Title: Replication of the “money illusion” effect in a Brazilian sample

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Publication of data and materials
In accordance with best practices in reproducible research, both the research plan and the data analysis plan were documented on the Open Science Framework (OSF) prior to data collection (accessible at: https://osf.io/48pqu/).

Abstract
Shafir, Diamond, and Tversky (1997, Money illusion, The Quarterly Journal of Economics, 112(2), 341–374) described the phenomenon of money illusion as the inclination to consider money without adequately taking into account the inflation factor, emphasizing nominal values rather than real ones. This study aims to replicate the four conditions outlined in the original research by Shafir and colleagues, adapted to the Brazilian context: problems that include different situations (earnings, transactions, contracts) in which people should make financial decisions that might be affected by money illusion. This cross-sectional and pre-registered study evaluated the money illusion in a sample of 372 Brazilian participants, conducted via mobile phone/computer. Inferential analyses of all problems were performed with the chi-square test (X^2), and the results found were very similar to the original findings: depending on the terms used (real, nominal, or neutral framing), participants showed varying inclinations towards opting for economically advantageous opportunities. The present study successfully replicated all four problems, both in the complete sample and the sensitivity analyses, which included only participants who accurately answered the verification questions for each problem. Based on these findings, it is plausible that the money illusion effect may exhibit cultural independence. This

assertion is substantiated by the replication of the effect within a distinct cultural context from the original study. To reinforce the empirical basis of this assertion, future investigations should investigate these findings across diverse cultural settings.

Keywords
Decision-making; Money Illusion; Nominal Values; Real Values; Replication.

Introduction

Money illusion is a cognitive bias in which there is a tendency to think about money in face value of a currency that changes with inflation (nominal terms) rather than the value of a product minus existing inflation (real terms), thus disregarding the impact of inflation on the (real) value of money (Shafir et al., 1997). Significant consequences result from this effect, such as hesitancy in selling a house when a nominal loss appears apparent but, in reality, it means a real gain or a misinterpretation of a nominal wage increase as a wage cut.

Shafir and colleagues' seminal 1997 article, which elucidates the money illusion effect, has significantly influenced the fields of economic psychology and behavioral economics, garnering over 1,242 citations on Google Scholar by 2023. The authors proposed that money illusion could explain rigid wages and contracts, in direct contrast to economic models that postulate full rationality in agents, such as the quantitative theory of money (Akerlof et al., 1996). Moreover, this phenomenon was suggested to be present in different financial situations, such as employers who apply increases of payment below the inflation rate to maintain workers more satisfied (Fisher, 1928/2011). In the presence of money illusion, individuals tend to consider money in nominal rather than real terms, resulting in a practical rather than theoretical approach to adjust to malleable and changing inflation. This phenomenon is described as “nominal inertia”, as proposed by Fehr & Tyran (2001). Despite its widespread citation and application across various fields, the original study has not yet received consistent and direct replication. As of now, there has been only one such attempt, in which Ziano and colleagues (2021) conducted a replication study with very close results to the original study.

Acknowledging that enhancing a theory's generalizability entails subjecting it to new evidence (Nosek & Errington, 2020), our study endeavors to adapt the

concept of money illusion to the Brazilian cultural context. Thus, the main objective of this pre-registered study was to replicate four of the problems initially proposed by Shafir and colleagues (1997) and to verify the presence of the money illusion effect in a Brazilian sample.

As hypotheses, we predict the presence of the money illusion effect across all four problems, as follows: in Problem 1, individuals may perceive workers as less content with a job and more inclined to resign when offered a larger wage increase in real terms, despite it being smaller in nominal terms; in Problem 2, individuals would rank the best deals among three house sellers based on nominal gains, instead of real gains; in Problem 3, participants may be less likely to buy the armchair, and more likely to sell it, even when the price increase is only nominal; and in Problem 4, individuals might opt for risky contracts in real terms over riskless ones in nominal terms in a computer purchase problem.

Materials and Methods

Specific adaptations were made to the questionnaire to suit the Brazilian context. Data collection was conducted through an online cross-sectional survey with the following inclusion criteria: (a) 18 years of age or older and (b) consent to participate in the study. This research received approval from the Research Ethics Committee of the Pontifical Catholic University of São Paulo (PUC-SP) in 2021 (Certificate of Presentation for Ethical Evaluation [CAAE]: 44181621.8.0000.5482, approval number 4.681.515).

