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Cognitive ability and risk preferences in a developing nation: Findings from the field

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ABSTRACT

We find a strong positive relationship between risk tolerance and cognitive ability which becomes stronger as adherence to the generalized axiom of revealed preference (a proxy for rationality) increases. In contrast to typical studies of this sort, our results are taken from a field study of individuals at the very bottom of the income distribution in a developing nation. Our results for some of the poorest in the world support a link between cognitive ability and risk preferences. We merge this with findings from developed nations and argue that our overall findings suggest a stable relationship for the human population as a whole irrespective of socio-economic status.

1. Introduction

Recent work has made a strong case for the potential for cognitive ability to at least partly explain risk preferences (Dohmen et al., 2018; Amador-Hidalgo et al., 2021; Andersson et al., 2016). However cognitive ability itself can be hard to define: it is a multidimensional and a latent trait, and as such can be measured in many very different ways (Friedman et al., 2007; Toplak et al., 2014). To date the focus has mainly been on advanced developed nations, for example Andersson et al. (2016) sample the Danish population and Amador-Hidalgo et al. (2021) consider first year Spanish undergraduates enrolled in business economics). This raises the possibility that results are not generalizable to individuals in the developing world who face especially severe risk (Puthillam, 2020).

We offer a first attempt to investigate the relationship between risk and cognitive ability across several novel dimensions. First, in stark contrast to typical developed world pools, we offer results from a field study in a developing nation pool with unusually low incomes. Much has been made of the reliance upon so-called WEIRD (Western, Educated, Industrialized, Rich, and Democratic) populations with the implication being that there is little variance in the background of participants (Puthillam, 2020). Our paper is part of a larger study of the decision-making of those in a position of desperation with incomes towards the minimum in Iran, itself a middle-income developing country. In the context of the notion of a WEIRD population our pool is non-WEIRD in *every single* dimension. Second, our context is one in which risk preferences are unusually salient: our subjects are potential donors in the world's only regulated kidney market. While the decision to sell a kidney may be explained by these individuals' financial insecurity, this also provides a context characterized by high levels of uncertainty: our subjects are already thinking in terms of how to make risky decisions. Third, methodologically, we will make use of the Critical Cost Efficiency Index (CCEI) which records the extent to which decision-making is consistent with the Generalized Axiom of Revealed Preference (Choi et al., 2014). This acts as a means to control for underlying rationality when investigating the relationship between risk preferences and cognitive ability, framing our key structural regression and

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Table 1
Risk attitude and cognitive function.

	(1)	(2)	(3)	(4)
	Choi et al. (2014)			
CRT	0.007**		0.006*	−0.036**
	(0.003)		(0.003)	(0.017)
CCEI		0.062***	0.046**	−0.007
		(0.019)	(0.21)	(0.030)
CRT*CCEI				0.047**
				(0.021)
N	1014	1182	1014	1014
adj. R^2	0.025	0.0232	0.028	0.031
	Carvalho et al. (2016)			
	Stroop (correct) as cognitive ability			
Stroop(correct)	0.002		0.000	−0.014
	(0.009)		(0.008)	(0.052)
CCEI		0.026	0.026	0.009
		(0.031)	(0.032)	(0.067)
correct*CCEI				0.019
				(0.066)
	Stroop (time) as cognitive ability			
Stroop (time)	−0.015**		−0.014**	−0.034
	(0.007)		(0.007)	(0.026)
CCEI		0.026	0.023	−0.168
		(0.031)	(0.031)	(0.275)
time*CCEI				0.025
				(0.036)
N	27565	27600	27565	27565
adj. R^2	0.001	−0.001	0.002	0.002
	Moghaddasi Kelishomi and Sgroi (2021)			
iq	0.008***		0.007**	−0.001
	(0.003)		(0.003)	(0.017)
CCEI		0.112***	0.084**	0.062
		(0.037)	(0.040)	(0.057)
iq*CCEI				0.008
				(0.018)
N	213	213	213	213
adj. R^2	0.040	0.025	0.056	0.053

