Have your cake and eat it too: real effort and risk aversion in schoolchildren

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Abstract

There is a large body of evidence documenting gender differences in preferences and their effects on a range of behaviours (including health and risky behaviours) and choices (including education, labour market, savings, marriage, and fertility). A key issue in order to mitigate some of the undesirable effects of these differences (the tendency for boys to engage in more risky behaviours or for girls to avoid choices that might instead benefit them) is establishing how soon such differences arise. Gender differences in competitiveness and risk aversion have been widely documented both in the lab and the field (Falk et al, 2015), and more recently adapting experiments normally performed with adults to children (Samak, 2013; Harbaugh et al., 2002). We advance this literature with a study of primary school children which consists of an innovative two-stage task game addressing both effort and risk: in the first stage a real effort task allows children to accumulate points playing a video game, and in the second they play a lottery game in which probabilities are presented visually. The two-stage task game is designed in order to avoid both the valuation and the probability problems that children normally face in such tasks. Our findings confirm the existence of gender differences in risk aversion once controlling for performance in a gender neutral task in schoolchildren, and contribute a visual way of using lotteries with children that yields results consistent with rational behaviour.

JEL classification

C79; C90; D81; J70

Keywords

Gender; Risk Aversion; Child Preferences; Artefactual Field Experiment

1. Introduction

There is a large record of studies looking at how women differ from men in risky preferences, and risk aversion has often been studied as one of the possible causes of the pay gender gap (women may self-select in less risky, therefore less remunerative, occupations). Croson and Gneezy (2009) report gender differences in preferences, distinguishing three main categories: risk preferences, social preferences and competitive preferences. Recent findings from the Global Preference Survey (Falk et al, 2015) suggest that women tend to be less patient and more risk averse and exhibit a stronger social predisposition than men across all 90 cultures included in the survey, and these differences in preferences are also strongly linked with a range of behaviours and choices, including in relation to education, fertility and labour markets.

It is important to understand what generates this difference, as the answer would shape the policies in a completely different way: if risk aversion is genetically inherited, then the matter would be to find out the right incentives to modify behaviours. On the contrary, if risk aversion depends on the environment around, then the target would be to interact with the family background and the culture transmitted behaviours since early childhood.

Evolutionary psychologists (Eals and Silverman 1994, Nicholson 1997) suggest risk aversion may be an inherited trait that comes from the hunter-gatherer ancestral society, where women had to self-preserve in order to safeguard their reproductive potential. This trait would then have settled over the ages with species selection (Fine, 2014). A different explanation for gender differences in risk aversion arises instead from the role of environmental factors on human behaviours, including the selection of particular technologies (Alesina et al, 2013).

Gneezy et al. (2009) represents a fundamental contribution to the debate, focusing on the gender differences in competitiveness. By means of an artefactual field experiment, the authors compare gender differences in competitiveness in two different types of society: a Matrilineal one (the Khasi tribe in India) and a Patriarchal (the Masai tribe in Tanzania). They find significant gender differences in competition: in particular women in the Khasi tribe show more competitive preferences than men in both tribes. A similar result is found by Booth and Nolen (2012) and Booth, Cardona-Sosa and Nolen (2014) in both risky and competitive behaviours. Booth and Nolen (2012) compare the effect that single-sex schools have on female attitudes toward risk. The experimental subjects are students from eight different UK secondary schools (from the counties of Essex and Suffolk), half of which single sex school and the other half co-ed (i.e. gender mixed) schools. Students participated in three different treatments: a real stake lottery, a hypothetical lottery and a general survey based on the self-assessment of the risk by each individual. Interestingly, their results confirm the effect that the single-sex school environment and also the single-sex group have on female risk attitude: girls have a higher preference for risky choices when attending a single sex school and when they are allocated to an all-female group (despite the school attended). Similar results are found in laboratory experiments, confirming that there is a significant difference between the female and male risk attitudes even in a controlled environment (Eckel 2008, Eckel and Grossman 2008)[1].