The participants did not receive financial compensation for their participation in the research. It was not mandatory to complete all problems; even if only one problem was completed, the data was included in the analysis (for the total sample for each problem, see Table S1). The self-administered questionnaire was created using the Qualtrics XM platform and the structure was adapted from the study conducted by Ziano et al. (2021). The questionnaire's link was disseminated through social networks. Data collection took place online over a period of 8 months, spanning from December 2021 to July 2022.

Open Science Framework

In accordance with best practices in reproducible research, both the research plan and the data analysis plan were documented on the Open Science Framework (OSF) prior to data collection (accessible at: https://osf.io/2gkxf). The plan included a presentation of the concept of money illusion and relevant literature, the research objectives, hypotheses, the translated and adapted versions of the problems, power analysis, the methodology for results analysis, and various other pertinent details. All material, datasets, and statistical analysis are also available on the OSF platform (https://osf.io/48pqu/).

Instruments

The questionnaire was composed of sociodemographic information, including age, gender, city of residence, level of education and family income, as well as the four problems designed (for more details on the translation process refer to ‘Translation and cultural adaptation’ in the supplementary material) to assess the money illusion effect, presented one by one, following the same order as the original

study. These four problems were illustrations of money illusion in various contexts: I) salary increase; II) real estate transaction; III) purchasing and selling decisions; and IV) susceptibility to risk. Diverse response options were provided to discern whether individuals exhibited susceptibility to the effect. Participants could either choose the nominally superior option (disregarding inflation) or opt for the best choice while considering the real value (influenced by inflation). For a better understanding of the problems, refer to Table S2.

In the first problem, two professionals received different increases in their salary, in distinct contexts of inflation. The presence of money illusion would be indicated if a participant selected Carolina as the best choice in terms of both economic advantage and happiness, while also identifying Maria as the most likely to quit her job. In the second problem, participants were asked to rank three house sellers (André, Bento, and Marcelo) based on the success of their transactions, assigning a "1" to the individual with the best deal and a "3" to the one with the worst deal. The manifestation of the bias would be evident if the subject ranked Marcelo as first, Bento as second, and André as third. The third problem would reveal the illusion if individuals demonstrated a reduced willingness to purchase an armchair while displaying an increased inclination to sell it. Lastly, in the fourth problem, participants were required to choose between riskier or less risky contracts under three different conditions: nominal, real, or neutral terms. The presence of the illusion would be observed if a participant selected contracts A, C, and E, as these would yield a certain return in nominal terms but an uncertain one in real terms.

There was an additional modification made to the questionnaire in comparison to both the original study and the replication study. This modification involved the inclusion of verification questions (refer to Table S3), which aimed to serve as a mechanism to verify participants' comprehension of the problems, given that the problems assessing the money illusion effect research were extensive and demanded a heightened level of attention to detail. The responses to these verification questions served as a quality control measure to ensure that participants had accurately comprehended each problem (refer to Table S1 for details).

Statistical analysis

We conducted power analyses for all problems with the *G*Power* software (version 3.1.9.2., 2014) (Faul et al., 2007), resulting in a total sample of 250

participants (more details regarding these analyses can be seen in the supplementary files). Inferential analyses were conducted for all problems using the chi-square test (X^2). These analyses compared the proportions of individuals who made a particular decision to an expected proportion of 50% (within conditions), which would indicate an equal distribution of people across conditions. Additionally, the X^2 test was employed to compare the distinct distributions observed between conditions for the various problems (across conditions). Sensitivity analyses were carried out for each problem after excluding participants who answered the verification questions incorrectly. These sensitivity analyses mirrored the main analysis, differing only in the number of participants included.

All statistical analyses were executed using the R statistical software (version 4.3.0) (R Core Team, 2023), with RStudio (version 2023.06.0+421) (RStudio Team, 2020) as the interface. The alpha value set for significance was 0.05. Given the multiple comparisons performed for each problem in the experiment, p-values were adjusted using the Bonferroni correction, a stringent method for controlling multiple comparisons. These corrections were applied separately for each problem (within problems, not across them). Our analysis used the following *R* packages: s*ummarytools (Comtois, 2022)*, *foreign (R Core Team, 2022)*, *DescTools (Signorell, 2023)*, *gplots (Warnes et al., 2022)*, *ggplot2 (Wickham, 2016)*, *tidyverse (Wickham et al., 2019)*, *readxl (Wickham & Bryan, 2022)*, *dplyr (Wickham et al., 2022)* and *osfr (Wolen et al., 2020).*

Results

Sample characterization

In total, 446 participants started the questionnaire, with a mean age of 31.6 (SD = 15.1) years observed in the sample. From those who responded to the demographic section (n=382), the sample was predominantly female (n=258, 67%) from São Paulo (n=333, 87%), more comprehensive description, refer to Tables S4 to S6 and Figures S1 to S3.

