ABSTRACT

"Averting risk in the face of large losses: Bernoulli vs. Tversky and Kahneman,"

by Antoni Bosch-Domènech and Joaquim Silvestre.

We experimentally question the assertion of Prospect Theory that people display risk attraction in choices involving high-probability losses. Indeed, our experimental participants tend to avoid fair risks for large (up to € 90), high-probability (80%) losses. Our research hinges on a novel experimental method designed to alleviate the house-money bias that pervades experiments with real (not hypothetical) loses.

Our results vindicate Daniel Bernoulli's view that risk aversion is the dominant attitude, But, contrary to the Bernoulli-inspired canonical expected utility theory, we do find frequent risk attraction for small amounts of money at stake.

In any event, we attempt neither to test expected utility versus nonexpected utility theories, nor to contribute to the important literature that estimates value and weighting functions. The question that we ask is more basic, namely: do people display risk aversion when facing large losses, or large gains? And, at the risk of oversimplifying, our answer is yes.

Keywords: Losses, Risk Attraction, Risk Aversion, Experiments, Prospect Theory, Bernoulli, Kahneman, Tversky. JEL Classification Numbers: C91, D81

"Averting risk in the face of large losses: Bernoulli vs. Tversky and Kahneman,"[1]

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1. Introduction

We question the assertion of Prospect Theory (Amos Tversky and Daniel Kahneman,1992) that people display risk attraction in choices involving high-probability losses. This assertion follows from two basic postulates of Prospect Theory, namely:

(i) The value function is strictly convex for losses;

(ii) People underweight high probabilities: this is the famous "inverted S" pattern of the probability weighting function.[3]

The two postulates reinforce each other for fair decisions involving losses when the probability of the loss is high, unambiguously implying risk attraction.[4]

But our experimental participants tend to avoid fair risks for large (up to € 90), high-probability (80%) losses, directly challenging the assertion of Prospect Theory.

Given the widespread acceptance of (i) and (ii) above, our result will no doubt be controversial. We offer three arguments for the skeptics. First, our experimental method is novel.

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[3] These postulates have been sustained by a large body of literature, initiated by Tversky and Kahneman (1992), which estimates value functions and probability weighting functions. See, for instance, Mohammed Abdellaoui (2000), Abdellaoui, Frank Vossmann and Martin Weber (2005), Colin Camerer and Tech-Hua Ho (1994), Nathalie Etchart-Vincent (2004), Hein Fennema and Marcel van Assen (1999), Richard Gonzalez and George Wu (1999), Drazen Prelec (1998), Peter Wakker and Daniel Deneffe (1996), Wu and Gonzalez (1996, 1999), and Wu *et al.* (2004). One of the few papers that question the convexity of value function on the loss domain Moshe Levy and Haim Levy (2002). See William Harbaugh *et al*. (2002a, b) and Ralph Hertwig (2005) for results that do not verify the inverted-S shape of the probability weighting function.

[4] See Section 4.2 below.

Second, this surprising finding fits well with our less objectionable results, in the same experiment, on the role of probabilities, the amounts at stake, and gains on risk attitudes (aversion or attraction). Third, hints can be found in the literature indicating that decisions concerning large losses are more subtle than what (i) and (ii) imply. We expand on these three lines.

First, much of the experimental support for the Tversky-Kahneman view that people are attracted to risk when facing high probability losses is based on introspection or on experiments with hypothetical money. Some support also comes from real-money experiments, although these results may be tainted by the house-money bias (see Section 2 below). Our experiment involves real money, but it follows a relatively complex procedure that we have designed in order to alleviate the house-money bias. On the basis of some indirect evidence, we believe that our method is to a significant extent successful in avoiding this pitfall.

Second, we find that the main determinant of risk attitude in a variety of decision tasks is the amount of money at stake. Our most striking result that the majority of decision makers display risk aversion for high-probability large losses accompanies our observations that:

(a) This majority is larger when the probability of the loss is small (20%), as suggested by (ii) above;[5]

(b) The results for gains (Section 5 below) also a higher frequency of risk aversion as the probability of winning increases, in the direction implied by (i) and (ii) above;

(c) The higher prevalence of risk aversion as the amount at stake increases can be seen as a manifestation of a general effect which is by now well established for real-money gains (Bosch-Domènech and Silvestre, 1999, Charles Holt and Susan Loury, 2002, and Section 5 below).

