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Selective insensitivity for losses but not gains in decision making under risk among the poor

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ABSTRACT

We analyzed decision making under risk in a group of 50 poor individuals and a group of 50 rich individuals from the city of Lima, Peru, using the Columbia Card Task game. Contrary to the decisions of the rich, the decisions of the poor were insensitive to changes in the magnitude of potential losses: the risk taking of the poor did not increase when potential losses were low compared to when they were high. The decisions of the poor were also significantly less sensitive to changes in the probability of potential losses, compared to those of the rich. On the contrary, similarly to the decisions of the rich, the decisions of the poor were significantly sensitive to changes in the gain amount: risk taking was higher when the gain amount was higher than when it was lower. The rich sample from Lima showed a similar pattern of risk-taking behavior as other non-poor populations from previous studies. Furthermore, the poor scored higher on the perceived constraints scale and showed the same level of unrealistic optimism for negative events, but less unrealistic optimism for positive events, than the rich.

1. Introduction

Decision making is a fundamental complex cognitive ability in every human being and the very core of the human freedom to self-determine. Indeed, suboptimal decision making is associated with maladaptive behaviors (Bechara et al., 1997, 2000; Paulus, 2007). Those born into poverty, in addition to being economically disadvantaged, are also less likely to escape from poverty–a circular self-reinforcing mechanism known as the “poverty trap” (Bowles et al., 2006). It is therefore important to study decision making under risk by poor individuals to better understand whether escaping from poverty may be hampered by a particular decision-making behavioral pattern. To do so, we analyzed the use of loss, gain and probability information in a risk-taking task by a sample of poor individuals. We then statistically compared the poor sample group's behavioral decision-making pattern with that of a comparable sample of rich individuals from the same city, and, although only descriptively, to that of non-poor populations that had engaged with the same task in previous studies. We did so to detect specific patterns of behavior in the poor sample group's risk-taking style that might negatively impact on their daily life decisions. A quasi-experimental design similar to ours was used in a study on ambiguity attitudes elicited from two groups of Chinese adolescents (poor rural and rich urban), which concluded that the poor rural adolescents were worse at dealing with ambiguity than their urban counterparts (Li, 2017).

Indeed, some evidence shows that poverty may reduce proper cognitive functioning (Mani et al., 2013; Spears, 2011). However, it has been claimed that poverty does not in itself directly impede cognitive functioning, but rather induces negative stress that, in turn, leads to short-sighted decision making (Hall et al., 2014; Haushofer and Fehr, 2014), although there is still no direct proof of this link. Indeed, it has been suggested that the poor see an economic dimension in many everyday experiences that others do not see and that these thoughts about cost and money change mental associations, and interfere with other experiences (Shah et al., 2018). Another opposing view, however, proposes that poor individuals gradually adapt to enduring financial strain and eventually become even more efficient than their richer counterparts in the domain of financial decision making (Dang et al., 2015).

The very few studies that have directly compared decision-making processes in both poor and rich individuals have yielded inconsistent results. For example, in a couple of studies the poor were found to be more rational than the rich. Lower-income individuals were found to be less susceptible to contextual variables in decision making (Shah et al., 2015), and Indian Mechanical Turk workers were found to behave more rationally than U.S. students (Spears, 2013). On the contrary, there is evidence of inadequate decision making under risk by poor children. Children aged 9–12 years exposed to chronic poverty were found to be less sensitive to low frequency–high magnitude losses in the Iowa Gambling Task (a risk-taking task) and exhibited greater maladaptive

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risk taking than children not exposed to poverty (Ursache and Raver, 2015).

In other situations poverty appears to be associated with individual preferences for risk but, the direction of this relation is unclear. Individuals who were more likely to face income uncertainty or to become liquidity-constrained were less willing to pay for risk security, thus exhibiting a higher degree of absolute risk aversion (Guiso and Paiella, 2008). Lower-income individuals were also found to be less willing to take risks, as measured by the general risk question used in the German Socio-Economic Panel (SOEP) (Dohmen et al., 2011). However, one field study found no differences in decision making or risk taking when poor individuals were examined before or after payday (Carvalho et al., 2016). Similarly, no significant association was found between risk aversion and low income in small-scale farmers in Uganda, Ethiopia, and India (Mosley and Verschoor, 2005).

Here, we investigate decision making under risk in a group of poor individuals using a well-known task, the Columbia Card Task (Figner et al., 2009), which allows us to study how decision makers adapt their choices when the parameters of the decision-making context change (i.e., their sensitivity to potential gains, losses, and probability). Sensitivity to losses, gains, and probability in poor individuals was then statistically compared to that from a sample of rich individuals from the same city of Lima, to detect differences in behavioral patterns. We also descriptively compared our findings on the decisions of the rich and poor subjects with findings from earlier studies on non-poor populations that performed the same task.

1.1. Overview of the study

To investigate the sensitivity of the poor to potential gains, potential losses, and associated probability in decision making under risk, we analyzed risky decisions on a computerized task by a sample of individuals from the poorest part of the city of Lima (Cono Este) and compared these decisions with those of a sample of rich individuals from the same city, but residing in wealthier areas.

Lima was chosen for two reasons. First, it is a city where poverty (Cono Este) and richness (wealthy area) are geographically close, thus ensuring that the poor sample group and the rich sample group shared basic common traits, such as national identity, language, and cultural background. Second, in Lima poverty is a genuine phenomenon, in the sense that it is not a consequence of other problems such as alcoholism, addiction, and so on.

Individual risk taking was assessed using a modified version of the Columbia Card Task cold version (cold-CCT) (Figner et al., 2009), known as the warm-CCT (Huang et al., 2013) (Fig. 1). The main variable of interest in the game is how many cards (out of a set of 32) each participant chooses to turn over in each trial. The trials vary in respect to the amount of loss, the amount of gain, and the probability of a loss, within each participant. The difference between the cold-CCT and the warm-CCT lies in the fact that in the warm version, participants click on which cards they want to be turned over, rather than merely indicating how many cards they want to turn over, as in the cold version; moreover, in the warm version feedback is given after each trial, whereas in the cold version feedback is given only after all trials are completed. Risk taking is measured by how many cards participants turn over before they decide to stop. The decision to turn over an additional card increases the outcome variability (i.e., risk) because the probability of encountering a loss card increases and the probability of encountering a gain card decreases (Figner and Weber, 2011; Figner et al., 2009). Previous behavioral studies have used different version of the CCT to measure decision making under risk in both adolescents and adults (Huang et al., 2013; Panno et al., 2013; Penolazzi et al., 2012).