Considering only the participants who completed at least one of the problems, the sample size was reduced to 372 participants. Our findings pertaining to each of Shafir's money illusion problems are presented below. We provide two analyses for

each problem: one encompassing the entire sample that responded to the problem and a second analysis that exclusively considered participants who answered the verification question correctly (a sensitivity analysis, available in the supplementary material).

Problem 1

In the first problem, a higher prevalence of money illusion was observed when the problem framed the issue in terms of job attractiveness. Participants predominantly selected Maria (62%) as the most likely to leave her job instead of Carolina, despite Maria being the worker with a real salary increase. When the question was framed in economic terms, the illusion was not present in the majority of participants (78%) that chose Maria who had a genuine salary increase as the one who was better off economically. Only 22% of participants opted for Carolina, indicating a nominal assessment rather than a real one. Notably, when the question emphasized happiness, there were no statistically significant differences among the characters (refer to Table 2). Overall, when comparing the various conditions, the results illustrate how the expression of money illusion depends on the emphasis of each question (X^2 = 20.0; p-value < 0.001; Cramer V = 0.242 [95% confidence interval: 0.149 - 0.351]) (see Figure 1). After excluding participants who answered the verification question incorrectly, the results remained consistent, suggesting that they were not due to attentional issues (for additional details, refer to Table S7 and Figure S4).

Table 1: Chi-Square test comparing participants' choices between Maria or Carolina in each condition of Problem 1 (different terms) and across conditions.

	N	*Maria*[1] n(%)	*Carolina*[2] n(%)	x^2	p-value
Economic Terms	112	87 (78%)	25 (22%)	34.32	< 0.001*
Happiness	118	58 (49%)	60 (51%)	0.03	0.854*
Job Attractiveness	112	69 (62%)	43 (38%)	6.04	0.014*
Total	342			20.03	< 0.001**

* indicates the p-value to a binomial X^2 test against a proportion of 50%.

** indicates the p-value relative to an X^2 test comparing condition vs person proportions.

[1] Maria = Ann [2] Carolina = Barbara in the original study

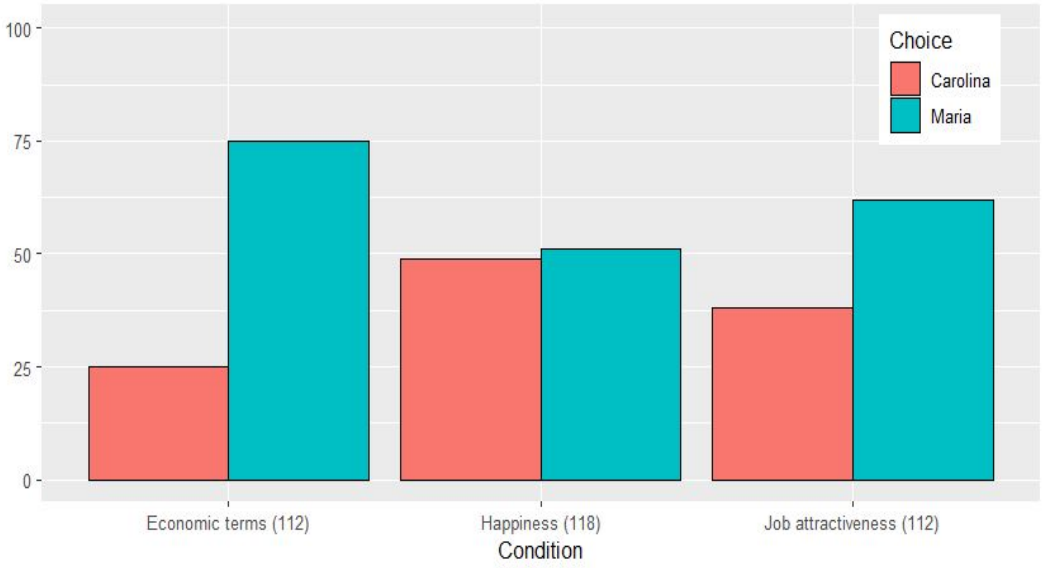

Figure 1. The frequency of participants' choices within each condition in problem 1 (n=342).