Third, the literature hints to the non-exceptionality of risk aversion when losses are large or ruinous. Etchart-Vincent (2004) finds that large (hypothetical) losses seem to generate some peculiar features, such as a larger proportion of concave utility functions, and less underweighting of large probabilities. And Dan Laughhunn *et al*. (1980) confirm that, in the face of a ruinous loss, a majority of business managers switches to risk aversion. In addition, the recent estimation of decision weights and value functions by Abdellaoui *et al.* (2005) fails to confirm the convexity of the value function on the loss domain: in their words, "For losses, no clear evidence in favor of convexity is observed." (p.1398).[6] Finally, William Harbaugh *et al*. (2002a, b) observe an

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[5] Because the overweighting of low probabilities in (ii) favors risk aversion and may possibly neutralize (i).

[6] These results qualify the earlier ones in Abdellaoui (2000).

unconventional S-shaped probability weighting function. Interestingly, their subjects had to choose between a certain outcome and a gamble, which is precisely the method that we follow here, whereas a large fraction of the prior experimental work asked participants to choose between two gambles.[7]

In a sense, our results vindicate Daniel Bernoulli's view that risk aversion is the dominant attitude, versus Kahneman and Tversky's idea that people are attracted to risk when facing losses, particularly at high probabilities. But, contrary to the Bernoulli-inspired canonical expected utility theory, we do find frequent risk attraction for small amounts of money at stake.

In any event, we attempt neither to test expected utility versus nonexpected utility theories, nor to contribute to the above-mentioned literature that estimates value and weighting functions. The question that we ask is more basic, namely: do people display risk aversion when facing large losses, or large gains? And, at the risk of oversimplifying, our answer is yes.

2. An experimental design to alleviate the house-money bias

The design of our loss treatments *L* and *L'* (see Section 3 below) addresses a basic difficulty in real-money experiments with losses, namely the need for the experimenter and the participants to agree on their perceptions of *what is a loss versus what is a gain*.

Since experimenters should not earn money from participants, any experiment with losses must involve either hypothetical losses or the provision of sufficient initial cash. Doubts have been raised about the reliability of the results from experiments with hypothetical losses (see Holt and Laury, 2002). But providing money to the participants has its pitfalls too. First, if participants do not earn the cash, then the cash provision will easily be interpreted as a windfall gain. And even if participants earn the necessary cash through their own skills and effort, they will still be playing with "house money." There are grounds for suspecting that playing with windfall gains or house money increases risk attraction.[8]

Our loss treatments implement a design that we believe avoids to a large measure both the *windfall-gains bias* and the *house-money bias*. Each treatment consists of two temporally separated

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[7] We lack sufficient information to know whether it is this difference in design that yields diverging behavioral conclusions.

[8] See, e.g., Martin Weber and Heiko Zuchel (2001), Scott Boylan and Geoffrey Sprinkle (2001), Kevin Keasy and Philip Moon (1996) and Richard Thaler and Eric Johnson (1990). According to Thaler and Johnson (1990), p. 657, "… after a gain, subsequent losses that are smaller than the original gain can be integrated with the prior gain, mitigating the influence of loss-aversion and facilitating risk-seeking." But see Jeremy Clark (2002) for small sums of money.

sessions: the quiz-taking session and the decision-making session. In order to alleviate the windfall-gains bias, in the first session the participants took a quiz on basic knowledge and earned cash -which was paid immediately after the quiz- according to the number of correct answers: €90 to the participants ranked in the first quartile, €60 to the second one, €45 to the third quartile, while the bottom group received €30. They were then told that they would be called several months later for a second session where they could possibly lose money, and they signed a promise to show up. The exact date for the second session was left unspecified at that time.

Because we guarantee that the eventual losses would never exceed the cash previously received at time of the quiz, the participants could admittedly feel that they were playing with house money. But we hoped to reduce this bias by postponing the decision-making session until four months later and after a semester break

Indirect evidence indicates that we mostly succeeded. The delay made a majority of participants feel by the time they made their decisions four months later that the previously earned cash had been integrated in their wealth and vanished in their everyday flow of expenditures. In the decision-making session, and after registering their choices, but before running the random device, participants were ask to answer an anonymous questionnaire about the prospective pain of losing money in the experiment. Only a 21% claimed to anticipate no pain since the money "was not actually theirs." The majority (e.g., 59% in Treatment *L*) agreed that it would be very painful to lose money because "the money was theirs," 9% accepted that they would feel some pain since it was "as if the money was theirs," 21% and 11% gave other answers. Post-experiment personal interviews showed similar results.[9]

3. Two experimental treatments involving losses

[9] To further investigate the role of time lags in the perception of loss, we submitted a questionnaire to a group of students not involved in our experiments. The questions concerned hypothetical gains and losses, as well as various time lags.

