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Of two minds: An experiment on how time scarcity shapes risk-taking behavior

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Abstract: Several studies report that the brain evaluates prospects and executes decisions as the outcome of two mental processing types: one described as slow and reflective and the other as fast and intuitive. We investigate how these two mental processes affect risk-taking behavior by using time pressure to establish an intuitive response. We observe that time constraints do not change risk attitudes. Furthermore, it is only when subjects are given ample time to decide and instructed to reflect that they show the well-documented shift of risk preferences across the domain of losses and gains.

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Abstract

Several studies report that the brain evaluates prospects and executes decisions as the outcome of two mental processing types: one described as slow and reflective and the other as fast and intuitive. We investigate how these two mental processes affect risk-taking behavior by using time pressure to establish an intuitive response. We observe that time constraints do not change risk attitudes. Furthermore, it is only when subjects are given ample time to decide and instructed to reflect that they show the well-documented shift of risk preferences across the domain of losses and gains.

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1. Introduction

This study uses a task involving allocating money between two assets that differ in terms of the risk and domain of outcomes to elicit individual risk preferences. There are many similar experiments in the literature. What distinguishes this study is that we varied the amount of time subjects had to decide. In the unconstrained time condition, subjects had unlimited time to reach a decision. In the constrained time condition, they had a few seconds to make their decisions.

Our goal is twofold. First, we vary the amount of time a participant has to decide to evaluate the cognitive mechanisms that underlie risk attitudes.

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We adopt a dual-process framework in which two different cognitive systems, intuition and reflection, compete for control of our thinking and choice behavior. Intuition-based decisions are produced by processes that are rapid, automatic, and effortless. Reflection-based decisions are produced by processes that are slow, sequential, and controlled (Kahneman, 2003; Evans, 2006). While it may not be clear how intuition and reflection interact to produce some decisions, there is a large consensus that intuitive decisions are relatively fast. In contrast, reflective thinking requires working memory resources that necessarily make it more time-consuming. By experimentally manipulating decision times, we can establish participants' intuitive responses.

A second goal is to vary the outcomes domain to assess whether a well-documented reversal of risk attitudes is supported by both intuition and a slow and deliberative decision process. Kahneman and Tversky (1979) found that individuals exhibit risk-seeking behavior to avoid a certain loss but exhibit risk aversion for a certain gain if the alternative is a larger gain that is only probable. This finding has been replicated in several studies[1]. Support for this gain-loss asymmetry is important for the decision-making literature, as it is used to explain a wide variety of field and experimental data. Under the presumption of a dual-process account of human reasoning, a natural question to ask is whether this gain-loss asymmetry has become internalized as an intuitive response that deliberation can mitigate or override. This paper addresses this question too.

We are not the first to assess risk preferences in the face of time scarcity. Related studies by Guo et al. (2017) and Diederich et al. (2020) evaluate the effect of time constraints on risk-taking behavior. They both found that time pressure amplifies framing effects in risky choices: when given x and asked to choose between playing a lottery of the form $L(x, p; -x, 1-p)$ and a sure

[1]See, e.g., Quattrone and Tversky (1988), Tversky and Kahneman (1992), Abdellaoui (2000), Mauro and Maffioletti (2004) and Bosch-Domenech and Silvestre (2006)

thing, under short time limits, more subjects were risk-averse when the sure thing was framed as a gain ("to keep" xp) and more subjects were risk-averse when the sure thing was framed as loss ("to lose" $x-xp$). However, our study differs in two important dimensions from this previous research.

First, the gambles used by Guo et al. (2017) and Diederich et al. (2020) involved keeping or losing initial amounts of experimental money that was given to the subjects, whereas we asked our subjects to gamble with money we made them earn. There is evidence that experimental subjects make different decisions when they use earned money compared to when they use money given to them (Oxoby and Spraggon, 2008; Reinstein and Riener, 2012; Corgnet et al., 2015; Hvide et al., 2019).