Ideally, a participant performing the task optimally should turn over more cards in the large-reward trials than in the small-reward trials, more cards in the small-penalty than large-penalty trials, and more cards in the trials with a small probability of losses than in those with a large probability of losses, thus showing good sensitivity to gains, losses, and probability. For example, an internally coherent or consistent decision maker should be more willing to accept a risk when the loss at stake is lower than when it is higher, thus showing loss sensitivity: a gamble with a potential loss of $5 should be more attractive than a gamble with a potential loss of $10, when every other parameter is kept constant (i.e., the amount of gains and the level of probability). By varying selectively the amount of loss, the amount of gain and the probability level of the loss, the Columbia Card Task allows us to measure individuals' sensitivity to gains, losses, and probabilities. Healthy individuals usually display an adaptive decision-making pattern–that is, they risk comparatively less when the potential losses are high than when they are low, they risk comparatively more when the potential gains are high than when they are low, and they risk less when faced with a greater, rather than a lesser, likelihood of incurring in a loss (Buelow, 2015; Figner et al., 2009; Holper and Murphy, 2014; Markiewicz and Kubinska, 2015).

Here, we aimed to verify whether poor individuals also display this standard pattern of decision-making behavior. Moreover, we aimed to verify whether the decisions of the poor differ significantly from those of the rich by comparing two geographically close but economically different sample groups from the city of Lima, Peru. It is true, though, that the two sample groups differed in a variety of aspects related to their socio-economic status, such as level of education, parental attentions received during childhood, and emotional experiences encountered during their lives. Indeed, poverty in real life does not imply only less available income, but is associated also with a very broad spectrum of social and affective deprivations linked to lower economic status. Our focus here is to describe the decision-making pattern of poor individuals, but also compare that behavioral pattern with that of rich individuals, embracing heterogeneity between the two samples as components of poverty status. This approach may limit the accuracy of our prediction, but we consider it to be more realistic and generalizable than an experimental design where poverty is induced artificially in a laboratory.

All participants in our study also completed self-reported measures of personal mastery, perceived constraints (Lachman and Weaver, 1998), unrealistic optimism (Weinstein, 1987), and self-reported risk taking (Wagner et al., 2007). These measures were used as covariates to ensure that poor-related differences in behavior were not due to systematic differences in the underlying characteristics of the study participants, and to verify secondary hypotheses.

2. Method

2.1. Participants

Research participants comprised 100 individuals all residing in Lima, Peru. Sample characteristics of the two groups and statistical differences are summarized in Table 1. The poor sample ($n = 50$) resided in Cono Este, a poor area of Lima, and the rich sample ($n = 50$) resided in various wealthy areas of Lima.

Poor participants were recruited with the support of a non-governmental organization (NGO) that had operated in Lima since 1989, implementing social inclusion and poverty eradication projects. Participants, however, were not involved in any development program at the time of the study. The poor participants were contacted via seven different public and private schools, and public and private employment offices, in the Cono Este area of Lima.

The rich participants were recruited via a private university with relatively expensive tuition fees, in Lima. We purposely chose young rich adults and not older rich adults in order to keep the ages between the two samples (poor and rich) as comparable as possible to reduce the possibility of any differences found between the responses of the two sample groups being ascribed to age differences. Although the warm-CCT has been found to be insensible to age, other versions of the CCT (e.g., hot-CCT and cold-CCT) have been found to be age-related (Defoe et al., 2015; Figner et al., 2009; Huang et al., 2013).

None of the poor subjects had previous experience with economic experimental tasks, whereas some of the university students had taken

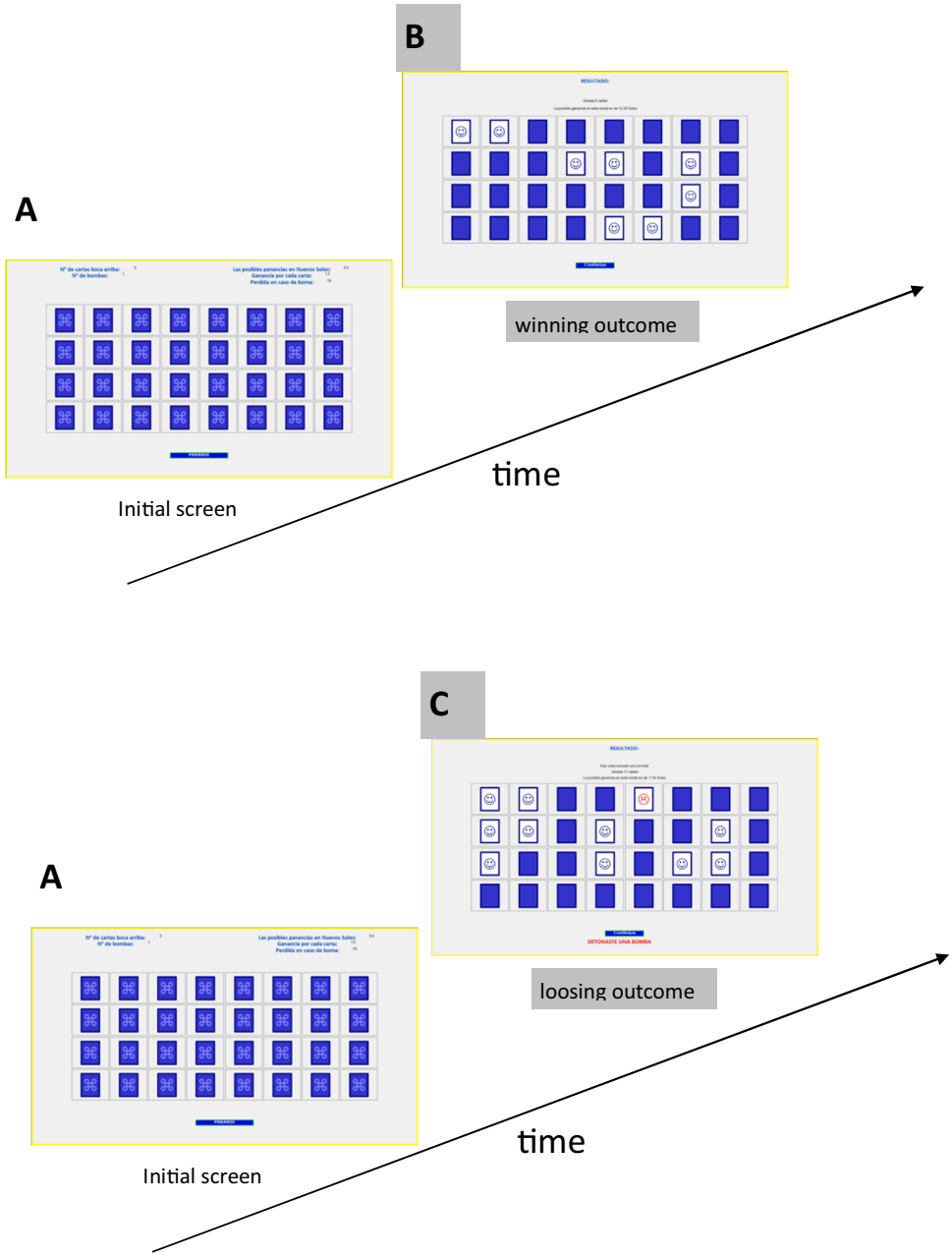

Fig. 1. The risk-taking task: The Columbia Card Task (18). The initial trial (A) and an example of a winning (B) and losing (C) outcome.

part in previous experimental studies but had no experience of the task used in this study. Participation was extremely high in the poor sample group (all those asked to participate did participate) and relatively high in the rich sample group (about 94% of those asked to participate did participate).

