicator functions that classify individuals either as above or below the median performance in each of our tests. For the case of Experiment 1 we also perform empirical analyses with continuous versions of the cognitive tests' scores. More specifically we take the following models to the data:

$$y_{is} = \alpha_1 HighScore_i + \alpha_1 LowScore_i + \eta_s + \phi_{is} \tag{1}$$

$$y_{is} = \beta_0 + \beta_1 Score1_i + \beta_1 Score2_i + \theta_s + \epsilon_{is} \tag{2}$$

where y_{is} is a binary variable taking the value one when individual i in session s picks the risky option. As presented above, $HighScore_i$ and $LowScore_i$ are indicators for above and below the median score in cognitive tests, respectively. $Score1_i$ and $Score2_i$ stand for the continuous scores in alternative cognitive tests.

These models compute raw differences in means (or associations, in the continuous case). We also estimate alternative versions that include covariates aiming at reducing the chance of omission biases in our estimates. That is:

$$y_{is} = \alpha_1 HighScore_i + \alpha_1 LowScore_i + \delta' X_i + \eta_s + \psi_{is} \tag{3}$$

$$y_{is} = \beta_0 + \beta_1 Score1_i + \beta_1 Score2_i + \delta' X_i + \theta_s + \lambda_{is} \tag{4}$$

with X_i as a vector with control variables that include age, gender and household socio-economic status. In the estimation of standard errors in all models we take into consideration the possible correlation of unobservables (η_s) within each session by clustering.

4.2 Results

Our first set of results regarding Experiment 1 is presented on two panels in Table 5. Panel A focuses on specifications that utilize dichotomized versions of cognitive test results while Panel B explores continuous versions of the test scores. Two sets of three columns are presented. Columns 1 to 3 show results from the incentivized risk-elicitation task, while Columns 4 to 6 are relative to the hypothetical risk-elicitation task.

Results from the first three columns suggest that there is no statistically significant difference between cognitive groups with regard to propensity to take risks. The second set of columns (Columns 4 to 6), however, indicates that based on choices in the hypothetical task our conclusion would have been dramatically different. On both measures of cognitive ability, high scores are significantly associated with larger probability of risky choices. The difference in choices between individuals with high-CRT and low-CRT scores amount to 13.8 percentage points (or 18.8% in relative terms). In the case of fluid intelligence scores such difference amounts to 10.6%. These differences are significant even when the impact of both cognitive tests is examined using joint-significance statistics.

Our non-significant results in incentivized settings are corroborated by findings from Experiment 2 (run in a different population of subjects). Table 6 reproduces econometric results that overwhelmingly indicate that there is no reason to believe that higher cognitive ability is statistically associated with higher propensity to opt for risk lotteries. This is the case for any of the cognitive tests employed in Experiment 2. We see this result as a robustness check of the ones presented above for Experiment 1.

Table 5: Risk-Taking Behavior by Cognitive Ability Group (Experiment 1)

	Incentivized risk-elicitation task			Hypothetical risk-elicitation task		
	Proportion picking risky option [1]	Proportion picking risky option [2]	Proportion picking risky option [3]	Proportion picking risky option [4]	Proportion picking risky option [5]	Proportion picking risky option [6]
Panel A: Dichotomized cognitive-ability measures						
High-ability (above median CRT score)	0.792 *(0.0515)* **	-		0.872 *(0.0474)* **	-	
Low-ability (below median CRT score)	0.736 *(0.0833)* **	-		0.733 *(0.0551)* **	-	
High Vs. Low Difference	0.056 *(0.0786)*	-	0.055 *(0.0792)*	0.138 *(0.0698)* **	-	0.132 *(0.0731)* *
High-ability (above median Fluid-intelligence score)	-	0.788 *(0.0659)* **		-	0.876 *(0.0474)* **	
Low-ability (below median Fluid-intelligence score)	-	0.764 *(0.0557)* **		-	0.792 *(0.0445)* **	
High Vs. Low Difference	-	0.024 *(0.0554)*	*0.0203* *(0.0550)*	-	0.084 *(0.0392)* **	0.0740 *(0.0386)* *
F-Test joint significance [p-value]			0.0320 [0.7325]			7.2900 [0.0045]**
Panel B: Continuous measures of cognitive ability						
CRT score (0-3)			*0.0309* *(0.0361)*			*0.0733* *(0.0250)* **
Fluid-intelligence z-score			*0.0079* *(0.0416)*			*0.0701* *(0.0248)* **
F-Test joint significance [p-value]			0.37 [0.6981]			11.84 [0.0005]**

Note: Standard-errors in parentheses are clustered at the session level. * indicates significance at 10%, and ** significance at 5%. Controls include gender, age, education of household head, household income and number of household members.