Second, and more importantly, the different response times included in the present study—10s and no limit at all—would allow us to evaluate how intuition and reflection shape risk attitudes. While a defining characteristic of intuitive responses is to be fast and effortless, it presumes accessibility to and processing of the stimulus, operations that, perhaps, cannot be done within one second (Kahneman, 2003).[2]

Looking at risk preferences from a dual-process perspective allows us to test a hypothesis that many behavioral scientists and businesses managers hold to be true: that fast thinking can lead us to make riskier decisions. Our results suggest this is not the case.

2. Methods

We recruited participants from an email pool of undergraduate students at the University of São Paulo in Brazil. There were 20 sessions with approx-

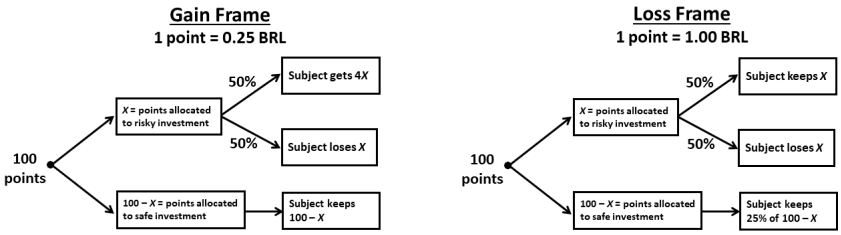
[2] Diederich et al. (2020) used 1s and 3s as response time limits, and Guo et al. (2017) used 1s and unlimited time limit conditions. Several experiments exploring the cognitive processes underlying individual decisions within a dual-process framework induce intuition allowing for no less than ten seconds. See, e.g., Greene and Nowak (2012), Shalvi et al. (2012) and Everett et al. (2017).

imately 25 participants each, for a total of 502 participants. Upon arrival, subjects received an ID number and were assigned to a desktop computer. The experiment consisted of two parts, and participants received instructions at the beginning of each part. In the first part, they were asked to complete a simple crossword under one minute. For completing this task, subjects were paid 100 experimental points to be used in the rest of the experiment. By making them feel they earned their money, as opposed to a windfall gain, we wanted to mimic naturally occurring environments in which investment decisions can often lead to a loss of one's own money. In the second part, subjects faced a portfolio problem in which they were asked to allocate their earned endowment between a safe and a risky investment. Responses were given as an integer from $0 - 100$ indicating the level of investment in the risky fund (X); the level of investment in the safe fund (S) was automatically calculated ($S = 100 - X$). Figure 1 illustrates the portfolio problem.

We employed the two-by-two design shown in Table 1. The first treatment manipulation varied the outcome domain of the risky asset. In the *gain* condition, the amount invested in the risky option, X, pays $4X$ with probability 0.5 and is lost with probability 0.5. The money invested in the safe option, $(100 - X)$, is kept by the participant. The payoffs are then $(100 - X + 4X)$ with probability 0.5 and $(100 - X)$ with 0.5. In the *loss* condition, the amount invested in the risky option pays nothing (i.e., the subject just receives X back) with probability 0.5 and is lost with probability 0.5. The safe investment entails a certain loss of 75%; thus, only a quarter of $(100 - X)$ is kept by the investor.

The second treatment manipulation varied the amount of time subjects had to make their decision. In the *constrained time* condition, they were given 10s to reach their decision, being told they would be eliminated from the experiment if they did not do so. With what is little time to reflect, their

Figure 1: The portfolio problem



decisions are expected to be fast and intuitive. In the *unconstrained time* condition, they were given as much time as they wanted and were instructed to be thoughtful before choosing how much of their endowment to invest in the risky asset. With plenty of time for deliberation, their decisions are expected to be conscious and reflective.

Table 1: Treatments

Treatments	**Decision time**		
Outcome domain	*Unconstrained*	*Constrained (10 sec)*	**N**
Gain	5 sessions, 129 participants	5 sessions, 137 participants	266
Loss	5 sessions, 122 participants	5 sessions, 114 participants	236
N	251	251	**502**

Once all subjects in the experiment had made their decisions, we used a fair coin to individually resolve the uncertainty about the actual outcome of their risky investment. No deception was used. Each subject was then paid accordingly and was asked to fill in a receipt form. We also asked subjects to respond to a series of questions about themselves (gender, age, race, field of study, parents' education). We added a comprehension question about the experiment, asking how much they would earn if all points were allocated to

the safe asset.