2.2. Materials and procedure

Each participant was asked whether they would like to participate, without specifying, at this stage, that they could potentially earn cash at the end of the experiment if they took part. They were informed that it was a behavioral experiment that aimed to understand economic behaviors. No reference to poverty or affluence was provided. Those who consented to take part were fully informed about the task and the possibility of earning as a result of their choices in the task. Participants were not compensated purely for participating, but received the amount they earned by playing the decision-making task. Participants were seated at a computer work station. To ensure their complete understanding of the task, the instructions were provided verbally in the local language, using cards as visual aids. All odds were demonstrated using cards, and no explicit reference to the term "probability" was given. Each participant was tested on the same tasks in the following order: (1) the risk-taking task, and (2) post-task questionnaire (sense of control, unrealistic optimism, risk attitude, socio-economic data).[1] The experimental sessions were conducted

[1] Before taking part in the risk-taking task, each participant was also asked to state their level of willingness to pay for five goods using the Becker–DeGroot–Marschak method (BDM) to ensure that the poor and the rich attributed the same value to the same monetary amount. This was necessary because we used monetary incentives, and any differences in behavior between the two groups may simply reflect a different value given to money. The poor and the rich expressed the same mean willingness to pay (see Table 1) showing that the rich and the poor attributed the same value to money.

Table 1
Descriptive statistics (means and ± SEM) for the poor and the rich samples.

	Poor group	Rich group	Test of difference
No. of cases	50	50	
Weekly family income [a]	608.26 ± 57.33	5823.77 ± 1677.36	t(98) = − 3.108**
Weekly gambling expenditure [a]	0.67 ± 0.42	10.80 ± 3.94	t(98) = − 2.557*
No. of family members	5.72 ± 0.41	4.18 ± 0.18	t(98) = 3.474**
House score (range 0–3)	1.94 ± 0.12	2.49 ± 0.10	t(98) = − 4.423***
Gender	22 F 28 M	29 F 21 M	$\chi^2(1) = 1.961$
Age	21.98 ± 0.52	19.00 ± 0.24	t(98) = 5.161***
Education (range 1–10)	7.80 ± 0.18	8.98 ± 0.02	t(98) = − 10.604***
Currently employed	23 No 27 Yes	44 No 6 Yes	$\chi^2(1) = 19.946$***
I have searched for a job	9 No 14 Yes	42 No 2 Yes	$\chi^2(1) = 26.09$***
Personal mastery scale (range 1–7)	5.89 ± 0.16	5.73 ± 0.10	t(98) = 0.818
Perceived constraints (range 1–7)	3.38 ± 0.17	2.33 ± 0.10	t(98) = 5.261***
Unrealistic optimism for positive events (range 1–7)	3.37 ± 0.15	4.68 ± 0.14	t(98) = − 6.209***
Unrealistic optimism for negative events (range 1–7)	3.12 ± 0.17	3.42 ± 0.08	t(98) = − 1.628
SOEP question (range 0–10)	7.16 ± 0.41	7.46 ± 0.19	t(98) = − 0.669
No. of cards turned over in the CCT	9.33 ± 0.67	10.82 ± 0.54	t(98) = − 1.742
WTP	4.03 ± 0.24	4.29 ± 0.26	t(98) = − 0.722

Notes.
[a] = currency: nuevos soles.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 2
The gain, loss and probability parameters used in each trial of the Columbia Card Task.

Trials	Gain amount	Loss amount	Probability of the loss
1	S/. 1.5	S/. 18	1 over 32
2	S/. 1.5	S/. 18	3 over 32
3	S/. 0.5	S/. 18	1 over 32
4	S/. 1.5	S/. 6	3 over 32
5	S/. 0.5	S/. 6	3 over 32
6	S/. 0.5	S/. 6	1 over 32
7	S/. 1.5	S/. 6	1 over 32
8	S/. 0.5	S/. 18	3 over 32

with a maximum of three subjects at a time for the poor, and eight subjects at a time for the rich.

2.2.1. Risk-taking task

Each participant was asked to play a version of the Columbia Card Task known as the warm-CCT (Figner and Weber, 2011) (Fig. 1; Figner et al., 2009). This task incorporates both rewards and penalties, both of which vary in magnitude and in probability. Gain amount, loss amount, and the probability of losing were varied between trials in a full-factorial within-subject design, presenting each of the eight combinations of factor levels three times (three blocks), thus resulting in 24 trials for each participant. Trials were presented in the same order for each subject. Participants were informed initially, and reminded throughout, that three of the 24 trials would be selected at random, and that the mean earned in the three trials would be paid to them.

In each trial, participant chose how many cards to turn over from a matrix of 32 face-down cards (Fig. 1A). The subject was informed that each card was associated with an outcome that could be either a loss or a gain. In the original CCT task (Huang et al., 2013), a "gain" card can vary in amount between 10 points and 30 points, a "loss" card can vary between 250 and 750 points, and the probability of a loss can vary between 1 and 3. Therefore, in the original CCT task the losses are much greater than the gains to account for the fact that the probability of turning a gain card is much higher than the probability of turning a loss card. In an attempt to keep our task as similar as possible to the original one, we retained the proportions between high–low gains and high–low losses, as well as those between gains and losses, equal to the original. The outcomes varied in magnitude: there was a large reward (1.5 nuevos soles), a small reward (0.5 nuevos soles), a small penalty (6 nuevos soles), and a large penalty (18 nuevos soles). One nuevo sol equals $0.29, which may seem a low amount; however, the cost of living in Peru is roughly 50% less than that in the United States (e.g., a Coke at a restaurant costs about $1.72 in the United States but only $0.66 in Peru). The penalties were also associated with a high probability (3 out of 32 cards) or a small probability (1 out of 32 cards) of occurrence. Table 2 lists the magnitudes and probabilities used in each trial. In each trial, before deciding how many cards to turn, the individual was informed about the level of the reward, the level of the penalty, and the probability of encountering the penalty in that trial. Next, the participant clicked on which cards they wanted to be turned over. When the participants had finished selecting cards, they pressed the stop button and the cards that they had chosen were revealed. Feedback was provided at the end of each trial. Participants received the corresponding reward amount for all the gain-cards selected (Fig. 1B); however, if they had selected a loss-card (Fig. 1C), the round was over (i.e., the gain-cards turned over after the loss-card in that game were not rewarded) and the loss amount was subtracted from the gain they had accrued in the current round.

Subjects played some practice rounds with paper cards and they orally answered comprehension questions before starting the task. The Spanish version of the CCT software was written using z-Tree software (Fischbacher, 2007). The software and the experimental procedure were pre-tested on 10 students in a pilot experiment conducted at the Cognitive and Experimental Economics Laboratory (CEEL) at the University of Trento.