Most evolutionary behavioural theories assert that gene-environment interactions cannot really be disentangled, and in order to understand the potential for intervention rather focus on tracing the ages at which gender differences arise. Samek (2013) finds no significant gender differences in competitive behaviours on a sample of pre-schoolers aged 3 to 5 years old. Her study measures competiveness by means of a piece rate versus tournament incentive scheme in a controlled experiment, specifically adapted for the young age of the participants. She uses a real effort task consisting in a fishing game: children had a magnet pole serving as fishing rod to catch fish on a spinning plate. The game consisted of three rounds. In the first round children played under the piece rate incentive scheme, so each fish caught earned one candy. In the second round, they were playing in a tournament incentive scheme where only the winner of the tournament got two candies for each fish caught. In the third round, children had the choice to select the incentive scheme between piece rate and tournament. The use of non-monetary rewards is one of the adaptations that need apply when designing incentives schemes for young children, who are not normally capable of making meaningful value comparisons when money is involved (valuation problem).

Cardenas et al. (2012) studies competitiveness and risk taking of children aged 9 to 12 years old comparing two different countries: Colombia and Sweden. The initial hypothesis is that in Colombia, due to a higher gender inequality, boys are more competitive than girls; whereas in Sweden no differences were expected. As far as risk taking is concerned, boys were expected to be more risk lover than girls and a wider gap was expected in Colombia with respect to

[1] For a complete and critical overview on the role that gender has on preferences over risk read Crosetto and Filippin (2015).

Sweden. The study makes use of two different tasks to evaluate individual competitiveness: in an outdoor physical activity they were competing in running and skipping rope, whereas in the indoor activity they had to either compete in a math or word search. The risk evaluation was composed by six choices similar to the Holt and Laury lotteries modified for children. Interestingly, this study finds that, while there is no significant gender difference in competitive behaviour in both countries, as far as risk aversion is concerned boys are more risk lover than girls, especially in Colombia.

When aiming to assess risk aversion in children, a further complication arises in that it is essential that experimental subjects understand the concept of probabilities linked to the different lotteries and individual's choice over lotteries is sensitive to change in expected value. This is especially difficult to assume when experimental subjects are very young, as schoolchildren's ability in probabilistic reasoning is strictly related to individual mathematical ability (Nunes et al., 2015). We call this the probability problem. One of the first attempts to look at the origins of risk aversion and its evolution over time by means of a monetary incentivized controlled experiment is the study by Harbaugh et al (2002). Changing the payoffs according to the age of the participants, the authors use simple lotteries where experimental subjects need to choose between a certain amount of money and a variable lottery where only the probabilities changed. They report higher risk loving behaviour at young age, which decreases with age. However, this study strongly rely on children's ability to process lotteries output.

In our study we examine gender difference in risk aversion among children between 9 and 11 years of age attending primary schools in northern Italy. Addressing the shortcomings of previous studies of risk evaluations of schoolchildren, we introduce a two-stage task game specifically designed to avoid both the valuation and the probability problems. The first stage of the game acts as a real effort task where children earn points playing a video-game. In the second stage, the points initially earned acted as starting points for a lottery game where children choose between a very simple safe and a risky option. The task has been designed in such a way children's risk preferences are revealed by the lottery choice, for which the points earned in the first part of the experiment act as endowment. The final score was then converted in sugar free jellies which were handed out to the participants by the experimenters at the end of the session.

2. Experimental Design

The experiment was run in 2013 in Turin (Italy), during the annual Turin Bookfair, an international book events that brings together editors, book writers and readers from all over the world. The fair has a special section on books for children. Our participants were schoolchildren from primary schools aged 9-11 attending a one-day school trip to the book fair and taking part in a series of talks and events. The activities included meetings with popular book writers, group discussions, movie shows, group activities and computer activities in a digital lab. Our experiment was one of the activities included in the digital lab, where children learnt about new educational apps and interacted with iPads. A total of 100 children took part in the experiment over three days, all coming from primary schools in the Turin area.