Table 6: Risk-Taking Behavior by Cognitive Ability Group (Experiment 2)

	Incentivized risk-elicitation tasks			
	Proportion picking risky option (CRT only) [1]	Proportion picking risky option (Quant. Reasoning only) [2]	Proportion picking risky option (Seq. Reasoning only) [3]	Proportion picking risky option (All cognitive) [4]
High-ability (above median CRT score)	0.713 *(0.0389)* **	-	-	
Low-ability (below median CRT score)	0.683 *(0.0240)* **	-	-	
High Vs. Low Difference	0.030 *(0.0480)*	-	-	0.027 *(0.0478)*
High-ability (above median quantitative reasoning score)	-	0.710 *(0.0498)* **	-	
Low-ability (below median quantitative reasoning score)	-	0.685 *(0.0207)* **	-	
High Vs. Low Difference	-	0.025 *(0.0553)*	-	*0.0218* *(0.0525)*
High-ability (above median sequential reasoning score)	-	-	0.682 *(0.0404)* **	
Low-ability (below median sequential reasoning score)	-	-	0.701 *(0.0400)* **	
High Vs. Low Difference	-	-	-0.019 *(0.0699)*	-0.0201 *(0.0698)*
F-Test joint significance [p-value]				0.34 [0.7945]

Note: Note: Standard-errors in parentheses are clustered at the session level. Sample has 106 observations. $*$ indicates significance at 10%, and $**$ significance at 5%.

Our final set of results is presented in Table 7. We reproduce the estimations of differences between high- and low-ability individuals in both experiments, but this time we include controls for demographic and socio-economic characteristics of subjects. There is no qualitative change in the conclusions presented above. We have reasons to believe that incentivization eliminates the positive statistical relation between cognitive ability and risk taking behavior seen in hypothetical tasks. To sum up, within the same group of subjects, we find that while higher cognitive ability (measured by different tests) leads to more risk taking behavior in hypothetical tasks, there are no such relation when real money is at stake.

Yet, some caution is in order with such conclusions. A potential problem with our design regarding the existence of a "hypothetical bias" driving the relationship between cognitive ability and risk aversion is that specificities of the risk-elicitation tasks differ between real and hypothetical treatments. While one might be concerned with the threat to internal validity that this poses, it should be noted that using the same task between incentive conditions would have the disadvantage of either force the adoption of a between-subject design, which is a less powerful comparison, or create a confounding problem as subjects could think we were testing for consistency and respond accordingly.

We think that even considering this caveat, our findings are informative to the literature in that they suggest an additional instance of how the "hypothetical choice bias" can lead to misleading conclusions.

5 Concluding Remarks

There is now a large body of both theoretical and empirical work in psychology indicating that there is a fairly amount of heterogeneity among individuals in their mental capabilities[13]. It is indeed hardly controversial that the ability to reason, plan, learn, and think abstractly indeed differ from one person to the other. Yet, standard economic models assume that individuals deploy the same "cognitive machinery" for finding solutions to economic problems they face. As a consequence, individual behavior in a real-world setting can look very different from those based on theoretical models that do away with the differences in cognitive abilities.

An increasing number of studies have been addressing this issue on the empirical front, investigating how economic behavior differ between cognitive groups. Part of this literature has focused on the role played by cognitive ability on attitudes towards risk. The majority of those studies use laboratory experiments to investigate whether those with greater cognitive ability are more or less likely to take risks. In some of these studies, individuals' risk aversion is elicited through a set of hypothetical choices that have no real money at stakes. Hypothetical choices are common in experimental psychology but tend to be viewed wish suspicion by economists as a good forecast of the actual course of action one would be committed to were the decision for real. We have reasons to believe they are right in taking the evidence with a grain of salt.