2.2.2. Post-task questionnaire

All participants also completed the Midlife in the United States (MIDUS) control beliefs scale (Lachman and Weaver, 1998), which includes 12 statements regarding personal mastery and perceived constraints. Participants indicated the degree to which they agreed or disagreed with each statement, as applied to themselves, on a scale from 1 (strongly agree) to 7 (strongly disagree).

The personal mastery items were reverse-coded so that higher scale scores indicated stronger control beliefs. Personal mastery was measured through the scores assigned to the following four statements (Cronbach's $\alpha = 0.62$): "I can do just about anything I really set my mind to;" "When I really want to do something, I usually find a way to succeed at it;" "Whether or not I am able to get what I want is in my

own hands;" and "What happens to me in the future mostly depends on me."

Perceived constraints were measured through the scores assigned to the following eight statements (Cronbach's $\alpha = 0.78$): "Other people determine most of what I can and cannot do;" "There is little I can do to change many of the important things in my life;" "I often feel helpless in dealing with the problems of life;" "What happens in my life is often beyond my control;" "There are many things that interfere with what I want to do;" "I have little control over the things that happen to me;" "There is really no way I can solve all the problems I have;" and "'I sometimes feel I am being pushed around in my life".

Taken together, the two scales are said to measure sense of control–that is, participants' beliefs about the degree to which they can influence what happens in their life.

Unrealistic optimism was measured following Weinstein (1980), by asking the participants to estimate the likelihood of experiencing an event compared to others of the same age, gender, and neighborhood. The list of events comprised seven positive items (Cronbach's $\alpha = 0.86$) and seven negative items (Cronbach's $\alpha = 0.76$). The respondents indicated the degree of agreement or disagreement on a 7-point scale (1 = significantly less likely than others; 2 = much less likely than others; 3 = a little less likely than others; 4 = the same as the others; 5 = a little more likely than others; 6 = much more likely than others; and 7 = significantly more likely than others). The events used were as follows: "Find a job with a good salary;" "Have a child who graduates at the University San Marcos/Pacìfico;" "Win a luxury car;" "Win a great cash prize;" " Go on holiday to the place of your dreams;" "Own a mansion near the sea;" "Go out for dinner with your favorite singer;" and "Get kidnapped walking around town;" "Get crushed under a tree;" "Lose a relative in the next two years;" "Suffer a violent crime;" "Experience a heart attack;" "Get struck by lightning;" and "Break an arm". A group average significantly greater than 4 points, both in positive and in negative items, indicated that the group had shown a typical pattern of unrealistic optimism.

Risk attitude was measured through the general risk question used in the German Socio-Economic Panel (SOEP) survey (Wagner et al., 2007), on a 0–10-point scale: "How do you see yourself: are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?"

Lastly, the questionnaire asked for personal information and family background, but also measured economic well-being and social status. One group of questions concerned the subjects' homes: information about the materials their home were constructed from, and about ownership, gave us important evidence about household living conditions. To evaluate household living conditions, we created a House Score index, which included: the category of the dwelling (score = 1 if an independent house or flat; score = 0 otherwise), the ownership of the dwelling (score = 1 if they are the owners; score = 0 otherwise), and the size of the dwelling (score = 1 if the house is larger than 100 m^2; score = 0 otherwise). The House Score index is the sum of the three dimensions and ranges from 0 to 3; the greater the score, the better the housing conditions.

Other questions regarding the family structure focused on the number of people living in the same household, the age distribution in the family, and the degree of kinship among family members. Questions about educational level and employment condition were as follows. Education was evaluated by asking about the highest level of schooling attained, according to a 10-point scale (1 = without any formal education; 2 = pre-schooling; 3 = some primary schooling; 4 = primary schooling completed; 5 = some secondary schooling; 6 = secondary schooling completed; 7 = some vocational schooling; 8 = vocational schooling completed; 9 = some university attended, and 10 = university degree attained). Employment was analyzed also in terms of willingness to work. We then gathered information about individual and household income earned in the last week. This short span of time was chosen because it is easier to remember. Employment within in the context of poverty is usually informal, fragmented, and highly unpredictable. Finally, we introduced a question about weekly expenditure on gambling and all the various types of hazard games, to capture risk-taking behavior in real life, even if we were aware that this measure might not have been a fair one, given the different availability of money in the two sample groups.

3. Results

3.1. Differences between the poor sample and the rich sample

The per capita income was 15.19 nuevos soles ($4.48) per day for the poor individuals and 203.59 ($60.11) per day for the rich individuals; hence, income was, on average, ten times higher for the rich individuals (Table 1).[2] The international poverty line is $1.90 a day, but the specific poverty line in the metropolitan area of Lima (*Lima Metropolitana*) is S/. 12 ($3.60) per day, which is very close to the income of the poor sample in this study (INEI, 2015). Poor participants spent less than S/.1 on gambling every week, while rich people spent more than S/. 10. On average, poor individuals came from larger families, made up of more than five members, and rich individuals came from smaller families made up of four members. Poor individuals scored 1.94 on the House Score index, while rich individuals scored 2.49, showing a significant difference. Gender distribution was kept equal in the two groups by design (around 50% male). On average, the poor were slightly older than the rich. For this reason, the effect of age was introduced in the analyses as a covariate. The two samples also differed in terms of educational background and employment: 4% of the poor did not complete secondary education and just 12% were attending university courses, while 68% were involved in some form of work. On the contrary, all the rich were university students, and only 16% were also working. Among the poor, 32% were attending school, while among the rich all were currently attending school. The intention to find a job was higher in the poor sample, and very few of the subjects in both samples were fully economically independent (1 in the rich sample and 3 in the poor sample). For these reasons, one should be cautious in forming any conclusions concerning employment with this data. In fact, the rich university students had a relatively low incentive to search for a job, while, most of the poor had been interviewed in employment offices, so they were more often seeking employment.

3.2. Behavioral risk-taking data

Our dependent risk-taking measure was the number of cards chosen in the Columbia Card Task, a continuous variable with a range of 0–32. The distribution of cards turned over for the poor participants (A) and rich participants (B) is shown in Fig. 2. We were interested in assessing the extent to which the rich and the poor adapted their risk-taking behavior to changes in the three task parameters: potential gain amount, potential loss amount, and probability of the potential loss. Using a linear mixed model analysis (LMM) we evaluated the effects of the within-subjects' fixed-factors 'gain amount' (low, high), 'loss amount' (low, high) and 'probability loss' (low, high); the between-subjects' fixed-factor 'group' (poor, rich), the group*gain, group*loss, group*probability interactions and 'subjects' as a random intercept. The LMM model included all the main effects of group, gains amount, loss amount, probability loss, the group*gain, the group*loss, the

[2] Note that the real income spread between the poor and the rich may have been underestimated. The poor may have been particularly embarrassed to answer the questions and thus overestimated their earnings, seeking to demonstrate that they fit a kind of "adequate standard." The rich may have underestimated their earnings, because they were likely to have not considered other assets such as investments, rent payments, and other indirect income streams that are more difficult to estimate.