Schoolchildren arrived in groups chaperoned by two teachers. After the registration at the book stand, the four experimenters divided the children in two or more groups, depending on class size. The experiment was played by 6 schoolchildren per time on iPads, which were specifically set for running only that specific activity and had no access on other activities during the experiment. The experimenters brought each child to the iPad dock station and touched the button to get to the first screen of the experiment. At the start, the lead experimenter explained the game to participants. In order to keep children's attention during the explanation, the experimenter memorized instructions and explained the game without reading them out. Keeping eye contact with the young participants was important for maintaining their attention alive and understanding if something was unclear in the instructions. Graphical examples of the game and the lotteries were provided during the explanation. A particular emphasis was given to the explanation of the lotteries: we graphically presented every lottery and we compared the two choices showing what exactly meant the choice between the safe option and the risky options. In order to explain the difference between the risky and safe choice in terms of final output we used two small coloured fabric bags. In one green fabric bag there was the plastic number corresponding to the safe option points; whereas the blue fabric bag was either empty or with the plastic number corresponding to the risky option. The experimenter went through a detailed explanation of the tasks two times and each time children were asked if they had understood. The first time the experimenter explained the instructions very carefully without the use of the ipad. The second time the children had the possibility to practice to the game and the lotteries by using the button Play 1, while the experimenter repeated the instructions. Immediately after the explanation was concluded, participants were allowed to raise their hands and ask questions one at the time to the experimenters, who approached the child and directly replied to the posed question. The experiment then began pushing the button Play 2.

In addition to the experiment, we also asked children to complete a short survey including a few basic questions with set options to gather information on parents' occupation and after school arrangements (whether with family, at school or at home with a baby sitter), in order to assess the extent to which they spent time with their school peers (by remaining in afterschool) and with their families. Peer effects have been extensively studied, including in education (Calvo-Armengol et al., 2007), and Sacerdote (2014) finds that although some of these effects are highly context specific (notably test scores and exam performance), significant and strong peer effects have consistently been found in studies of risky behaviours (crime, drinking, smoking) and in career choices. Preferences are also found to be strongly linked to parental attitudes and preferences (Alan et al. 2014), as well as the amount of parental time invested in children (Zumbühl et al, 2013), and recent work by Johnston et al. (2014) making use of the 1970 British Cohort Study finds that gender role attitudes of mothers and children's measured 25 years apart are strongly correlated and that both the human capital and the labour supply of daughters (and that of sons' partners) are strongly affected by their mothers'.

2.1 The Real Effort Task

The experimental literature presents copious and variegated examples of real effort tasks. From the slider (Gill and Prowse, 2012) to the maze (Gneezy et al., 2003), solving tasks as the 2-digit game (Vesterlund and Nierderle, 2007) and the counting-zeros (Abeler et al., 2011) or simply entering data in a computer (Gneezy and List, 2006), their key feature is that they elicit a concrete effort exerted by the participant responding to the underlying incentives. Real effort tasks have been applied to study different individual decision processes (Lezzi et al., 2015, Rosaz and Villeval, 2012) both in the lab and in the field. The majority of these experiments study labour market applications in a laboratory setting (Brandts and Charness, 2004; Dohmen and Falk, 2011; Sutter and Weck-Hannemann, 2003).

In the last decade, there have been also several applications of real effort task in field experiments, some of which compared the results found in the field with previous literature based on laboratory experiments in search of corroboration. Gneezy and List (2006) use two different real effort tasks to test the gift exchange hypothesis in an "actual labour market". They compare the results from the field experiment with the average results from the gift exchange in the lab experiments. A group of participants were hired for a one time job at a public library to enter data on a list of books. The second group participated to a door-to-door fundraising campaign for a university research centre. The results they found was that the real effort task in a field experiment context confirmed the lab experiments results only in the short term, whereas after a few hours the task was started the gift effect on labour productivity decayed. Falk and Ichino (2006) designed a field experiment to evaluate the effect of peer pressure on individual productivity. The task consisted in filling envelopes with a letter. In the treatment group, participants were completing the task in group of two in the same room, getting the possibility to observe the work completed by the other worker. In the control group, subjects were completing the task alone, without any other participant in the same room. Comparing treatment and control group Falk and Ichino (2006) found that peer effect has a strong influence on individual productivity of stuffing envelopes, increasing the final output by 16%.

