Motivating Risky Choices Increases Risk Taking

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ABSTRACT

We study the impact of the mode of cognition on risk taking. In an online experiment we ask participants to make a simple decision involving risk. In the control group no manipulation is made, while in the treatment group we exogenously manipulate the mode of cognition by requiring subjects to write down a text that motivates their risky choice before any action is actually taken. Such motivation treatment is meant to induce more reflection upon the action to be taken. Our results show an effect of the motivation treatment on risk taking, suggesting that higher reflection makes subjects more prone to risk taking. The effect is stronger if we consider only subjects who imperfectly understand the probability distribution implied by the simple choice task. Based on our experimental findings, we suggest that reflection and comprehension might be substitutes when individuals make decisions involving risk.

Introduction

In many real-life situations people make decisions intuitively with barely no effort, while in other situations they exert a substantial effort to make more conscious and reflected decisions. Given the pervasiveness of decisions involving risk, it seems important to understand how these different modes of cognition affect decision-making under risk. Such understanding would be especially relevant for policy interventions related to excessive or insufficient risk taking.

Experimental evidence shows that risk preferences are not always a stable trait of the individual across different choice situations, especially for what concerns risk aversion in relation with different modes of cognition[1,2]. While such evidence points to an effect of cognition on risk taking behavior, there is no general consensus on how this effect actually shapes risk taking. Greater reliance on intuition has been found to lead choices involving risk to be more in line with risk aversion[3]. In particular, in the domain of gains, people tend to be more risk averse if their choices are more intuitive. Although this prediction might be consistent with the finding that subjects' Cognitive Reflection Test scores are inversely related with risk aversion[4], results from other researches focusing on the causal effect of the mode of cognition on risk taking are not conclusive. Time pressure on decision-making leads to more risk aversion[2,5], and cognitive load is associated with more risk-averse behaviors[1]; however, reliance on intuition appears to increase risk tolerance[6], and arousal increases risk taking[7], suggesting that reliance on intuition is not necessarily associated with more risk aversion. Finally, depleting self-control seems to have negligible effects[8]. Further, there is evidence that lower reflection is correlated with higher probabilities to participate in risky activities[9]. Thus, it is fair to say that the actual effect of cognition on risk taking seems to depend on the method which is employed to manipulate the mode of cognition.

We contribute to this literature by investigating how risk taking is affected by greater reflection induced by the request to motivate one's decision. Such method has never been applied to study this issue. We run an online experiment where we ask participants to make a simple decision involving risk: the "Bomb Risk Elicitation Task" (BRET)[10], which has been recently used in a number of studies to measure risk taking behavior[11–14]. We attempt to manipulate the extent of reflection by means of a motivation treatment: participants are required to motivate their choice with a written text before any decision is actually made. Online experiments are characterized by shorter procedures and lower stakes with respect to laboratory experiments, which reasonably increase the likelihood that participants make quick and intuitive decisions[15]. On the one side, this suggests that inducing greater reflection – as we attempt to do – can produce greater effects than in typical laboratory experiments. On the other hand, there is the risk that experimental subjects put too little effort in the experimental task for any effect to emerge. For instance, experimental subjects on Amazon Mechanical Turk have been shown to devote limited attention while performing online tasks[16]. To avoid this, our experiment was designed to be quick, graphically informative, and engaging, in order to minimize the the risk that experimental subjects put little attention. For this reason we applied the BRET with graphical representation[14] instead of other measures of risk preferences applied in the literature which involve thoughtful introspection or require complicated hypothetical reasoning[17–20].

The experimental data that we collect provide evidence for a positive effect of the motivation treatment: participants in the treatment group take significantly more risk than participants in the control group. This is in line with previous work[3] suggesting that decisions processed intuitively are more likely to be consistent with risk aversion. Moreover, the treatment effect is stronger for the individuals who, even if answering correctly the control question, failed the comprehension questions on probabilities of the BRET. Finally, we observe that better understanding is associated with more risk only for participants who are in the control group. These findings suggest that reflection, as triggered by the motivation treatment, and comprehension of the BRET, as measured by correct answers to questions on probabilities, are substitute factors that can increase risk taking.

Ours is the first experiment on risk taking behavior where cognition is manipulated by means of the recently developed method where subject are required to motivate their decision with a written text[21]. While it has yet to be established whether such motivation treatment is more or less effective in inducing reflection than traditional ones, like time delay[2,22–26] or priming[6,24,27,28], it does have been proved to be easily implementable and to work properly in an online setting[15,29].