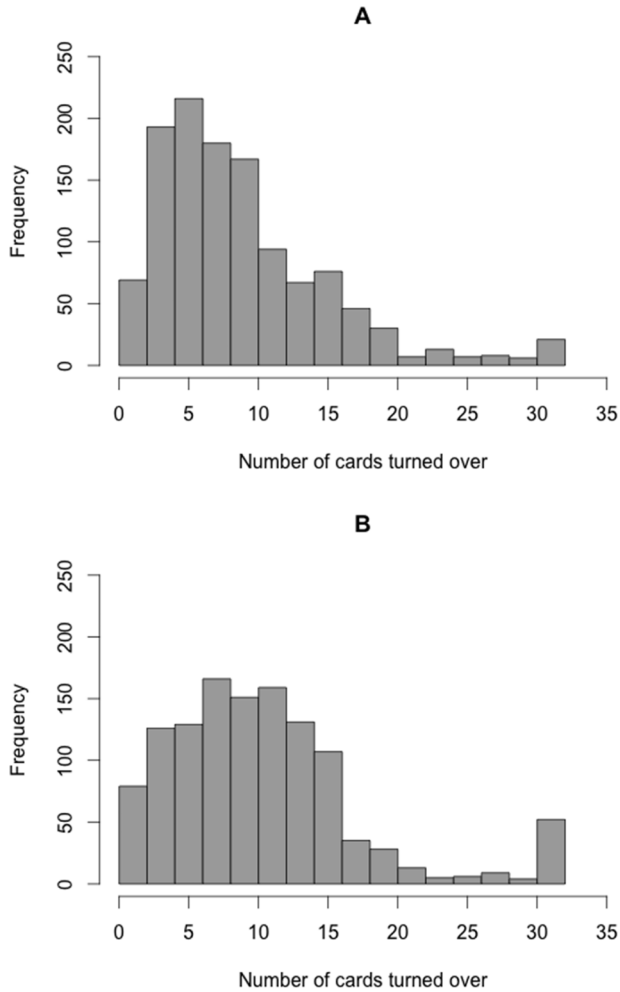

Fig. 2. Frequency of cards turned over in the Columbia Card Task in the poor sample (A) and in the rich sample (B).

group*probability interactions, and subjects as a random intercept in one single model. Frequentist analyses, including SDs and SEMs, were performed by simply averaging the trials for each factor (e.g., trials with low loss vs. trials with high loss).

The LMM analysis revealed a significant main effect for gain amount ($F_{1,\ 2286} = 27.444$, $P = 0.000$), loss amount ($F_{1,\ 2286} = 34.531$, $P = 0.000$), and probability loss ($F_{1,\ 2286} = 313.219$, $P = 0.000$), but not a significant main effect for condition. Even if the poor turned over fewer cards ($M = 9.329$; $SD = 6.2434$; $SEM = 0.1802$) than the rich ($M = 10.819$; $SD = 6.9038$; $SEM = 0.1993$), showing a lower propensity to take risks, this difference was only marginally significant ($F_{1,\ 98} = 3.034$, $P = 0.085$). On average, the risk-taking behavior of the overall sample was sensitive to changes in the gain parameters, to changes in the loss amount, and to changes in the probability: individuals turned over more cards in trials with a high reward ($M = 10.581$; $SD = 7.0085$; $SEM = 0.2023$) than they did in trials with a low reward ($M = 9.568$; $SD = 6.1742$; $SEM = 0.1782$); they turned over more cards in trials with a low penalty ($M = 10{,}643$; $SD = 6.8436$; $SEM = 0.1976$) than they did in trials with a high penalty ($M = 9506$; $SD = 6{,}3460$; $SEM = 0.1832$); and they turned over more cards in trials with a low probability of losing ($M = 11.786$; $SD = 7.3380$; $SEM = 0.2118$) than they did in trials with a high probability of losing ($M = 8.363$; $SD = 5.2955$; $SEM = 0.1529$).

Moreover, the main effects were also qualified by a significant interaction between group*loss amount ($F_{1,\ 2286} = 26.460$, $P = 0.000$) and between group*probability loss ($F_{1,\ 2286} = 18.784$, $P = 0.000$). All other interactions were non-significant (all P-values > 0.05), including the group*gain amount interaction ($P = 0.330$) (Fig. 3A).

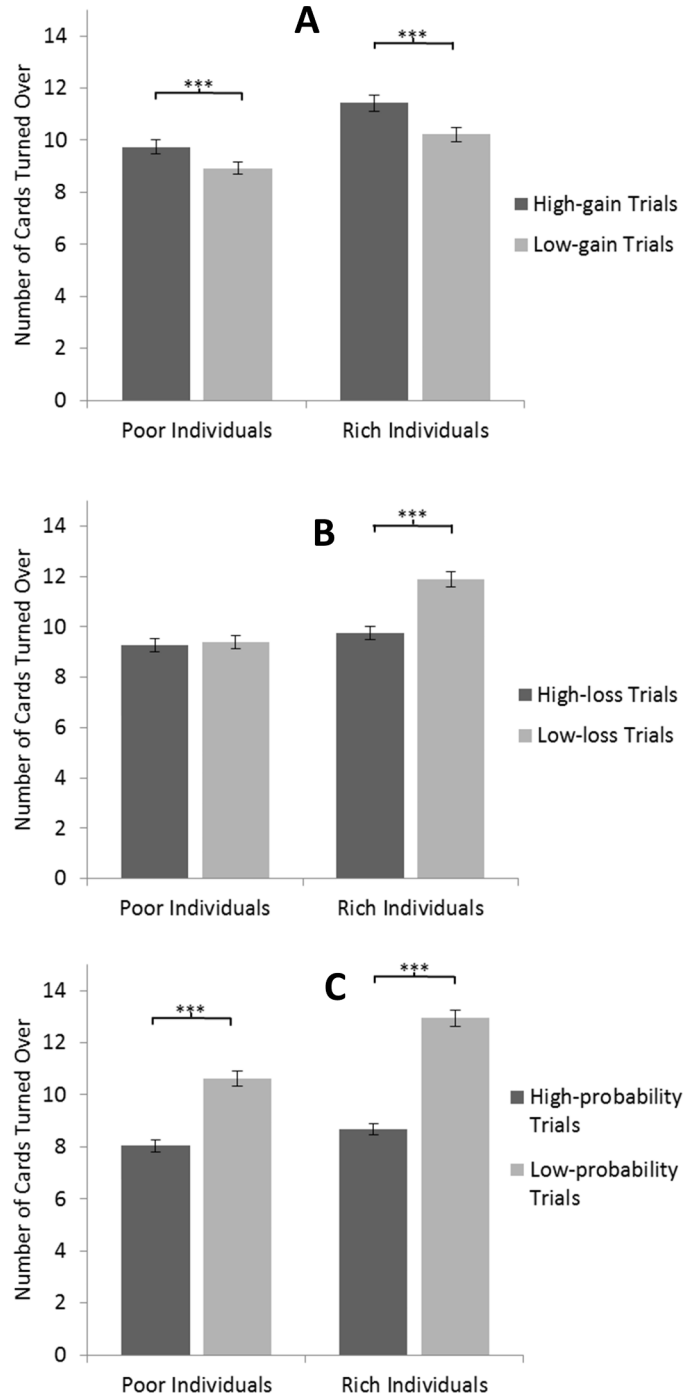

Fig. 3. Number of cards turned over (risk taking) by the poor and the rich when the potential reward (A), the potential penalty (B) and the probability (C) varied. Error bars represent ± SEM.