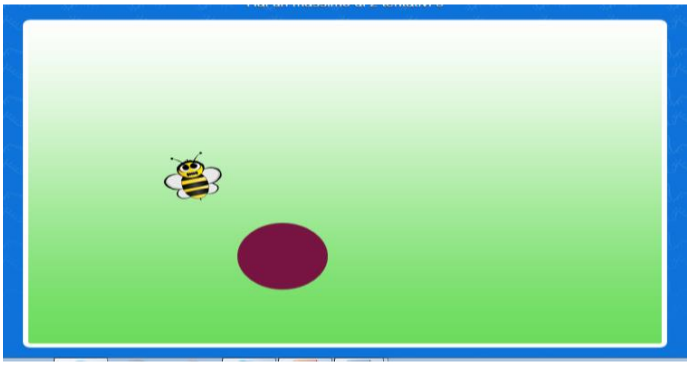
In the last decade, real effort tasks have been used also to study the origins of preferences and to elicit individual decision making since young age. In Calsamiglia et al. (2013) schoolchildren were required to solve Sudoku games in order to evaluate the effect of affirmative action policies on tournament performance and on incentives schemes. Belot and Van de Ven (2011) test whether favouritism has any detrimental effect on individual performance in a tournament. Schoolchildren aged 6 to 8 and 10 to 12 were involved in a physical real effort game, moving as many balls as possible from one basket to another in 30 seconds. The authors were interested in studying the effect that favouritism has in terms of work environment efficiency and they found schools as the perfect environment for tackling their research question: "school children interact with each other on a daily basis and are embedded in a long-term social network" (Belot and Van de Ven, 2011, p.1248) similar to what happens in the workplace. The results showed that despite children tends to favour their friends, the favouritism generate a reciprocal sentiment that boost effort in the real effort game. Alan et al. (2016) use a mathematical real effort task in order to evaluate the effect of an educational intervention, designed to improve individual grit, on primary school children. The training program involved a team of educational experts and school teachers, aiming at educating school children aged 8 to 10 years old to goal setting, perseverance and goal achievements. The effect of the training on the student population was measured by means of the incentivized real effort task, test scores and pre-and post-treatment questionnaires. The real effort game consisted in a grid where children had to find pairs of numbers that summed up to

100. There were two different types of grids, one easier to solve and the other more difficult, with two different rewards, four gifts for game solved versus only one gift for game solved. If the grid was not solved than players got zero gifts. Children had to choose at the beginning which type of reward/grid they wanted. The authors found that the treatment group, exposed to the educational training, were more likely to select the more rewarding incentive scheme engaging in the more difficult game.

All these studies are examples of how it is possible to use real effort tasks in order to study the effect of incentives, effort provision and eventually the evolution of the decision process since early childhood. Applying real effort tasks has an important benefit: since the reward is the effect of an effort, controlling for individual ability, players clearly express their preferences.

We introduce a real effort task in order to elicit individual risk preferences at early age. Our task is constructed in such a way that children earn, exerting an effort, the points that then represents the endowment used to play the risky lotteries. In this way, we do not provide children with house money to express their risk preferences, but we make them gaining their endowment avoiding windfall effect (Houser and Xiao, 2015).

The real effort task is a simple game called SnackQuest, which required children to tap on balloons in order to pop them before a bee reached them. The choice of game was made in consultation with game designers to whom we asked specifically which video games were most played by boys and girls (the number of girls playing games is steadily increasing, and is now similar to that of boys, as documented by the families' survey conducted by the Italian Statistical Office, ISTAT http://www.istat.it/it/archivio/91926). All of our participants declared they had played videogames of this type before and were familiar with iPads.



The game lasted between 60 and 80 seconds and presented a maximum of 2 balloons that could be popped. Children obtained one point if they did not manage to pop any balloon, five points if they popped 1 balloon and ten points if they popped 2.

The points earned in the game were then used as initial endowment for the lotteries. Therefore, those who scored 1 point started the lottery with an endowment of 1, those who scored 5 points started the lottery with an endowment of 5 and who scored 10 points started the lottery with an endowment of 10.

Translation: 'You earned 1 point! Now you can try your luck: you will have five opportunities to choose between keeping your point, or trying your luck to increase it. One of those will be chosen by the computer as your final score, so pay attention to all of them!'

Upon completing the task, the screen displayed the total points collected and children were invited to move to the lotteries, which were presented as a succession of five screens each presenting two disks representing the safe choice always on the left hand side with its value clearly legible and the risky choice always on the right hand side with its two possible values clearly legible. Below is one example of the screens:

Translation 'Choose the pie you prefer'

Each lottery gave the choice between one safe option versus a risky option. Children had to choose for 5 times between these two alternatives. The lotteries have been designed following the Multiple Price List scheme (Holt and Laury, 2002) adapted by Dohmen et al.(2010).