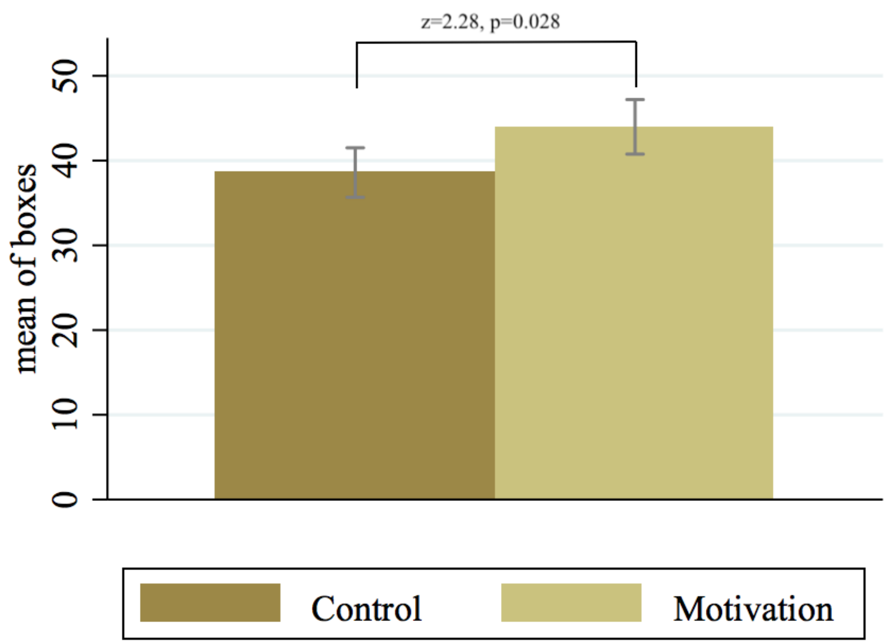

Figure 1. Number of boxes opened in the control group and treatment groups. The treatment effectively increases the number of boxes opened by about 10% (from 39.6 to 44 boxes; statistics reported for Mann-Whitney tests of equal distributions).

Results

Out of 398 participants, 9 are excluded from the dataset before the analysis, as 2 subjects failed the control question (1 in the control group and 1 in the treatment group), and 7 subjects decided to open 100 boxes (4 in the control group and 3 in the treatment group), which is a dominated strategy and therefore likely to be associated with a mistake (Supplementary Information provides the analysis of the data with no restrictions). 200 participants were randomly assigned to the control group, and 189 to the treatment group where they had to write a motivation for their decision before taking action in the BRET. Subjects in the treatment group took about 60 seconds more than those in the control group to complete the BRET. On average experimental subjects completed the whole experiment in 3 minutes. Average earnings were 0.49 GBP.

The treatment and the control group appear to be balanced. Gender, age, and self-assessment of risk preferences, which are all potentially associated with risk taking behavior, are similarly distributed in the two samples. Mann-Whitney tests cannot reject the hypothesis that the control variables have the same distribution in the two groups (gender z = 0.034, p=0.97; age z = 0.789, p=0.43; self-assessment of risk preferences, z = 0.564, p=0.57). Also, the fraction of correct answers to the comprehension question – concerning the probability of getting the bomb in the BRET – is not substantially different in the control group (37.5%) and in the treatment group (41.3%) (Fischer's exact test, p=0.468).

The treatment effect

To assess risk taking behavior we use the number of boxes opened by experimental subjects in the BRET, ranging between 0 and 100 (also referred to simply as "boxes"). The greater the number of boxes opened, the greater the risk taken.

Figure 1 shows how the mean of boxes opened varies between the control group and the treatment group. There is a treatment effect which induces experimental subjects to take more risk: the average number of boxes opened in the control group is 38.59, while the average number of boxes opened in the treatment group is 43.98, with a statistically significant effect size of about 10% (Mann-Whitney test, z=2.28,p=0.028).