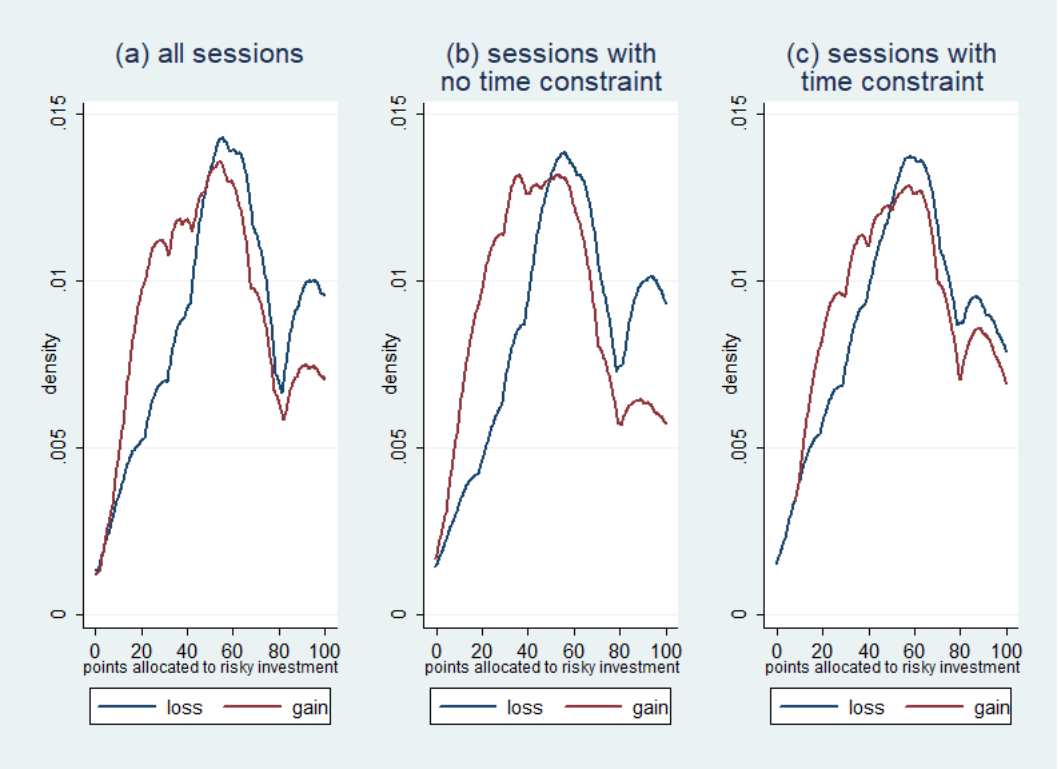
Before participants completed any task, we told them that their winnings would be converted to real cash at a certain ratio. For subjects in the loss treatments, each experimental point was worth 1 Brazilian Real (BRL). For subjects in the gain treatments, each experimental point was worth 0.25 BRL. This difference in exchange rates was to ensure that allocations in the risky investment have the same expected value across conditions. No show-up was paid to subjects, but they could avoid leaving the experiment without nothing through their choices. Sessions lasted for 60 min at most, and subjects earned 39.64 BRL on average. The hourly Brazilian minimum wage is 5.00 BRL. The monetary amounts paid to subjects are, therefore, meaningful. Experimental sessions were equally divided among the four treatment conditions, which were randomly assigned to sessions. Participants chose which session to attend without knowing to which treatment they were assigned.

3. Results

To preview our main results, we show the estimated densities for gain and loss frames based on the subjects' choice for the portfolio problem. Figure 2(a) shows the classic asymmetry across domains, as participants tend to take more risk under the loss frame. The distribution for loss subjects places more weight on higher shares of experimental points allocated to the risky investment compared to gain subjects. Figures 2(b) and 2(c) indicate that this effect comes basically from sessions without time constraints. When participants had little time to decide, the distributions under gain and loss were quite similar.