In one situation, a Mr. A and a Mr. B gained and lost the same amounts of money, but while Mr. A experienced the gain and the loss on the same day, Mr. B's loss occurred several weeks later. Respondents were asked to compare the happiness of Mr. A. and Mr. B after losing the money. Of the 107 respondents, 71 considered Mr. A the happier one, whereas 27 thought it was Mr. B and 9 said that both were equally happy.

In another situation, we asked to compare Mr. C, who won and lost some money on the same day, and Mr. D, who earned the difference between Mr. C's gain and loss. Most people (87 out of 107) viewed Mr. D as the happiest one. Taken at face value, the answers indicate that individuals feel more pain if a loss does not coincide in time with a gain, suggesting that their capability to integrate the loss with a previous gain is limited when *time separates* the moment of the gain from the moment of the loss, even when the loss and the gain are presented together as in the examples described.

All treatments in this paper share a basic design. Participants are voluntary students from the *Universitat Pompeu Fabra* who have not taken courses in economics or business, and we try to maintain an equal proportion of sexes. Twenty-one participants took part in the decision-making session of Treatment *L*.[10] Participants were told that they would be randomly assigned, without replacement, to one of seven classes corresponding to seven possible money amounts to lose, namely €3, 6, 12, 30, 45, 60 and 90, with the proviso that a participant could not be assigned to a class with an amount of money to lose exceeding the cash earned four months earlier in the quiz. Then, a participant was asked to choose, for each of the possible classes and before knowing to which class she would eventually belong, between the certain loss of 0.2 times the money amount of the class and the uncertain prospect of losing the money amount of the class with probability 0.2 and nothing with probability 0.8. In what follows we say that a participant displays *risk attraction* (resp. *risk aversion*) in a particular choice if she chooses the uncertain (resp. certain) alternative.[11]

To record their decisions, participants were given a folder that contained one page for each money class. In each page, they were required to register, under no time constraint, their choice between the certain loss and the uncertain prospect. Participants were then called one by one to an office where the participant's class was randomly drawn. Next, the experimenter and the participant checked in the participant's folder (his or) her choice for that particular class. If her choice was the certain loss, she would pay 0.2 times the amount of money of her class. If, on the contrary, she chose the uncertain prospect, then a number from one to five was randomly drawn from an urn. If the number one was drawn, then the participant would pay the amount of money of her class. Otherwise, she would pay nothing. Some of the participants who lost money paid their losses on the spot, while the remaining ones, who had often incurred heavy losses, paid within a few days. We are happy to report that all of them ended up paying.

The experimental data are presented in Table A1 of Appendix 1.

Treatment *L*' was performed with thirty-four students.[12] The treatment had exactly the same format as Treatment *L*, except that the probability of the loss was now a hefty 0.8, instead of 0.2. The

[10] We personally contacted every one of the twenty-four subjects who had taken the quiz and had collected the cash four months earlier to inform them on the date, hour and venue of the decision-making session. Remarkably, twenty-one of them did show up. The male/female ratio ended up being 10/11.

[11] A risk-neutral participant could choose either the certain or the uncertain prospect, his or her choice being at random. But the likelihood that the results of our experiments consist of random variation is statistically indistinguishable from zero.

[12] Thirty-six participants had taken the quiz, but two did not show up for the second part of the *L*' experiment. The final male/female ratio was 18/16.

experimental data are displayed in Table A2 of Appendix 1. Because of the higher probability, the average loss was now higher than in Treatment *L*. Yet once more all losers paid their losses.

4. Risk aversion for large losses

4.1. Our data

Table 1 presents, for each amount of money that a participant could lose, the fraction of participants who displayed risk attraction by chosing the uncertain loss alternative. Taking one row at a time, we observe an unmistakable decrease in the frequency of risk attraction as the amount of the possible loss grows larger, proving that the amount of money at risk is a major factor in determining the risk attitude. This was already observed in experiments involving non-hypothetical gains (Bosch-Domènech and Silvestre, 1999, Holt and Susan Loury, 2002), and in the classical field study of Hans Binswanger (1980). Together with the evidence presented in Section 5 below, we find that the *amount effect*, defined as the increase in the frequency of risk-averse choices as the amount of money at stake increases, is robust, and it applies both to gains and to losses.