Notes: The dependent variable, risk-taking, is measured by the average fraction of tokens allocated to the cheaper account as in Choi et al. (2014). IQ in Moghaddasi Kelishomi and Sgroi (2021) is measured using Raven's progressive matrices test, CRT in Choi et al. (2014) is the Cognitive Reflection Test. Carvalho et al. (2016) uses 48 numerical Stroop to measure cognitive ability. Stroop (correct) is the correct answer dummy in each trial and Stroop (time) is the log of response time in each trial (in milliseconds). The panel for Carvalho et al. (2016) uses the data from the before payday sample, $n = 575$ (results for the after payday sample are very similar). Robust standard errors are reported in parentheses, $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

providing some important insights. Note also that this contrasts with the price-list methodology of Amador-Hidalgo et al. (2021) and Andersson et al. (2016). Andersson et al. (2016) argue that the relationship between cognitive ability and risk-taking may be an artifact of a particular type of mistake which is a feature of their price-list design. Since our design does not use price lists this issue would not arise in the context of our experiment.

2. Method and results

Our main method uses an experimental design combined with a series of survey questions undertaken in the field in Iran. Our design was registered in August 2017 at the start point of the field study which ran until May 2019, with further telephone interviews and follow-up sessions continuing until February 2021. The online appendix includes subject instructions and demographics. Our study also takes advantage of the data collected by Choi et al. (2014) from a random sample of 5,000 Dutch-speaking individuals in the Netherlands and Carvalho et al.'s (2016) second study using members of the GfK KnowledgePanel (KP) in the US with an annual household income of $40,000 or less. We regress a measure of risk-taking behavior on cognitive ability and decision-making quality using the data obtained from the experiments in Choi et al. (2014), Carvalho et al. (2016) and Moghaddasi Kelishomi and Sgroi (2021).

We use the following key measures:

Risk-taking: As part of a portfolio choice experiment, all three studies first describe a cheaper account that is attractive to a risk neutral individual together with alternatives that are more attractive to risk-averse individuals. Each participant is then asked to select where to allocate tokens across these accounts. Risk-taking can then be defined by the average fraction of tokens allocated to the cheaper account. The task is described fully in the online appendix (as "task 6").

Cognitive ability: To measure participants' cognitive ability, Choi et al. (2014) uses Frederick (2005)'s Cognitive Reflection Test. Carvalho et al. (2016) uses 48 numerical Stroop. "Stroop correct" is the correct answer dummy in each trial and "Stroop time" is the log of response time in each trial (measured in milliseconds). The IQ test score in Moghaddasi Kelishomi and Sgroi (2021) is measured using Raven's progressive matrices test.

Decision-making quality: This is defined by the consistency of choices in the portfolio task with the General Axiom of Revealed Preference (GARP). Following Choi et al. (2014), we measure the extent of GARP violation using Afriat's 1967 critical cost efficiency index (CCEI).

2.1. Risk taking behavior and cognitive ability

Table 1 presents the OLS results from estimating the risk-taking variable on cognitive ability and decision-making quality in Choi et al. (2014), Carvalho et al. (2016), and Moghaddasi Kelishomi and Sgroi (2021). Column 1 includes only the cognitive ability variable in each experiment. The estimated coefficients confirm the positive association between cognitive ability and risk-taking behavior. We control for age and gender across all models. In column 2 we include only decision-making quality which reveals a positive association with risk-taking behavior. Column 3 shows that the positive association between cognitive ability and risk-taking behavior remains significant after we control for decision-making quality. In column 4 we add the interaction of cognitive ability and decision-making quality to verify whether the association between ability and risk attitude varies with rationality. The results indicate that the association is indeed increasing in subjects' decision-making quality measured by the CCEI index. The estimates are once again consistent across all three experiments. The coefficient signs suggest that the highest association between cognitive ability and risk attitude is observed for the most rational individuals (CCEI = 1) and the association weakens as individuals become less consistent in decision-making.[1]

The point estimates in column 3 of Table 1, from the bottom panel for Moghaddasi Kelishomi and Sgroi (2021), for instance, indicate that a one standard-deviation increase in IQ is associated with a 0.2 standard-deviation increase in the average fraction of tokens allocated to the cheaper accounts, the risk-taking measure. Similarly, a one standard-deviation increase in the CCEI score is associated with a 0.15 standard-deviation increase in risk-taking.

[1] We test jointly whether the coefficients on cognitive ability and the interaction term between cognitive ability and decision-making quality are equal to 0, $(\beta_{CA}, \beta_{CA*CCEI}) = 0$ and also test the joint significance of the cognitive ability effect and the interaction term, $(\beta_{CA} + \beta_{CA*CCEI}) = 0$. The two tests are both significant with $p = 0.049$ and $p = 0.017$, respectively, in Choi et al. (2014), $p = 0.021$ and $p = 0.48$ in Carvalho et al. (2016) using Stroop (time) as a measure of cognitive ability, and with $p = 0.035$ and $p = 0.021$ in Moghaddasi Kelishomi and Sgroi (2021).