We now turn to the regression analysis. Specifically, we estimate the following equation:

Figure 2: Kernel densities



Note: Densities estimated using the Epanechnikov kernel function.

$$Points_i = \alpha + \beta Loss_i + \gamma Constrained_i + \delta X_i + \varepsilon_i$$

where $Points_i$ is the number of experimental points that subject i allocated to the risky investment, $Loss_i$ is equal to 1 if i was part of a loss session and 0 otherwise, and $Constrained_i$ is equal to 1 if i was part of a time-constraint session and 0 otherwise. Moreover, X_i is a set of controls that include information from the session (dummies for day and for time of the day) and the individual (gender, age, along with dummies for field of study, race, mother's education, and father's education). Estimation outcomes are in Table 1. Panel A displays the results for all sessions, while panels B and C show estimates for sessions without and with time constraints, respectively.

Standard errors are clustered at the session level.

Column (1) displays regressions without any controls. The results show that subjects under the loss setting indeed tend to take significantly more risks. In the whole sample, loss participants allocate on average almost 7 more points to the risky investment than do gain participants. This is quantitatively relevant, given that the average and standard deviation of *Points* in the whole sample are 58.5 and 27.5, respectively. More importantly, such an effect is much stronger when agents have ample time to decide. Conversely, in sessions with time limits, the coefficient on *Loss* is statistically indistinguishable from zero at the conventional levels of significance.

The remaining columns provide results from robustness exercises. In column (2) we include controls. Our main message does not change, and quantitatively, the effects become even stronger. In column (3), we also exclude individuals who failed to answer the comprehension question correctly, as their responses are likely noisier. The coefficient of *Loss* rises in magnitude in all cases and becomes significant (at 5%) even for sessions with time limits. Nonetheless, the effect is still much stronger when individuals can decide without time pressure.

Finally, some individuals made their choice quite quickly, even when there was no time limit. Since the availability of time likely did not matter for them, we estimate regressions including only participants who took relatively longer to choose (at least 30 seconds). The results do not change significantly (see column (4)).

Interestingly, time pressure does not seem to directly affect risk taking, as the coefficients of *Constrained* in panel A are all statistically insignificant and relatively small in magnitude. However, the interaction between time constraints and the gain/loss frame matters. In particular, we detect a strong bias towards risk taking under the loss setting when individuals had ample time to decide.

Table 2: Regression Results

	(1) No controls	(2) Controls	(3) Controls Comprehension question correct	(4) Controls Decided in at least 30s
A. ALL SESSIONS				
Loss	6.813	8.790	11.866	–
	(2.328)***	(2.248)***	(3.006)***	
Constrained	1.970	1.850	2.458	–
	(2.307)	(1.948)	(2.045)	
R-squared	0.02	0.10	0.14	–
N	502	495	297	–
B. SESSIONS WITH NO TIME CONSTRAINT				
Loss	10.571	16.288	20.747	17.765
	(3.052)***	(2.674)***	(3.900)***	(4.001)***
R-squared	0.04	0.14	0.19	0.16
N	251	249	162	187
C. SESSIONS WITH TIME CONSTRAINT				
Loss	3.026	2.041	10.787	–
	(3.256)	(2.176)	(3.820)**	
R-squared	0.00	0.13	0.19	–
N	251	246	162	–

Notes: *p<.1, **p<.05, ***p<.01. Robust standard errors, clustered at the session level, in parenthesis.

4. Conclusions

This paper presents an experimental investigation of the effect of time pressure (which promotes intuition relative to reflection) on risk attitudes. We find that only when we give subjects ample time for deliberation do they take more risks to avoid a certain loss (loss frame) than to make an extra gain (gain frame). When subjects have a tight time constraint to decide, this gain-loss asymmetry effect disappears. Furthermore, forcing subjects to decide quickly has no significant effect on risk-taking in a given frame. Our results provide evidence that intuition does not support the gain-loss asymmetry effect (risk aversion for gains or risk-seeking for losses) and that instructing people to reflect and decide slowly creates this effect.

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