4.2. Comparison with the real-money literature

The experimental literature on losses deals mostly with hypothetical money amounts, and occasionally with real money just received from the experimenter and thus subject to the house-money bias (often on top of a windfall-gain bias). Therefore, no comparison between our results and the previous ones is straightforward. The comparison is also more problematic for papers that, while using real money, aim at objectives different from ours, such as Mikhail Myagkov and Charles Plott (1997), who test the predictions of Prospect Theory in a purely market context, John Dickhaut *et al*. (2003), who study the neurophysiological processes behind choice behavior, Peter Brooks and Horst Zank (2005), who test for loss aversion and gain seeking behavior, and Charles Mason *et al*. (2005), who test for departures from expected utility maximization.

Robin Hogarth and Hillel Einhorn (1990), and Laury and Holt (2000) do directly test risk attitudes in the face of real-money losses, but they deal with amounts of money not exceeding $10, where they find a lower frequency of risk attraction than we do for those amounts. However, in Hogarth and Einhorn (1990) a majority of participants display risk attraction for the very low loss of $0.10. Interestingly, the real-money experiments in Hogarth and Einhorn (1990) display an amount effect similar to ours: risk aversion becomes more frequent as the amount of money that can be lost increases (although the scales are different: from $0.10 to $10 in Hogarth and Einhorn, versus €3 to €90 for us).

	Amount of Money						
	€3	**€6**	**€12**	**€30**	**€45**	**€60**	**€90**
Treatment *L* (losses with prob. = 0.2)	0.86	0.71	0.62	0.29	0.23	0.27	0.33
Treatment *L´* (losses with prob. = 0.8)	0.91	0.97	0.71	0.47	0.50	0.35	0.37

Table 1. Fraction of participants, in Treatments *L* and *L´*, who display risk attraction (by choosing the uncertain alternative) for the various possible amounts of the loss. The color red highlights a majority of participants displaying risk attraction. The color green, a majority displaying risk aversion.

4.3. Comparison with the hypothetical-money literature

Hogarth and Einhorn (1990) conduct experiments with both real and hypothetical money, and the amount effect that they observe in the real-money treatments vanishes in the hypothetical treatments. This lack of amount effect in the hypothetical-money setting is actually replicated by Etchart-Vincent (2004), whose results are reproduced in the second row of Table 2. They may be compared with the last row of Table 2, which summarizes some of our data from Table 1, and shows the powerful effect of the amount of the loss.[13] Particularly striking are the differences at the two ends of the rows.

[13] The last row of Table 2 is constructed as follows.

First column: 0.73 is the average of the three entries in the first row and columns 1-3 (which cover the loss amounts €3, €6 and €12) of Table 1.

Second column: 0.30 is the average of the two entries in the first row and columns 6 and 7 (which cover the loss amounts €60 and €90) of Table 1.

Third column: 0.86 is the average of the three entries in the second row and columns 1-3 (which cover the loss amounts €3, 6 and 12) of Table 1.

Fourth column: 0.36 is the average of the two entries in the second row and columns 6 and 7 (which cover the loss amounts €60 and €90) of Table 1.

		Low Probability of Loss		High Probability of Loss	
		Small Losses	Large Losses	Small Losses	Large Losses
Hypothetical Losses	Tversky & Kahneman (1992)	**0.20**		**0.87**	
	Etchart-Vincent (2004)	Small (around $1190) Hyp. Loss, Prob. ≤ 0.1 **0.20**	Large (around $13,310) Hyp. Loss, Prob. ≤ 0.1 **0.18**	Small (around $1190) Hyp. Loss, Prob. ≥ 0.5 **0.65**	Large (around $13,310) Hyp. Loss, Prob. ≥ 0.5 **0.56**
Real Losses	This paper	Small (around €7) Real Loss, Prob. = 0.2 **0.73**	Large (around €75) Real Loss, Prob. = 0.2 **0.30**	Small (around €7) Real Loss, Prob. = 0.8 **0.86**	Large (around €75) Real Loss Prob. = 0.8 **0.36**

Table 2. Fraction of participants who display risk attraction in various articles. Again, the color red highlights a majority of participants displaying risk attraction, whereas the color green, a majority displaying risk aversion.