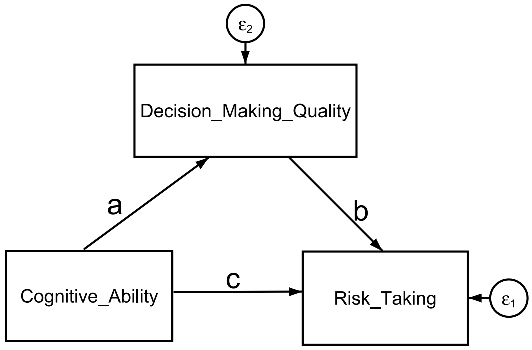

Fig. 1. Structural equation model.

2.2. Structural equation modeling

In order to evaluate the direct and indirect effect of cognitive ability on risk-taking behavior we use structural equation modeling (SEM) à la Amador-Hidalgo et al. (2021). This aims to show the extent to which the quality of decision-making mediates the relationship between cognitive ability and risk-taking behavior, and allows us to compare our results on mediation directly to their findings.

Fig. 1 provides a schematic representation of the SEM model. We estimate the total, direct and indirect effect of cognitive ability mediated through the decision-making quality. The Maximum Likelihood estimates are reported in Table 2 for the SEM model. The first column shows the direct effects of cognitive ability and the quality of decision-making on risk-taking behavior as well as the direct association between cognitive ability and the quality of decision-making, the directions, and the SEM parameters c, b, and a described in Fig. 1, respectively. All the direct effects except the effect of decision-making quality on risk-taking behavior in Carvalho et al. (2016) are statistically significant at the 1 or 5 percent significance level across all three experiments. Column 2 presents the indirect effect of cognitive ability through participant's decision-making quality. The effects are positive and statistically significant in Moghaddasi Kelishomi and Sgroi (2021) and Choi et al. (2014) and are of the expected sign though not significant in Carvalho et al. (2016). The total effect of cognitive ability on risk-taking behavior in column 3, is positive and significant which is consistent with our earlier findings and those in the literature.

The indirect effects of cognitive ability on risk-taking behavior mediated through decision making quality, shown on column 2 of Table 2, are relatively small compared to the direct effects in column 1. Importantly, these results imply that there is a genuine relationship between individuals' cognitive ability and their risk attitudes which does not stem from the quality of their decision-making. This finding effectively extends the results on WEIRD-populations to our distinctly non-WEIRD pool and contrary to Amador-Hidalgo et al. (2021) our measure of rationality does not hinge on probability calculation errors when facing lottery choices.

3. Conclusion

Our results provide new evidence for a negative relationship between risk aversion and cognitive ability, especially when we control for adherence to the generalized axiom of revealed preference (a classic measure of rationality). Moreover, our evidence is derived from a field setting as far removed from the standard WEIRD environment as possible, strengthening the idea that the relationship is general.

Table 2
The impact of cognitive ability of risk taking behavior via decision making quality.

	Direct effects inside (.)	Indirect effects a*b	Total effects c+a*b
	Choi et al. (2014)		
Risk-taking as a function of			
CRT	0.008^{***}(c)	0.0015^{***}	0.009^{***}
	(0.003)	(0.006)	(0.004)
CCEI	0.063^{***}(b)		
	(0.003)		
Dep var: CCEI			
CRT	0.024^{***}(a)		
	(0.000)		
	Carvalho et al. (2016)		
Risk-taking as a function of			
Stroop (time)	-0.014^{**}(c)	-0.0009	-0.015^{**}
	(0.032)	(0.50)	(0.022)
CCEI	0.023(b)		
	(0.47)		
Dep var: CCEI			
Stroop (time)	-0.0376^{***}(a)		
	(0.003)		
	Moghaddasi Kelishomi and Sgroi (2021)		
Risk-taking as a function of			
IQ	0.006^{**}(c)	0.0013^{**}	0.008^{***}
	(0.017)	(0.036)	(0.003)
CCEI	0.084^{**}(b)		
	(0.030)		
Dep var: CCEI			
IQ	0.015^{***}(a)		
	(0.000)		

See note under Table 1.

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