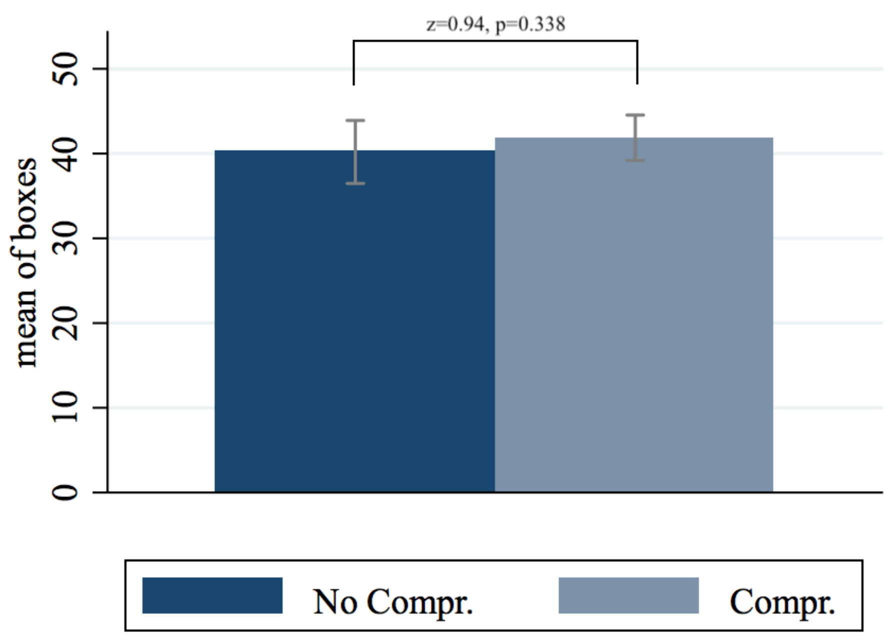

Figure 2. Number of boxes opened by the experimental subjects splitted in the group of those who gave a wrong answer to the comprehension question regarding the probabilities involved in the BRET (left bar) and in the group of those who gave a correct answer (right bar). No appreciable difference is found between the two groups (statistics reported for Mann-Whitney tests of equal distributions).

The role of comprehension: An exploration

To check if experimental subjects understood the probabilities involved in the BRET, at the end of the experiment we asked them "If you have collected 35 boxes, what is the probability of getting the bomb?" and they had to enter manually a number (see Slide 5A in the Supplementary Information). The answers to this comprehension question were not appreciably different between the control and treatment groups. Moreover, as shown by Figure 2, the average number of boxes opened was not appreciably different between experimental subjects who answered correctly to the comprehension question and those who did not.

Yet, we found appreciable differences in the average number of boxes opened in the control group (Figure 3, left chart) when we compare experimental subjects who answered correctly to the comprehension question and those who did not (Mann-Whitney test, z=2.54, p=0.011). In particular, experimental subjects who gave a wrong answer opened, on average, less boxes than those who did answer correctly. In contrast, we found no difference when we do the same comparison for the treatment group (Mann-Whitney test, z=1.10, p=0.274).

This finding suggests that the treatment and the comprehension of the probabilities involved in the BRET may have interacted in some way. To explore this possibility we also looked at the treatment effects within the group of experimental subjects who answered correctly to the comprehension task and those who did not. Consistent with this idea we find that the treatment effect is appreciable only for the latter group (see Figure 3, right chart).

Further, we tested the hypothesis that the mean boxes opened in the sub-group of subjects in the motivation treatment who gave a correct answer to the comprehension question is equal to the mean of boxes opened in the control treatment who gave a wrong answer to the comprehension question: the Mann-Whitney test does not reject the null hypothesis (p = 0.180, z=1.34).

Regression analysis

In order to assess the joint statistical significance of what can be inferred from the previous non-parametric analysis, we run a series of regressions (reported in Table 1). We use linear regressions (OLS) where the dependent variable is the number of boxes opened while the independent variables are treatment, comprehension, and their interaction, besides three additional control variables (sex, age and self-reported willingness to take risk).

From Model (1) we see that the treatment effect resists to the inclusion of a dummy variable taking value 1 when the answer to the comprehension question was correct. The estimated linear effect of the treatment is that, on average, about 5.5 additional boxes are opened, while comprehension seems not to have an effect *per se*.