For small losses with low probabilities (first column), a majority (73%) of our participants display risk attraction, whereas few (20%) of Etchart-Vincent do. (Her figures for low-probability losses in fact agree with those in the pioneering work by Tversky and Kahneman, 1992, reported in the first row of Table 2.) This, admittedly huge difference should nevertheless be qualified on at least two grounds. First, how small is a small loss? For us, "small" means around seven (real) euros, whereas, for Etchart-Vincent, "small" means close to twelve hundred (hypothetical) dollars. The pattern, which we observe, of decreasing frequency of risk attraction as the amount at stake increases implies that, to the extent that twelve hundred hypothetical dollars "translates" into an amount of real euros higher than seven, the percentage of risk-attracted choices for that larger real amount would be lower than 73%, in the direction of Etchart-Vincent's figure. Second, how low is a low probability? For us, it is 0.2, whereas for Etchart-Vincent it does not exceed 0.1. A lower probability of the loss will tend to decrease, *ceteris paribus*, the frequency of risk attraction (see, e.g., our Table 1 as well as the second row of Table 2), which may partially explain why Etchart-Vincent's frequency of risk attraction at low probability is lower than ours.

In any event, the high proportion (73%) of risk taking for small amounts of low-probability losses that we observe fills a data gap not covered in the previous literature, and for this data range, it yields a quite novel observation. While empirically new, the observation does not contradict Prospect Theory if one assumes that the overweighting of the 0.2 probability is not too strong relative to the convexity of the value function on the loss domain.

Going back to Table 2, we observe that the entries for high probabilities display a certain symmetry with those for the low probabilities. The most striking instance appears in the last column, where the majority (64%) of our participants display risk *aversion* for the high probability (0.8) of a large loss (real €75 on average). This sharply contrasts with Etchart-Vincent's majority (56%) of risk *attraction* for her large losses (hypothetical $13,310). More significantly, our result directly challenges the usual account of Prospect Theory, with a convex value function in the loss domain, and with underweighting of high probabilities, which, as stated in the introduction, unambiguously predicts risk attraction in the face of high-probability losses.[14]

Interestingly, while for large losses our result disagrees with the hypothetical large-loss frequency of Etchart-Vincent, our *small-loss*, high-probability figure of 86% is indistinguishable from the 87% of Tversky and Kahneman's (1992) (right half of first row of Table 2), and not too far from the 65% reported by Etchart-Vincent.

Notice that, for the top two rows (hypothetical losses) of Table 2, the figures for low probability are quite similar (20%, 20% and 18%), while very different from those for high probability (87%, 65% and 56%). On the other hand, within each probability range, the amount matters less (20% vs. 18%, and 65% vs. 56%). The opposite pattern appears in our experiment: the figures in the last Row of Table 2 are similar for low- and high-probability small losses (73% vs. 86%), or for low- and high-probability large losses (30% vs. 36%). The bottom line is that, when we try to understand behavior confronting losses, the explanatory power of the amount of money dominates that of the probability, whereas the probabilities provide the best organizing principle for the pattern observed by those who adopt the hypothetical-money method.

5. Risk attitudes in the face of gains

[14] Proof. Let the loss-domain value function $v^-(z)$ be strictly convex, with $v^-(0) = 0$ and $v^-(z) < 0$ for $z < 0$, and let the weighting function $w^-(p)$ satisfy $w^-(p) < p$, for high p. Then, for $z < 0$, $v^-(pz) < pv^-(z)$ (by strict convexity) and $pv^-(z) < w^-(p)\, v^-(z)$ for high p, i.e., $v^-(pz) < w^-(p)\, v^-(z)$, implying that the decision maker prefers to lose $|z|$ with probability p (and nothing with probability $1 – p$) to losing $|pz|$ for sure, hence displaying risk attraction in than choice. ■

In order to check the robustness of our experimental design, we contrast our loss treatments *L* and *L'* with similar treatments, labeled *G* and *G'*, that involve gains in the seven money classes €3, 6, 12, 30, 45, 60 and 90, reported in Bosch-Domènech and Silvestre (2002). A participant in Treatment *G* was asked to choose, for each of the seven money classes and before knowing to which class she would eventually belong, between the certain gain of 0.8 times the money amount of the class and the uncertain prospect giving the money amount of the class with probability 0.8 and nothing with probability 0.2. Treatment *G'* was identical to Treatment *G*, except that the probability of the uncertain gain was now 0.2, instead of 0.8. Table 3 adds to Table 1 above two new rows with the frequencies of risk attraction in *G* and *G'*.