Problem 2

The outcomes of problem 2 also confirmed the presence of money illusion within our sample. Marcelo, who exhibited nominal gains but the most substantial loss in real terms, was selected as the top choice by 43% of participants (refer to Table 2). The other characters also followed the "illusional pattern" with 68% of the sample opting for Bento as their second choice and 49% selecting André as their third choice (see Figure 2), thereby indicating the presence of the effect ($X^2 = 236.0$; p-value < 0.001; Cramer V = 0.382 [95% confidence interval: 0.335 - 0.432]). In addition, sensitivity analyses revealed a consistent pattern similar to that observed in the total sample (for details, refer to Table S8 and Figure S5).

Table 2: Present replication results for Problem 2

	N	1st choice	2nd choice	3rd choice	X^2	p-value
André[1]		95 (35%)	42 (16%)	132 (49%)	45.64	< 0.001*
Bento[2]		57 (21%)	184 (68%)	28 (11%)	153.55	< 0.001*
Marcelo[3]		117 (43%)	43 (16%)	109 (41%)	36.79	< 0.001*
Total	269				235.99	< 0.001**

* indicates the p-value to a binomial X^2 test against a proportion of 50%.
** indicates the p-value relative to a X^2 test comparing condition vs person proportions.
[1] André = Adam; [2] Bento = Ben; [3] Marcelo = Carl in the original study.

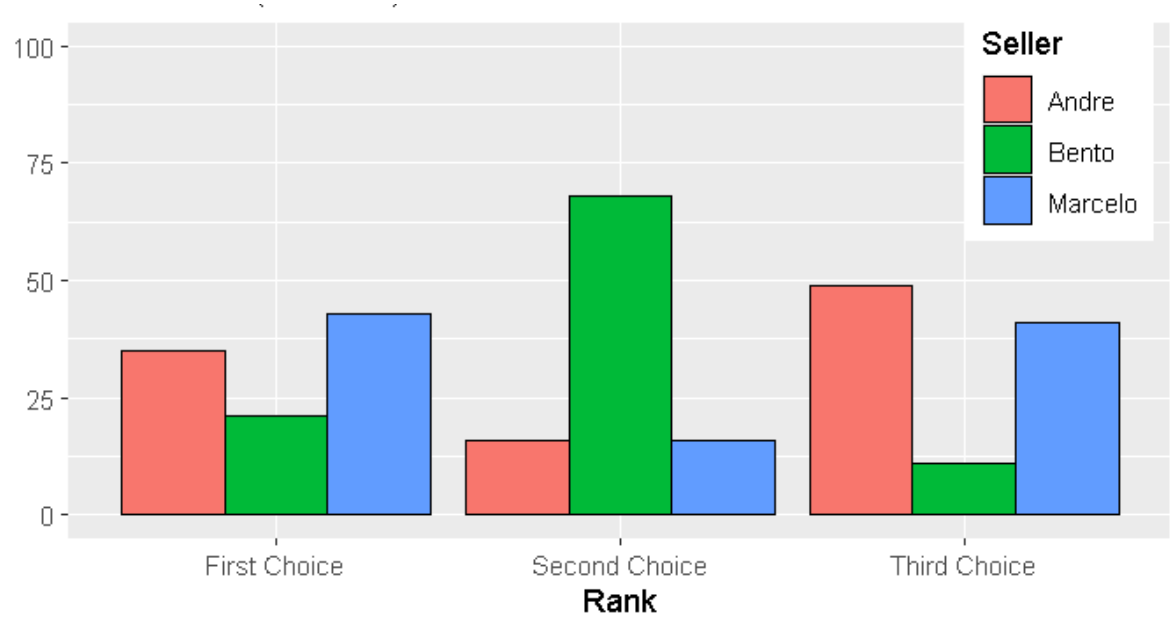

Figure 2. The frequency of participants' choices when ranking each seller in problem 2 (n=269).