Our study investigated this issue in the context of risk-taking behavior and its relationship with cognitive ability. One simple laboratory experiment was designed and implemented to test the hypothesis that the association between cognitive ability and risk aversion is not affected by whether risk aversion is measured through hypothetical or real choices. We also looked at the sensitivity of the relationship between cognitive ability and risk aversion to differences in cognitive tests. In particular we employed tests that differ on their degree of association with "crystallized intelligence" (intelligence reliant on accumulated knowledge).

Contrary to what has been found in other studies, the evidence from our two laboratory studies indicated that higher cognitive ability is *not* associated with lower levels of risk aversion measured through real risky choices, even controlling for demographic and socio-economic heterogeneity. Yet, and perhaps more surprisingly, the results of our main experiment do show that individuals with higher cognitive ability are less likely to display risk averse behavior but only when hypothetical risky-elicitation

[13]For a comprehensive review of the literature on intelligence testing, see, e.g., Neisser *et al.* (1996)

Table 7: Risk-Taking Behavior by Cognitive Ability Group by Cognitive Ability Group (Models with controls)

	Incentivized risk-elicitation tasks			Hypothetical risk-elicitation task		
	Proportion picking risky option	Proportion picking risky option	Proportion picking risky option	Proportion picking risky option	Proportion picking risky option	Proportion picking risky option
	[1]	[2]	[3]	[4]	[5]	[6]
Panel A: Experiment 1 (197 subjects), linear probability regression analysis						
High CRT Vs. Low CRT	0.031		0.033	0.128		0.123
Difference	*(0.0747)*		*(0.0776)*	*(0.0689)* *		*(0.0719)* *
High fluid-intelligence Vs. Low		0.020	0.017		0.061	0.049
fluid-intelligence Difference		*(0.0606)*	*(0.0595)*		*(0.0386)*	*(0.0392)*
F-Test joint significance			0.1300			5.1000
[p-value]			[0.8806]			[0.0168] **
Panel B: Experiment 1 (197 subjects), linear probability regression analysis with continuous measures of cognitive ability						
CRT score (0-3)			0.021			0.068
			(0.0345)			*(0.0245)* **
Fluid-intelligence z-score			0.004			0.051
			(0.0479)			*(0.0236)* **
F-Test joint significance			0.1900			11.2700
[p-value]			[0.8256]			[0.0006] **
Panel C: Experiment 2 (106 subjects), generalized linear model analysis						
High CRT Vs. Low CRT	-0.006	-	-0.006			
Difference	*(0.0526)*		*(0.0529)*			
High quantitative-reasoning Vs. Low quantitative-reasoning Difference	-	0.002	0.004			
		(0.0633)	*(0.0605)*			
High sequential-reasoning Vs. Low sequential-reasoning Difference	-		-0.015			
			(0.0708)			
	-					
F-Test joint significance			0.07			
[p-value]			[0.9955]			

Note: Standard-errors in parentheses are clustered at the session level. $*$ indicates significance at 10%, and $**$ significance at 5%. Controls in Experiment 1 include gender, age, education of household head, household income and number of household members. Controls in Experiment 2 include gender, age, race, education of household head, and household income.

tasks are employed. This result suggests an additional instance of how the "hypothetical choice bias" can lead to misleading conclusions.

Our results have immediate implications for studies concentrated on investigating whether cognitive capacity has a bearing on aspects of human economic behavior: some of the aspects that may account for the individual differences in performance for particular levels of cognitive ability, such as performance errors, heuristic decision-making, and computational limitations, may be mitigated if decisions have real economic consequences. The reason is simple: individuals might deploy different combinations of effort and analytical process depending on the stakes at play. More specifically, our study suggests that if these risk-elicitation tasks used in the literature are to be taken seriously in that they capture risk preferences, and the cognitive tests we use are a reliable measurement instrument of one's reasoning skills, then the finding that individuals with higher cognitive ability are willing to take more risks must be further examined.

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