	Amount of Money						
	€3	**€6**	**€12**	**€30**	**€45**	**€60**	**€90**
Treatment *G* (gains with prob. = 0.8) (i.e., prob. of bad outcome = 0.2)	0.57	0.57	0.29	0.05	0.10	0.10	0.05
Treatment *L* (losses with prob. = 0.2)	0.86	0.71	0.62	0.29	0.23	0.27	0.33
Treatment *G´* (gains with prob. = 0.2) (i.e., prob. of bad out. = 0.8)	0.92	0.92	0.79	0.46	0.50	0.17	0.17
Treatment *L´* (losses with prob. = 0.8)	0.91	0.97	0.71	0.47	0.50	0.35	0.37

Table 3. Fraction of participants, in Treatments *G*, *L*, *G´* and *L´*, who display risk attraction (by choosing the uncertain alternative) for the various amounts of money a stake. The color red highlights a majority of participants displaying risk attraction. The color green, a majority displaying risk aversion.

Recall that our uncoventional result is the one expressed by the four last entries of the last row of Table 3, namely the low frequency of risk-attracted choices when facing high-probability, large losses: this is our direct challenge to Prospect Theory. Yet these cells do not appear out of place in Table 3: they extend to high-probability large losses the more familiar pattern of risk aversion that we find for low-probability, large losses (row 2), for high-probability large gains (row 1) and for low-probability large gains (row 3). Notice also that the frequencies of risk attraction of the last row of Table 3, for large amounts, are low, yet higher than the figures corresponding to the remaining rows of the table. Hence, our observations agree with the often-reported increase in the frequency of risk attraction when moving either from gains to losses, or from low- to high-probability losses.

In addition, recall from Section 4.3 above that Hogarth and Einhorn (1990) found an amount effect for real-money losses (as we do), but not for losses in hypothetical money (which is reproduced by Etchart-Vincent, 2004). Gains display exactly the same pattern.[15] Hogarth and Einhorn (1990), Holt and Laury (2002, 2005), and Glenn Harrison *et al*. (2005) find an amount effect when the gains are real, but not when they are hypothetical. That an effect of such relevance and magnitude vanishes as experiments turn to hypothetical money points towards the need of caution when adopting the hypothetical-money method.

Note also that we ask participants simply to choose between a binary lottery and a certain outcome. This is less convoluted than asking participants to reveal their willingness to pay for a lottery, as it has been often done in previous experiments. And the two procedures may well elicit significantly different risk attitudes, as discovered by the preference-reversal literature that Paul Slovic and Sarah Lichtenstein (1968) initiated.

Finally, we addressed the concern that our participants could perhaps integrate the various choices required from them, and try to balance safer with riskier decisions. Accordingly, we statistically checked for the type of "embedding bias" that would occur if the choice made for a particular amount of money varied as the decision was embedded in a set of four, five, six or seven decisions. The statistical test, reported in Bosch-Domènech and Silvestre (2006b), did not rule out the immunity of our procedure to embedding bias.

[15] Classical studies using electroencephalography (EEG) provide a thought-provoking parallel to our amount effect. It turns out that the stimuli provided by the outcomes of monetary gambles elicit a slow-wave response in the brain, labeled P300, which increases in amplitude with the *amount of money* won or lost. Interestingly, its amplitude does not vary depending on whether the subject encounters *gains or losses* (see S. Sutton *et al.* 1978, V. S. Johnston 1979, but also the qualifications reported in Nick Yeung and Alan Sanfey, 2004).

6. Conclusions

We focus on risk attitudes in the face of money losses. Historically, the oldest of the three main views on money risk attitudes is that of Bernoulli, 1738, which sees most people as risk averse most of the time. By positing a fundamental gain-loss asymmetry, Kahneman and Tversky subverted in 1979 this then dominant wisdom, advancing the view that risk attraction is the norm for losses, whereas risk aversion is the norm for gains. Later developments added a role for probabilities, leading Tversky and Kahneman in 1992 to propose a *fourfold pattern*, with risk aversion in either high-probability gains or low-probability losses, and risk attraction for low-probability gains or high-probability losses.

We introduce a third factor, namely the amount of the loss, while designing a new method to alleviate the "house money" bias that pervades real-money experiments with losses. Much of the previous experimental evidence of risk taking in the face of losses is confined either to hypothetical losses or the loss of small amounts, limitations that our experimental design avoids.