To analyze the significant group*loss amount interaction, we ran univariate tests[3] on the simple effects of loss amount within each level of group. These tests revealed that the rich turned over significantly more cards in the low-loss trials than in the high-loss trials ($F_{1,\ 2396} = 31.861$, $P < 0.0001$). However, the poor did not turn over more cards in the low-loss trials than in the high-loss trials ($F_{1,\ 2396} = 0.141$, ns) (Fig. 3B). Univariate tests of simple effects were also performed to analyze the significant group*probability loss interaction. The results

[3] We used SPSS MIXED procedure where degrees of freedom are obtained by a Satterthwaite approximation.

revealed that the rich turned over significantly more cards in the low-probability loss trials than in the high-probability loss trials ($F_{1,\ 2396} = 135.378$, $P < 0.0001$). Likewise, the poor turned over significantly more cards in the low-probability trials than in the high-probability trials ($F_{1,\ 2396} = 49.809$, $P < 0.0001$). It has to be remembered that the probability was associated with the loss and not with the gains. This pattern of results is therefore a rational behavior, since more risk taking is expected when the probability of incurring a loss is lower than when the probability is higher. However, as shown by the means in Fig. 3C, the poor displayed this optimal pattern to a lesser extent than the rich, which explains the significant group*probability loss interaction. Overall, the findings are thus consistent with the hypothesis of a different decision-making process under risk is operating in rich and in poor individuals.

Previous studies using the CCT showed that, on average, healthy individuals turn over about the same number of cards as did the individuals in our samples (i.e., about 12 cards per trial). More interestingly, non-poor participants in previous studies showed similar sensitivity to changes in probability, and to changes in loss and gain amounts, to our rich sample (Buelow, 2015; Figner et al., 2009; Holper and Murphy, 2014; Markiewicz and Kubinska, 2015). This further supports the hypothesis that the poor individuals had an unusual decision-making pattern that differed from that of the rich examined in this study, but also from that of other non-poor populations analyzed in previous studies.

Evidence from simulation studies (e.g., Barr et al., 2013) shows that failing to include random slopes often leads to severely inflated Type 1 errors (with Type 1 error rates being higher than 50%, instead of the nominal 5%). Thus, we re-run our mixed-models analysis and made sure that all within-subject predictors were modeled not only as fixed but also as random slopes. We used R (R Core Team, 2017) and lme4 (Bates et al., 2015) to perform a linear mixed effects analysis of the relationship between the number of cards turned over and the condition. As fixed effects, we entered condition, gain amount, loss amount and probability loss as well as the interaction between condition and the other parameters. Fixed effects for sex, age, education and income, were also included. As random effects, we had intercepts for subjects and by-subject random slopes for the effect of gain, losses, and probability. *P*-values were obtained using the Kenward–Roger approximation. The LMM analysis revealed a significant main effect for condition ($t_{140} = 2.34$, $P < 0.05$) as a consequence of poor turning over fewer cards ($M = 9.329$; $SD = 6.2434$; $SEM = 0.1802$) than the rich ($M = 10.819$; $SD = 6.9038$; $SEM = 0.1993$). The main effect of loss amount was also significant ($t_{98} = 2.43$, $P < 0.05$) while gain and probability were not significant. Moreover, the group*loss amount interaction was significant ($t_{98} = 4.15$, $P < 0.001$) as well as the group*probability loss interaction ($t_{98} = 2.03$, $P < 0.05$). All other interactions were non-significant (all *P*-values > 0.05), including the group*gain amount interaction ($P = 0.430$).

3.3. Questionnaire data

The poor reported significantly higher scores on the perceived constraints scale than the rich but they did not show a higher score on the perceived personal mastery scale (Table 1). Thus, it can be deducted that the poor–more than the rich–believe there is little they can do to change many of the important things in their lives. However, like the rich, they too believe that when they really want to do something, they usually find a way to succeed at it. We interpret these data as reflecting a realistic perception among the poor of their disadvantaged condition, but a strong internal self-confidence and self-mastery regarding their ability to control life events. Contrary to a view that sees the poor as inactive because they feel helpless and resigned to their destiny, the poor in our sample seem to believe that most of their condition is determined by external factors, because, internally, they feel that if they really want something, they can succeed in having it, mirroring exactly the views of the rich individuals in our sample.

The poor and the rich also differed in unrealistic optimism for positive events, but not for negative events. Individuals are usually optimistic in their future life predictions, in that they tend to believe that positive things will more likely happen to them than to another fellow and that the reverse is true for negative things–that is, that they are more likely to happen to others. This pattern of belief is termed "unrealistic optimism", or "optimistic bias" (Weinstein, 1982). Our results showed that the rich displayed the typical unrealistic optimism bias for positive events, while the poor did not. Specifically, the rich believed that positive events are more likely to happen to them than to their fellow other; the poor instead, believed that positive events will happen less likely to them than to their fellow other. This group difference was not replicated for the negative events. In particular, both the poor and the rich groups showed the typical unrealistic optimism bias regarding negative events: they both believed that negative events were less likely to happen to them than to others. Therefore, the rich show the standard pattern of unrealistic optimism results–more positive events to the self and more negative events to others–while the poor displayed a different pattern: they did not believe that positive events would happen to them more than to others, while they did believe that negative events would happen more to others than to themselves. In summary, the poor showed an unrealistic optimism bias only for negative events. We think that this could be viewed as an instance of a realistic representation of their condition: their own lives of hardship remain clearly in mind and the poor have no illusions that positive events will happen more frequently to them than to others, in contrast to the views of most wealthy people. However, they are not pessimistic in nature because they do indeed display an unrealistic optimism bias for negative events. Finally, both the poor and the rich individuals described themselves as moderately prepared to take risks, with no group difference in this self-reported risk attitude measure (SOEP). This shows that, at a conscious level, both groups think they are equally likely to take risks, whereas their behavioral data show that the poor risk less than the rich, when losses are low.

3.4. Covariates

Several measures were introduced into the main analysis as covariates[4] (Table 3). For each covariate, a separate model was employed.

We computed for each covariate the probability of rejecting the null hypothesis (group*loss = 0) while not rejecting the null hypothesis (covariate = 0). This probability waslower than 5% for all the covariates (i.e. 0.8% for Age, 4.9% for Education, 4.5% for Income, 4.6% for Self-Mastery, 4.6% for Constraints, 4.6% for Positive Unrealistic Optimism, and 4.6% for Negative Unrealistic Optimism). This suggests that in our experimental setting covariate analysis is reliable and Type 1 error rates are not biased.