Problem 3

In line with previous findings (Shafir et al., 1997; Ziano et al., 2021), prior to conducting analyses for this problem, we combined the Brazilian real (face value currency) and percentage data within the 'buy' and 'sell' conditions. This decision was made because we found no differences when comparing frequencies ("More", "Same", and "Less") for changes described in Brazilian currency and percentage values within each condition (p-value for 'buy' = 0.37 and p-value for 'sell' = 0.38).

A comparison of the probabilities associated with buying and selling decisions across the conditions ('less', 'same', and 'more') indicated disparities between selling and buying choices (X^2 = 117.4; p-value < 0.001; Cramer V = 0.471 [95% confidence interval: 0.389 - 0.558]), as displayed in Table 3.

Within this problem, the majority of participants (n = 270) opted neither to sell nor to buy the chair, suggesting an equal likelihood of both actions. However, the money illusion was apparent within a segment of the sample. In the 'buy' condition, a substantial proportion (48%) expressed a reduced inclination to purchase the chair, whereas in the 'sell' condition, a significant portion (33%) indicated an increased likelihood of selling the chair (see Table 3 and Figure 3), even though the chair's price increase was merely nominal. Consequently, the presence of money illusion in this problem was confirmed. Finally, sensitivity analyses revealed a pattern consistent

with that observed in the overall sample (for further details, refer to Table S9 and Figure S6).

Table 3: Present replication results for Problem 3

Problem 3 (n= 264)	**N**	**Buy***	**Sell***	***x²***	**p-value**
More	102	14 (5%)	88 (33%)	-	-
Same	270	123 (47%)	147 (56%)	-	-
Less	156	127 (48%)	29 (11%)	-	-
Total	264 participants 528 choices			117.38	< 0.001**

*Both manipulations, with the values described in Reais (R$) and in percentages (%) had no effect and were combined

** indicates the p-value relative to a X^2 test comparing decision vs probability of buying/selling.

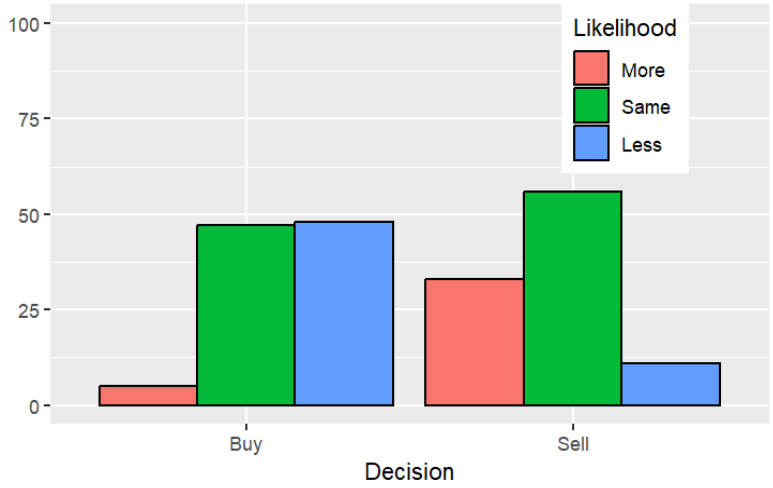

Figure 3. The frequency of participants' choices (more, same, less) for both “buy” and “sell” conditions in problem 3 (n=264).

Problem 4

In this problem, it became evident that, across all conditions (real, nominal, and neutral), a number of participants chose the risky contract type, which is less advantageous, indicating the presence of money illusion. It is noteworthy, however, that the frequency of the risky contract never exceeded that of the riskless contract (see Figure 4). In each condition, the response rate for 'contract type' exhibited a significant difference in the 'real' (p-value < 0.001) and 'nominal' (p-value = 0.001) conditions, but not in the neutral condition (p-value < 0.777) (refer to Table 4 and

Figure 4). Importantly, there was no discernible distinction between the 'real' and 'nominal' conditions for either the risky or riskless contracts, with proportions of 22% and 27%, respectively (p-value = 0.511).

Once again, even after excluding participants who answered the verification question incorrectly, the results remained consistent, thereby indicating that the observed outcomes were not due to attentional problems (for further details, please consult Table S10 and Figure S7).