A main result is that, contrary to the recent views, and as Bernoulli thought, risk aversion is the majority attitude when substantial amounts of money can be lost. This parallels the pattern that we have observed for gains. To paraphrase Kahneman and Tversky, the relevant distinction appears to be, not between the domains of gains vs. losses, as they claim, but between the domains of large vs. small money amounts.

The thrust towards risk aversion for large amounts and towards risk attraction for small amounts does not conflict with the four-fold pattern of Prospect Theory for decisions involving either gains or low-probability losses. But risk aversion in the face of high-probability, large losses raises a major challenge to Prospect Theory. Yet this is precisely what we observe in a range of data not directly covered by previous experiments. It leads us to conclude that, when it matters, most people display risk aversion.

Appendix 1. Experimental data

	Amount of Money (Euros)						
	3	6	12	30	45	60	90
Participant AL	c	c	c	c	c	c	c
Participant BL	c	c	c	c	-	-	-
Participant CL	ur	c	c	c	c	c	-
Participant DL	ur	c	c	c	c	-	-
Participant EL	ur	un	c	c	c	-	-
Participant FL	ur	un	c	c	-	-	-
Participant GL	ur	un	c	c	-	-	-
Participant HL	ur	un	un	c	c	c	c
Participant IL	ur	un	un	c	c	c	-
Participant JL	ur	un	un	c	c	c	-
Participant KL	ur	un	un	c	c	-	-
Participant LL	ur	un	un	c	c	-	-
Participant ML	ur	un	un	c	c	-	-
Participant NL	ur	un	un	c	-	-	-
Participant OL	ur	un	un	un	un	-	-
Participant PL	ur	un	un	un	un	un	-
Participant QL	ur	un	un	un	un	un	un
Participant RL	c	c	c	un	un	c	-
Participant SL	ur	c	un	un	c	c	c
Participant TL	ur	un	un	c	c	c	un
Participant UL	ur	un	un	un	c	un	c

Table A1. Treatment *L*. A letter *c* (green cell) indicates choosing the certain loss (thus displaying risk aversion), while the letters *un* (red cell) indicate choosing the uncertain loss (thus displaying risk attraction). The dashes indicate that the participant was not asked to make the corresponding choice.

	Amount of Money (Euros)						
	3	6	12	30	45	60	90
Participant AL'	un	c	c	c	c	-	-
Participant BL'	un	un	c	c	-	-	-
Participant CL'	un	un	c	c	-	-	-
Participant DL'	un	un	c	c	-	-	-
Participant EL'	un	un	c	c	c	-	-
Participant FL'	un	un	c	c	c	c	-
Participant GL'	un	un	c	c	c	c	c
Participant HL'	un	un	c	c	c	c	c
Participant IL'	un	un	un	c	-	-	-
Participant JL'	un	un	un	c	-	-	-
Participant KL'	un	un	un	c	c	-	-
Participant LL'	un	un	un	c	c	-	-
Participant ML'	un	un	un	c	c	c	-
Participant NL'	un	un	un	c	c	c	-
Participant OL'	un	un	un	c	c	c	-
Participant PL'	un	un	un	c	c	c	c
Participant QL'	un	un	un	un	-	-	-
Participant RL'	un	un	un	un	c	c	-
Participant SL'	un	un	un	un	un	-	-
Participant TL'	un	un	un	un	un	-	-
Participant UL'	un	un	un	un	un	-	-
Participant VL'	un	un	un	un	un	c	-
Participant WL'	un	un	un	un	un	c	-
Participant XL'	un	un	un	un	un	c	c
Participant YL'	un	un	un	un	un	un	-
Participant ZL'	un	un	un	un	un	un	-
Participant AAL'	un	un	un	un	un	un	c
Participant BBL'	un	un	un	un	un	un	un
Participant CCL'	un	un	un	un	un	un	un
Participant DDL'	un	un	un	un	un	un	un
Participant EEL'	c	un	un	c	-	-	-
Participant FFL'	un	un	c	un	c	-	-
Participant GGL'	c	un	c	c	un	-	-
Participant HHL'	c	un	un	un	-	-	-

Table A2. Treatment *L´*. A letter *c* (green cell) indicates choosing the certain gain (thus displaying risk aversion), while the letters *un* (red cell) indicate choosing the uncertain gain (thus displaying risk attraction).

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