The results showed that the group*loss amount and group*-probability loss interactions remained significant even after we controlled for age, number of family members, personal mastery, perceived constraints, and unrealistic optimism for negative events. Unrealistic optimism for positive events did have some impact: it did not reduce the group*loss amount interaction but eliminated the group*-probability loss interaction. This might indicate that the same underlying factor may be responsible for both the low sensitivity of the poor to anticipating changes in probability in the risk-taking task and for their unrealistic pessimism regarding positive events. Since education varied solely in the poor sample, we only computed the analysis of covariance for this group. This analysis shows that education did not impact the way in which the poor participants used the loss

[4] As a robustness check, using the simulation tool developed by Westfall and Yarkoni (2016) we checked that in our covariate analysis the Type I error rate was close to its nominal value of 5% given our sample size, effect size, and reliability of parameters (Westfall & Yarkoni, 2016).

Table 3
F-values of LMM models, before and after, including covariates (significant effects are indicated with asterisks). Number of Cards turned over is the dependent variable.

		Models in LMM						
		Gain	Loss	Probability	Group	Group × gain	Group × loss	Group × probability
Model without covariate								
All sample		27.444***	34.531***	313.219***	3.034	0.950	26.460***	18.784***
Poor group		12.771***	0.377	125.385***				
Rich group		15.027***	47.288***	189.004***				
Model with covariate								
Age	0.528	13.168***	27.485***	166.922***	1.291	0.399	24.822***	12.829***
Education[a]	0.767	14.113***	1.101	100.213***				
Income	1.255	24.578***	29.071***	284.025***	1.495	0.295	5.858*	1.975
Num. fam.	1.570	11.339**	0.843	196.790***	1.723	0.489	4.539*	12.380***
Pers. mastery	0.528	9.805**	8.572**	84.943***	0.429	0.473	10.566**	4.750*
Perc.constr.	0.820	13.670***	27.462***	191.836***	4.444*	0.489	15.535***	17.497***
UO pos	1.453	24.337***	29.348***	256.607***	4.904*	0.305	20.808***	1.696
UO pos	1.040	19.815***	20.155***	214.611***	1.958	1.542	11.942**	11.086**

Note. Num. Fam. = Number of family members; Pers. Mastery = Personal Mastery; Perc. Constr. = Perceived Constrains; UO Neg = Unrealistic optimism for negative events; UO Pos = Unrealistic optimism for positive events.
* $p < .05$.
** $p < .01$.
*** $p < .001$.
[a] This covariate was computed only for the poor sample.

information: the factor loss amount was not significant in the poor sample either before or after introducing this covariate. As an additional robustness check, we matched the subsample of poor individuals attending university with the rich university students having similar age and gender by using propensity score matching technique choosing maximum proximity as criteria. Our finding on loss insensitivity holds within this new sample: poor individuals attending university do not turn over less cards when losses are high ($M_{high} = 10.89$, $SD = 5.54$) compared to when losses are low ($M_{low} = 11.43$, $SD = 5.88$), $t_{189} = -0.64$, $P = 0.52$) while rich university students do adapt their choices ($M_{high} = 12.10$, $SD = 7.40$, ($M_{low} = 9.27$, $SD = 7.50$), $t_{190} = 2.62$, $P < 0.01$).

Finally, income did have a moderating effect by reducing the group*loss amount interaction and eliminating the group*probability loss interaction. This result further strengthens the observed differences between the poor and the rich, since income is the closest proxy for classifying one as poor.

4. Discussion and conclusion

We investigated how a sample of poor individuals from a disadvantaged area of the city of Lima (Peru) adapted their risk-taking choices in a game where the parameters of the decision-making context (potential gains, losses and probability) change. The purpose was to evaluate the risk-taking sensitivity of the poor to changes in losses, in gains, and in probability, and compare this with the sensitivity of a sample of rich individuals from the same city.

The poor showed a marked insensitivity to changes in the amount of potential losses and a diminished sensitivity to changes in the level of risk probability in their decision-making behavior compared to the rich, but showed an adequate sensitivity to changes in gain amount. When offered the chance to win money in a laboratory task that entailed decision making under risk, the poor were sensitive to changes in potential rewards, in that they risked more when the stakes were high and less when they were low, but they were not at all sensitive to changes in potential losses, in that they risked to the same degree whether the stakes were high or low. The poor's insensitivity to changes in loss was due to the fact that they showed reduced risk-taking when the losses were low, compared to the rich sample.

An important question is to establish whether this loss-insensitivity hints at maladaptive behavior. According to Figner et al. (2009), an optimal strategy to maximize earnings in the Columbia Card Task game needs to take into account all three factors: probability, gain amount, and loss amount. Indeed, the rich group in our study showed significant sensitivity to all three parameters, as did the non-poor adult participants of previous studies that used the cold-CCT (Buelow, 2015; Figner et al., 2009; Kluwe-Schiavon et al., 2016; Penolazzi et al., 2012; Pripfl et al., 2013). Hence, we can assert that the poor exhibited a rigid decision-making style compared to the rich in the Columbia Card Task game, characterized by a loss-avoidant behavior in the face of risk.

One explanation for the loss-insensitivity behavior of the poor in risk taking is to assume that the poor try to avoid “any” loss (either high or low). People born into poverty could may show a specific decision-making style directed at avoiding losses, whatever the size of these losses. Given their conditions of extreme resource scarcity and their frequent experiences with negative-type events, the poor behave in a specific way that is functional to survive in their environment but that may be, at the same time, inadequate for optimal decision making in specific circumstances. For example, a loss-avoidant behavior may prevent the poor from grasping an opportunity to acquire a gain in face of a small loss.

Another explanation calls into question the focus of attention. The poor may have paid more attention to changes in the rewards than to changes in the penalties. Remember that each of the 24 trials, played by each participant, changed with respect to three parameters–the penalties, the rewards, and the probability of the penalties. The poor may have paid attention to the changes in rewards, and not to the changes in penalties, and even less to the changes in probability. This behavior may have been intentional or unintentional. If the behavior of the poor was intentional, it would indicate that the poor choose to behave in a way that disregards penalties, maybe because they give less weight to penalties (desensitization to losses) or because they believe negative events will not happen to them (unrealistic optimism). However, this very last explanation is not supported by our data because the poor showed the same unrealistic optimism for negative events as the rich. On the contrary, if the behavior of the poor was not intentional, then this would indicate that it is an instance of reduced ability in information processing, which, for some reason, selectively penalizes the cognitive processing of losses and not that of rewards. A state of cognitive stress has been argued as the cause of the diminished cognitive performances of the poor (Haushofer and Fehr, 2014). However, if the poor simply experience greater cognitive impairment than the rich, we

would have observed an insensitivity to all three decision-making parameters (gain, loss, probability), yet we observed a specific insensitivity to losses (as have other studies on the disadvantaged categories reviewed below). It could, however, be that losses, for some reason, are more difficult to cognitively process than other parameters.