Table 1: Lotteries design

Endowment	Cake A	Cake B
1	1 point for sure	50% chance of getting 5 points and 50% of getting 0 points
1	2 points for sure	50% chance of getting 5 points and 50% of getting 0 points
1	2.5 points for sure	50% chance of getting 5 points and 50% of getting 0 points
1	3 points for sure	50% chance of getting 5 points and 50% of getting 0 points
1	4 points for sure	50% chance of getting 5 points and 50% of getting 0 points
5	5 points for sure	50% chance of getting 14 points and 50% of getting 0 points
5	6 points for sure	50% chance of getting 14 points and 50% of getting 0 points
5	7 points for sure	50% chance of getting 14 points and 50% of getting 0 points
5	8 points for sure	50% chance of getting 14 points and 50% of getting 0 points
5	9 points for sure	50% chance of getting 14 points and 50% of getting 0 points
10	10 points for sure	50% chance of getting 25 points and 50% of getting 0 points
10	11 points for sure	50% chance of getting 25 points and 50% of getting 0 points
10	12.5 points for sure	50% chance of getting 25 points and 50% of getting 0 points
10	14 points for sure	50% chance of getting 25 points and 50% of getting 0 points
10	15 points for sure	50% chance of getting 25 points and 50% of getting 0 points

We designed the scoring system so that the third choice was always the switching point from risky to safe choice at all endowment levels for a risk neutral child. This middle point offers exactly the same expected value as the risky choice, making the risk neutral decision maker indifferent between risky and safe choice. In the first two choices a risk neutral subject would choose the risky option, getting an expected value higher than if they had opted for the safe choice. In the last two options, a risk neutral individual would choose the safe option, getting a higher expected value. Risk loving children would select always the risky options, whereas risk averse children would choose always the safe option. Given the age of the participants and the difficulty in choosing between lotteries, we limited the number of choices and the variability in the prizes in order to make the lottery choice easy to understand.

The computer programme randomly chose one of the five lotteries as the final score, and that was displayed in a final screen thanking participants and pointing them to the experimenters for converting their points into jellies.

3. Results

3.1 First stage: real effort task

In line with the real effort literature, we found no significant gender differences in the first stage of the experiment (the video game), as Table 2 illustrates:

Table 2 Average Score by gender

Score in the Real Effort Task	**Boys**	**Girls**	Total
1	**29**	**25**	**54**
%	*48.33*	*62.5*	
5	**23**	**12**	**35**
%	*38.33*	*30*	
10	**8**	**3**	**11**