In Model (2) the interaction between the treatment and comprehension variables is added. The estimated treatment effect, net of comprehension, grows to about 11.3 (of additional boxes opened) and remains statistically significant, while the estimated coefficient of the comprehension variable is about 6.6 and

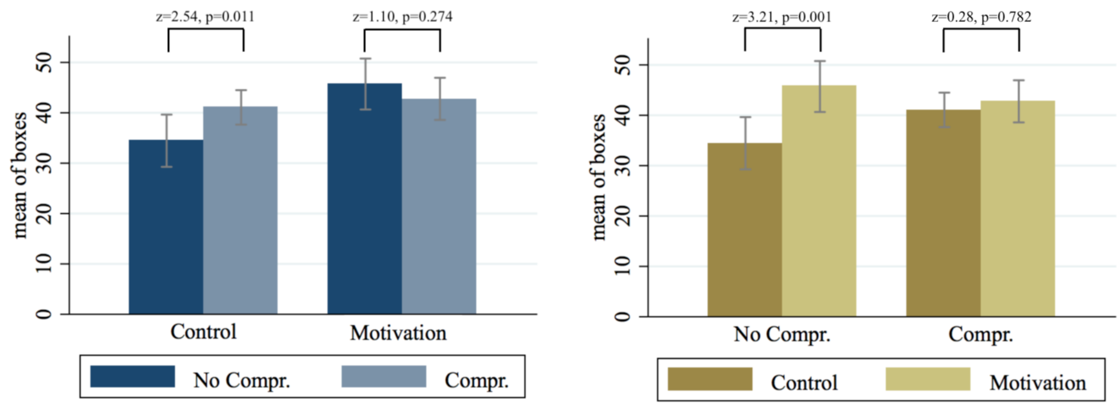

Figure 3. *Left chart.* Number of boxes opened in the control and treatment groups, splitting experimental subjects in the group of those who gave a wrong answer to the comprehension question regarding the probabilities involved in the BRET (left bar) and in the group of those who gave a correct answer (right bar). No appreciable difference is found between the two groups for the treatment group, while in the control group we find that more boxes are opened by those who answered correctly to the comprehension question (statistics reported for Mann-Whitney tests of equal distributions). *Right chart.* Number of boxes opened by experimental subjects split in the group of those who gave a wrong answer to the comprehension question regarding the probabilities involved in the BRET (left bar) and in the group of those who gave a correct answer (right bar), further divided by control and treatment groups. No appreciable treatment effect is found for the group of those who answered correctly to comprehension question, while a strong treatment effect is found (from 34.5 to 45.7 boxes) for those who answered wrongly (statistics reported for Mann-Whitney tests of equal distributions).

Dependent variable:	Model	Model	Model
Number of boxes opened	(1)	(2)	(3)
Motivation (treatment)	5.460**	11.25***	10.69***
	(2.219)	(3.679)	(3.502)
Comprehension (correct answer)	1.895	6.619**	7.045**
	(2.308)	(3.159)	(2.944)
Motivation × Comprehension		-9.558**	-9.116**
		(4.594)	(4.401)
Female			0.137
			(2.188)
Age			0.378*
			(0.223)
Self-reported willingness to take risk			3.071***
			(0.534)
Constant	37.41***	34.45***	7.045
	(2.173)	(2.633)	(7.774)
Observations	389	389	389
Adjusted R^2	0.012	0.021	0.108

Table 1. Linear regressions where the dependent variable is the number of boxes opened in the BRET. Motivation is a dummy variable taking value 1 if the subject is in the treatment group; Comprehension is a dummy variable taking value 1 if the subject has correctly answered the question about the probability implied by the BRET; Female is a dummy variable taking value 1 if the subject is a woman; Age is equal to the number of years of the subject; Self-reported willingness to take risk is a variable between 0 and 10 where 10 is the maximum willingness to take risk. Robust standard errors are reported in parenthesis. Statistical significance is indicated as follows: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

becomes statistically significant. Moreover, the estimated coefficient of interaction between treatment and comprehension is about -9.6 and statistically significant. Overall, these estimates confirm that the treatment effect is quite stronger among experimental subjects who did not answer correctly to the comprehension question and, further, that in the control group comprehension led to take more risk. These findings confirm our main result that the motivation treatment effectively increases risk taking in the BRET and, moreover, they suggest that the motivation treatment and the comprehension of the probabilities involved in the BRET are, at least to some extent, substitutes.

In Model (3) we add as controls gender, age and the self-reported willingness to take risk. Results concerning the variables included also in Model (2) are substantially the same as in Model (2). It is worth noting that while gender does not seem to play any role, more aged subjects tended to open more boxes (one more for 3 additional years of age) as well as subjects who declared greater willingness to take risk (three more boxes for each level of willingness, ranging from 0 to 10).

Discussion

In this paper we explored experimentally the effects of inducing greater reflection on risk taking. Although this has been investigated in previous studies, the evidence collected so far is mixed and suggests that much depends on the method applied for manipulating cognition. We add to the ongoing discussion by providing evidence from an online experiment where we attempt to manipulate cognition by means of a motivation treatment, namely by requiring experimental subjects to write down a text that motivates their choice before they can actually take action.