Table 4: Present replication results for Problem 4

Problem 4 (n= 257)	**AB (real)**	**CD (nominal)**	**EF (neutral)**	**N**
Risky contract (A/C/E)	19 (22%)	23 (27%)	40 (47%)	82
Riskless contract (B/D/F)	67 (78%)	63 (73%)	45 (53%)	175
X^2	15.82	10.22	0.08	45.87
p-value	< 0.001	0.001	0.777	< 0.001*

*Cramer V total (comparing the distribution from all problems) = 0.189 [0.139-0.244]

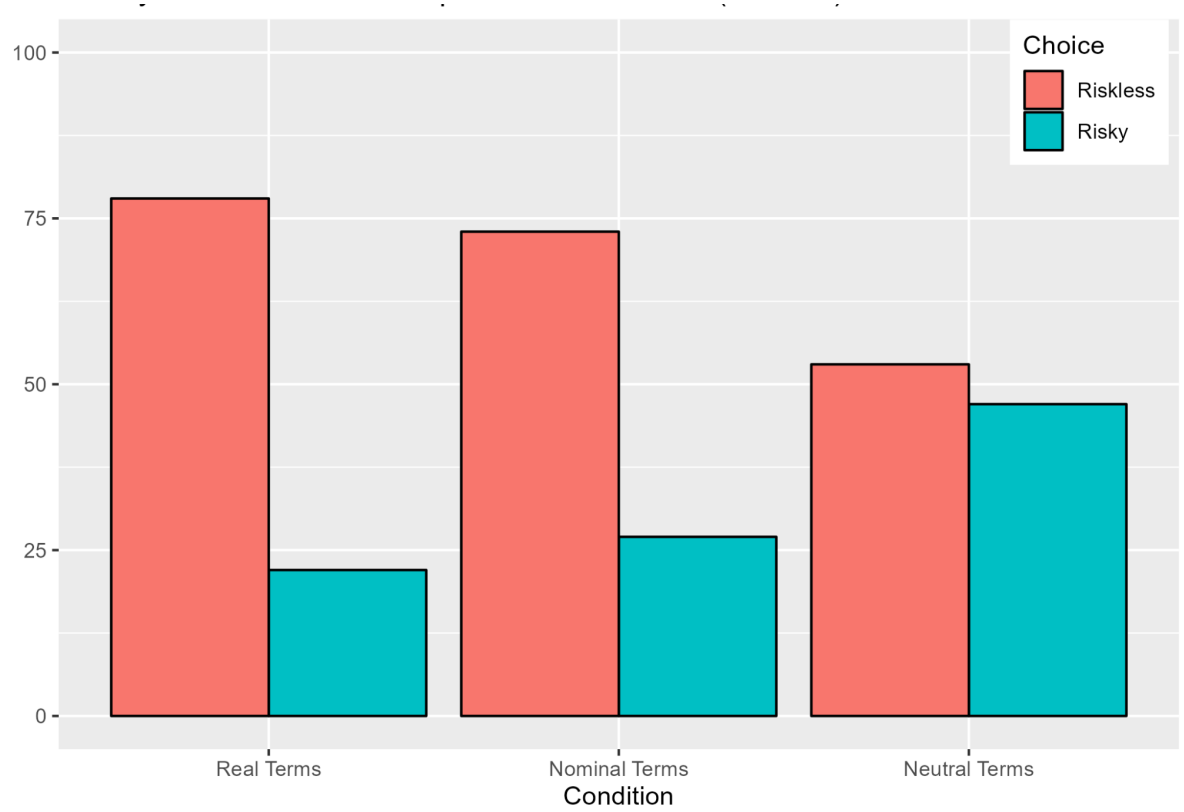

Figure 4. The frequency of participants' choices of contract types across frames (real, nominal and neutral) in problem 4 (n=257).

Conclusion

In our study, we effectively replicated all of the problems from Shafir's experiments 1-4 (1997) using a new sample, temporally and geographically distinct (25 years apart, in Brazil). Further replication criteria based on LeBel et al. (2019) were detailed in the supplementary files (Table S11). Our findings represent a significant advancement in exploring the generalization of money illusion within the global South and Latin American populations. In the following section, we examine specific details of each of the experiments.

In the first problem, Brazilians exhibited money illusion in their decision-making regarding earnings, mirroring the findings of the two prior studies. Furthermore, there was a confirmation of the initial hypothesis, which posited that participants would choose the option in which workers would be more inclined to resign if they received a greater increase in salary in real terms, even though it was smaller in nominal terms. Consistent with previous research, participants showed a higher degree of money illusion when the problem was described in terms of job attractiveness, compared to when it was framed in economic terms. Conversely, when the problem was evaluated in terms of happiness, our sample exhibited no discernible differences in their selection of individuals, whereas in previous studies, Barbara (Carolina in our replication) was the more frequently chosen option. Despite this small variation, we conclude that this replication was successful and was signal-consistent (according to LeBel et al., 2019) to previous studies in terms of effect size, as we obtained a Cramer V of 0.24, while the original study reported 0.26 and the replication study reported 0.28.