%	*13.33*	*7.5*	
Total	60	40	100
%	*100*	*100*	

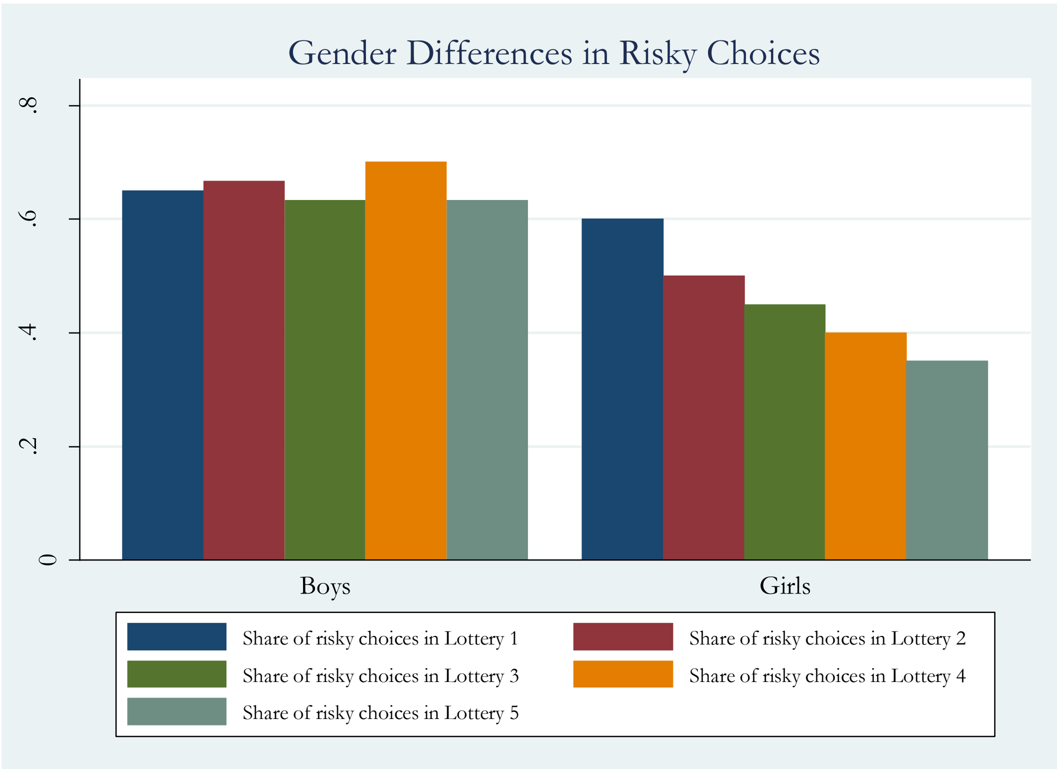
We perform a ranksum test to analyse if there is a difference in scoring between girls and boys and if that difference is significant. The test has a p-value of 0.15 excluding a significant difference between scoring in the real effort task (Prob > |z| = 0.1485).

This result is important because it suggests that there are no gender differences in performance when the task is designed in a gender neutral way and purely to elicit effort.

3.2 The second stage: measuring risk through lotteries

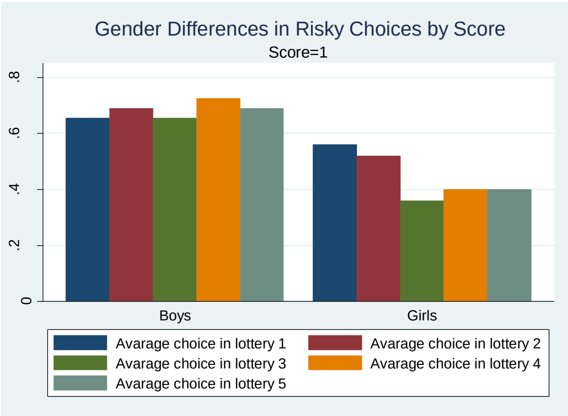
We observed the usual pattern of behaviour in lotteries, with switching from safe to risky options as the expected value of the risky options increased. This is important as it suggests children are behaving rationally and understand the way the choices were posed well.

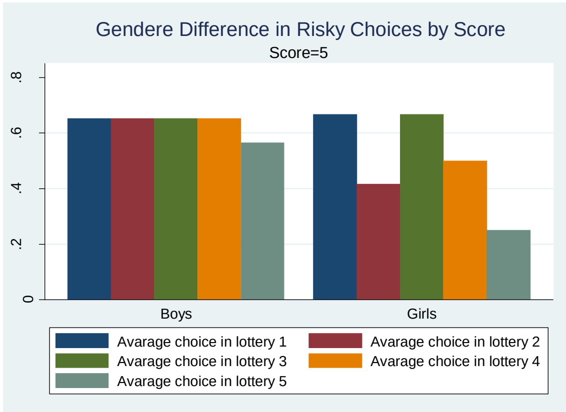
Figure 1

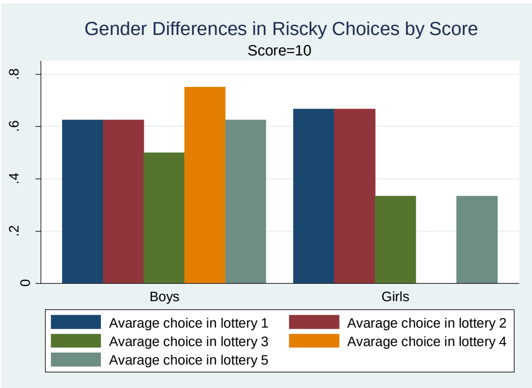


We also clearly observe gender differences in risky choices, with boys more willing to take risk at all endowments levels, as illustrated in figures 2-4 below:

Figures 2-3-4: Gender differences in risky choice by initial endowments







3.3 The effect of family and peers

We were also interested in testing whether risky choices were affected by parental employment (and particularly whether the pupil's mother works) as well the amount of time normally spent with peers and family, controlling for pupil's gender and performance in the real effort task. In order to test for this, we run an OLS regression model of risky choice[2], controlling for gender, performance in the real effort task and both parental employment and peer effects (measured by extra time spent with classmates in afterschool). The dependent variable Risky Choice is a count variable that adds together all the risky options taken by the

[2] The dependent variable Risky Choice has been constructed as a count variable. For this reasons we performed a Poisson regression as additional estimation procedure. We did not find significant differences in the estimation outputs. Albeit, Poisson estimations that include more than three independent variables are non-significant.

players in the lottery. The players had to make a choice for each of the five lotteries; therefore the maximum value of Risky Choice is equal to 5 and the minimum value is zero, in case the player always chose a safe option. Game Score is a dummy variable equal to zero if the player got only one point in the SnackQuest game and equal to one if the player scored five or ten. Given that only eleven children scored ten in the SnackQuest game, we decided to create a variable Game Score grouping players scoring five and ten versus who got one in the game. Mother in Work and Father in Work are dummy variables equal to one if the parent has a job, we do not distinguish between permanent and temporary jobs. Afterschool is a dummy variable equal to one if the kid spends additional time at school for extra curriculum activities.

Table 3: Parental and peer influences on risky choices

Risky Choices	(1)	(2)	(3)	(4)	(5)
Female	-0.983	-1.027	-1.000	-1.027	-1.026
	(0.344)**	(0.349)**	(0.355)**	(0.353)**	(0.352)**
Game Score		-0.087	-0.096	-0.088	-0.086
		(0.336)	(0.339)	(0.341)	(0.341)
Afterschool		-0.165		-0.163	-0.169
		(0.364)		(0.389)	(0.387)
Mother in Work			0.046	0.085	0.021
			(0.389)	(0.412)	(0.395)
Father in work			-0.764	-0.749	
			(0.828)	(0.838)	
Constant	3.283	3.389	4.048	4.057	3.373
	(0.201)**	(0.281)**	(0.804)**	(0.815)**	(0.406)**
R^2	0.08	0.08	0.09	0.09	0.08
N	100	100	100	100	100

* p<0.05; ** p<0.01
Robust Standard Errors in parentheses

The regression analysis confirms the gender effect illustrated with the figures in section 3.2. We do not find evidence of either parental or peer effects in our sample, although this is probably due to the relatively small sample size.

4. Conclusions

Our paper contributes to the literature seeking to understand if gender differences in risk preferences arise during childhood. We test gender differences in risk in children making use of a real effort task, which allows us to enter endowments that are earned in a gender neutral task designed to elicit pure effort, thus providing differentiated endowments by effort and enabling to control for performance. We develop a videogame that is designed for this purpose and a visual representation of lotteries that allows overcoming the problems children normally face in evaluating probabilities and understanding monetary values.

Our findings confirm gender differences in risk in children of primary school age, which has very important implications for the design of school curricula and education programmes more widely: much mathematical testing and activities fitting within the science curricula, for example, are often based on pupils taking risks, which could in and of itself lead to gender bias in the performance of pupils, and contribute to the explanation of why girls' maths achievements are often below those of boys in Italy.

Worldwide the achievements in maths by girls have been found to be strongly connected with the wider gender norms of societies (Guiso et al, 2008), as well as a range of differences in cognitive and emotional factors, but even in countries where girls outperform boys in this subject, such as the UK, they often opt out of continuing to study them for reasons associated with a range of issues including gender stereotyping and school environments (Favara, 2012) and parental (and particularly mothers') attitudes Johnston et al (2014). As a result, and there is a gender gap in the choice of science and maths subjects (Institute of Physics, 2013; Smith and Golding, 2015) that affects the selection of women out of STEM subjects (Science, Technology, Engineering and Maths) at University and in the labour market, with important effects on pay gaps, career gaps and individual and household outcomes later on (Petrongolo and Olivetti, 2008; Ceci and Williams, 2010).

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