Another possible explanation for our findings is that the poor have a higher discount rate. However, we tend to believe that a higher discount rate is not the cause of what we observed in our study, but rather it is another consequence of a state of cognitive stress in the poor, as suggested by Haushofer and Fehr (2014). Indeed, a higher discount rate should equally impact losses, gains and probability, and not only losses.

Interestingly, other studies have shown that disadvantaged individuals[5] display differences in decision making under risk in particular when evaluating losses, but not gains. For example, internet gaming disorder (IGD) subjects, compared to control subjects, are less likely to adjust their decisions based on probability level and outcome magnitude in the loss domain than in the gain domain (Yao et al., 2015). Underperformance on a decision-making task in chronic marijuana users diagnosed with substance abuse disorder was correlated with a reduced activity in the anterior cingulate cortex and the medial frontal cortex during the evaluation of a loss, whereas no difference was found during the evaluation of a gain (Wesley et al., 2011). Maltreated children show decision-making impairments, especially in the loss domain, and are insensitive to changes in loss magnitude for risky options (Weller and Fisher, 2013). At-risk, high sensation-seeking adolescents allocate fewer attentional resources to negative outcomes (but not to positive) (Cservenka et al., 2013).

To explain why other categories of disadvantaged people, such as internet gamblers, are insensitive to variations in losses, a neurocognitive explanation has been suggested. One hypothesis proposes that disadvantageous decision making in the loss domain may relate to alterations in cortico-striatal functioning among individuals with internet disorders and drug addictions (Balodis et al., 2012; Naqvi and Bechara, 2010) with a critical role of the insular (Noël et al., 2013; Samanez-Larkin et al., 2008). This type of neuro-structural explanation does not indicate the ultimate cause of the inability (or unwillingness) to anticipate losses, but may support a developmental hypothesis. A brain development hypothesis has been put forward by several researchers to explain why the poor are cognitively impaired. This explanation focuses on the factors influencing brain development in early childhood (Phillips and Shonkoff, 2000). Human and animal studies highlight the critical importance of brain development during the early years of life for setting in place the structures that will shape future cognitive, social, emotional, and health outcomes (Noble et al., 2005). Less parental attention and lower education levels may influence the cognitive development of poor people. Poverty in childhood, therefore, may lead to poorer outcomes later in life (Hair et al., 2015; Luby et al., 2013; Mackey et al., 2015; Noble et al., 2015) and a reduced likelihood of ever escaping poverty. Taken together, this evidence suggests that decisions by the poor may be affected by a specific decision-making style related to the way the poor perceive and anticipate potential losses, rather than potential gains.

What implications does this cognitive style have on daily life decisions? It is estimated that in 2014 some 1.2 billion people lived on less than USD 1.25 per day, and 2.7 billion lived on less than USD 2.50 per day. A widespread belief in the scientific community is that this condition of pervasive and abject poverty is irreversible; but an optimal decision-making process is a prerequisite for self-determining one's own future. We find that the poor are insensitive to changes in potential losses, but not potential gains. They refuse to risk in a situation where the expected value of the gamble is very favorable but entails a very small chance of losing. However, it is not clear whether this loss-avoidant behavior sometimes turns into a maladaptive decision-making style in real life, contributing to the "poverty trap."

There are two major merits in relation to the present study. First, it measured behavior in a controlled environment (a computerized task) using incentivized mechanisms where independent factors (gain, loss, probability) were experimentally varied within the subject. Studying behavior experimentally is a difficult task because it requires that a certain amount of time is devoted to every single participant and it requires a certain setting. For this reason, samples cannot be as large as survey studies. Second, we measured poverty in a true-life poor setting. Our sample of the poor consisted of people who lived in houses that were little more than hovels, in neighborhoods where there are no paved roads and a high degree of degradation. This is not the same as comparing low-income individuals with high-income individuals within a sample of all rather-wealthy individuals, which is the typical study design used in survey studies.

4.1. Limitations and future research

Along with several merits, this study also has several limitations that should be considered. First, we chose to study poverty in early adulthood (19–21 years of age) during the transitional period from adolescence to adulthood because at this age many important life decisions are made yet it is likely that the impacts of childhood remain present. Our samples, therefore, have limited external validity and our conclusions may be restricted to this age group. Future studies should investigate whether this result can be generalized to other age groups during adulthood.

A related aspect is the fact that we were unable to vary the level of education within the rich sample (all rich participants were university students) and therefore we could not use this variable as a statistical control. However, as regards the validity of the samples chosen in the present study, it should be noted that in this age group (19–21 years) the typical rich individual attends a university, whereas, the typical poor individual does not. Choosing only rich individuals who do not attend a university, would have certainly leveled-out education as a possible confounding factor, but would have introduced other sample distortions (rich young people who do not attend a university are exceptions). The opposite strategy, likewise, was not feasible: a sample of poor young people who attend a university would have leveled-out education as a confounder, but would have introduced other sample distortions (poor university students who attend a university are the exception). The same problem remains true even if the samples are chosen from an adult population because, presumably, the poor and the rich adult samples, if they are representative of their population, will still vary in education. Moreover, a replication of this study in older adults may not necessarily change the results. Indeed, the sample of rich students we examined showed the same behavioral pattern in the CCT as did non-disadvantaged adults in previous studies (Buelow, 2015; Figner et al., 2009; Kluwe-Schiavon et al., 2016; Penolazzi et al., 2012; Pripfl et al., 2013).

A further limitation of this study is that poverty was not randomly assigned. Poverty can be randomly assigned only in laboratory studies. However, individuals made temporarily poor in the laboratory are not individually different from the rest of the population. Likewise, individuals who are born rich and then fall into poverty carry over the majority of the cognitive characteristics that they had before becoming poor. Poverty necessarily is accompanied by other attributes. Being poor means to have a lower education level, fewer calories in the diet, less parental investment, fewer positive experiences, worse health, fewer cognitive stimulations, and, sometimes, lower cognitive abilities. There is now an extensive literature on cognitive differences between the poor and the rich, and this literature concludes that poverty induces a scarcity in a bandwidth of domains, among which cognitive ability is

[5] Here, "disadvantaged" is a generic term for individuals or groups of people who face special problems such as physical or mental disability, or lack of money or economic support, or are politically deemed to be without sufficient power or other means of influence.

only one of many (Schilbach et al., 2016). Therefore, it may be that cognitive ability mediates the relation between poverty and loss insensitivity. Poverty, in the present study, is intended as a broad concept encompassing many potentially causal factors, like access to education, health, liquidity constraints, and exposure to violence. Our research does not attempt to identify which of these causal factors is responsible for the behavioral differences between poor and rich individuals. Future studies along this line should indeed include more measures of individual differences both in cognitive abilities and in decision-making styles.

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All authors designed the experiment, discussed the results and revised the paper. P.R. collected the data. L.S. and P.R. analyzed the data.

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