Our main finding is that the motivation treatment induces more risk taking, as measured by the number of boxes opened in the BRET[10]. This suggests that greater reflection makes subjects more prone to take risks[3]. However, we also find that the treatment effect is sizeable for the subjects who did not answer correctly to the comprehension question regarding the probability distribution implied by the BRET, while the effect almost disappears for subjects who gave the correct answer. Moreover, while the motivation treatment does not appear to affect comprehension of the probability distribution implied by the BRET, the latter seems to go with more risk taking only for the control group. Overall, these findings suggest that the motivation treatment and the comprehension of the probabilities involved may be substitutes in promoting risk taking.

Our results could perhaps be explained with reference to the reduction of ambiguity brought about by greater reflection. Subjects with imperfect probability understanding who also reflect little on their decision might be affected by incompetence, which is a well-known source of ambiguity aversion[30]. Thus, as people tend to prefer clear over vague prospects[31], it is reasonable to expect a positive relation between risk taking and reflection as far as there is no probability understanding.

To better understand the role played by the comprehension of the probability distribution implied by the choice task, and to check whether this is the outcome of a some other unobserved variable, future research may be dedicated to explicitly manipulate comprehension by means of a treatment where, e.g., the probabilistic assessment of the choice task is favored. Such experiments would clarify whether comprehension may be a policy target to affect choices under risk, or simply a measure of exogenous cognitive abilities[32,33]. Furthermore, by exogenously manipulating ambiguity aversion, it would be possible to explore more deeply our interpretation of the relation between reflection and risk taking. For example, according to the *comparative ignorance hypothesis*[34], ambiguity aversion arises only from a comparison with more knowledgeable individuals or with less ambiguous prospects, which are settings not allowed in our design.

Methods

This study was pre-registred on AsPredicted.org and run on Prolific, a crowdsourcing platform which recruits participants for research purposes[35]. Our experimental design does not require simultaneous interactions among players, which is often troublesome in online experiments[36].

The experiment was conducted using oTree[37]. Data were collected in a single session in March 2019. On Prolific, the experiment was labeled "An experiment on decision making", and was described as follows: "This is an experiment on decision making. We will ask you to complete a quick task, which may allow you to earn additional payments, and a short questionnaire". The sample was restricted to subjects from the UK and the US, in an age between 18 and 35. A minimum of two submissions in previous studies, with at least a 50% approval rate, was also imposed. We gave an estimate of three minutes for the time needed to complete the experiment, while we set to 10 minutes the maximum time for completion. Subjects received a show up fee of 0.30 GBP.

All participants gave their informed consent at the beginning of the experiment, and they were given instructions about the task to be performed. Payoffs were automatically converted in USD for participants from the US.

To measure risk taking behavior we employed the BRET[10] which is increasingly applied in the experimental literature[11–14]. In our implementation of the BRET (for which we used a pre-programmed tool for oTree[38]) subjects had to choose how many boxes to collect from a 10x10-grid containing 100 boxes. They were told that one of the boxes contained a bomb that, if picked, would have destroyed all boxes, but they ignore where it was located. If they collected the bomb, they earned zero; otherwise, they received 0.01 GBP for each box. Note that expected performance (and earnings) is maximized at 50 boxes.

The manipulation of the cognitive mode was attempted with a motivation treatment: subjects in the treatment group were required to write down a motivation for their decision (of at least 30 characters) before they could enter the number of boxes they wanted to open. At the end of the experiment, subjects were asked to fill a questionnaire including demographic information, their self-reported willingness to take risk[39], a test of comprehension of the task (subjects were asked: "If you have collected 35 boxes, what is the probability of getting the bomb?" and they had to enter manually a number; see Slide 5 in the Supplementary Information).

In the last screen of the questionnaire we administered the TIPI[40] (not analyzed in this paper) together with a control question to verify data validity (subjects were asked: "If you're reading this check 'Agree little"', and they had to check as indicated; see Slide 6 in the Supplementary Information).

Informed consent was obtained by all experimental subjects. In particular, the participants were informed that data would be used anonymously for scientific purpose only. The experiment was conducted online in accordance with relevant guidelines for experiments with human and approved by the LUISS' ethics committee.

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Author contributions statement

E.B., L.B., and L.S. contributed equally to conceiving and conducting the experiment, as well as to analysing the results and writing the paper.

Additional information

The authors declare no competing interests.