In the second problem, it was seen that the money illusion influenced participants' responses, as they ranked André as the person who made the worst deal, followed by Bento, and considered Marcelo to have made the best deal. When comparing our results with those of the replication and the original study, it appears that they were remarkably consistent and exhibited the same distribution pattern with regard to the money illusion.

For problem 3, our findings were also very close to those of Shafir et al. (1997) and Ziano et al. (2021). Across all three studies, the problem involving the character 'most likely to sell the armchair and least likely to buy it' demonstrated the presence

of the money illusion effect. This was evident in the reversal of the participants' choice pattern, influenced by the nominal phrasing of the problem's question. Consequently, we confirmed the hypothesis that individuals are inclined to sell when presented with a nominal gain and avoid purchasing a product when they perceive a nominal loss. Thus, we consider the replication of this problem to be successful within our cultural context, presenting a stronger effect size for the *buy* condition and a smaller one for the *sell* condition when compared to the original study (Table S11).

In the final problem (Problem 4), which involved hypothetical contracts, the majority of participants were able to identify the risky contract (in real terms) in both the 'real terms' condition and the 'nominal' one. Consequently, participants exhibited risk aversion in both contexts – as suggested in the original study, the hypothesis that the risk aversion bias would overlap the money illusion effect –, and there was no discernible difference between 'real' and 'nominal' conditions in our sample. In the original study, the authors reported similar results in nominal terms, with the majority of individuals choosing the riskless contract, suggesting that the manifestation of money illusion in the context of nominal framing was not as pronounced as in the real terms context. However, this discrepancy was not observed in the replication conducted by Ziano et al. (2021), in which the proportions of risk (45%) and riskless (55%) contracts did not differ for nominal terms. As for the 'neutral' terms condition, no disparities between risky and riskless contracts were observed in our study or in previous studies, indicating that risk became less clear when the problem was framed in neutral terms, In summary, the pattern of participant choices closely mirrored that of the original study (with a smaller effect size, as can be seen in Table S11), further underscoring the success of our replication. However, in this case, it is important to notice that the results were unclear regarding the demonstration of the money illusion effect, because there were no disparities between the risky and riskless contracts in the ‘neutral’ condition. Future replication studies may be needed to better understand the generalization of this effect for this condition.

While this study has successfully replicated all the problems of the original study, some limitations must be considered. There was a notable variation in the socio-economic status of participants, as indicated by family income. However, our sample exhibited a pronounced concentration of participants with substantial purchasing power, along with high levels of education. This pattern is a common feature in academic research in psychology, as highlighted by Bloom (2017).

Furthermore, a significant percentage of our sample (67%) consisted of women, which slightly deviates from the gender distribution in Brazil, where women constitute 51% of the population (IBGE, 2023). With regard to how this study assessed the money illusion effect through hypothetical problems without participants actually experiencing the described situations, it is advisable to conduct further experiments that expose participants to practical problems involving real gains or losses (using real money or tokens). Despite these limitations, this study conducted a rigorous power analysis and employed established methodologies for data collection and analysis.

All four replicated problems obtained very similar results compared to the original study. The same results were obtained with the sensitivity analyses. For all problems, the observed statistical significance and outcomes were aligned with the original and replication studies (Shafir et al., 1997; Ziano et al., 2021), with a slight variation in the effect size for problems 3 and 4. Finally, we recommend that the putative connections between risk aversion and money illusion should be further investigated through other problems presenting new scenarios specifically designed to evaluate this relationship.

Disclosure:

Statement: In the course of preparing this work, the author(s) utilized OpenAI's ChatGPT version 3.5 to assist in checking grammar, spelling, improving language and readability, given that English is not the native language of the authors. Following the use of this tool/service, the authors thoroughly reviewed and edited the content as necessary, assuming full responsibility for the publication's content. Furthermore, it is important to note that no conflicts of interest exist, as this research did not receive funding from any agency or any other inappropriate influences in this work.

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