



“Piensa” twice: On the foreign language effect in decision making



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ABSTRACT

In this article, we assess to what extent decision making is affected by the language in which a given problem is presented (native vs. foreign). In particular, we aim to ask whether the impact of various heuristic biases in decision making is diminished when the problems are presented in a foreign language. To this end, we report four main studies in which more than 700 participants were tested on different types of individual decision making problems. In the first study, we replicated Keysar et al.'s (2012) recent observation regarding the foreign language effect on framing effects related to loss aversion. In the second section, we assessed whether the foreign language effect is present in other types of framing problems that involve psychological accounting biases rather than gain/loss dichotomies. In the third section, we studied the foreign language effect in several key aspects of the theory of decision making under risk and uncertainty. In the fourth study, we assessed the presence of a foreign language effect in the cognitive reflection test, a test that includes logical problems that do not carry emotional connotations. The absence of such an effect in this test suggests that foreign language leads to a reduction of heuristic biases in decision making across a range of decision making situations and provide also some evidence about the boundaries of the phenomenon. We explore several potential factors that may underlie the foreign language effect in decision making.

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1. Introduction

The main goal of this article is to explore to what extent decision making processes are affected by the language in which a problem is presented. More precisely, we are interested in assessing whether the decisions and biases observed when people make decisions in various domains are affected by whether problems are presented in a native or in a foreign language.

When individuals are faced with problems that require making decisions they make use of all sorts of heuristics that do not necessarily follow rational rules (for a review, see Kahneman, 2011). These biases are supposed to reveal the functioning of implicit intuitive decision processes that allow individuals to make fast decisions without involving a more costly and slowly formal/logical reasoning (e.g., Chaiken & Trope, 1999; Kahneman, 2003; Plessner & Czena, 2008; Stanovich & West, 1998; Tversky & Kahneman, 1981). The engagement of intuitive processes in decision making, and the consequent decision biases that such engagement results in, is sensitive to various factors, such as the speed with which a decision has to be made, the concurrent cognitive load, the individuals' stress levels, the cognitive fluency afforded by the specific problem,

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the mood of the participant, and more (e.g., Alter, Oppenheimer, Epley, & Eyre, 2007; Bolte, Goschke, & Kuhl, 2003; Degner, Doycheva, & Wentura, 2011; Epley & Eyre, 2007; Rand, Greene, & Nowak, 2012). One factor of particular interest in the present context is the so-called emotional resonance that a problem elicits. Emotional resonance refers to the emotionality elicited by a given problem. For example, when a problem involves life and death decisions, the emotional reaction to the problem may vary depending on whether the people involved in the problem are known to the participant. Indeed, problems involving a high emotional connotation, and likely to elicit high emotional reactions, are said to be especially susceptible to heuristic biases, therefore reducing the recruitment of more logical reasoning (e.g., Loewenstein, Weber, Hsee, & Welch, 2001; Naqvi, Shiv, & Bechara, 2006; Quartz, 2009; Slovic, Finucane, Peters, & MacGregor, 2002). Following this logic, it has been hypothesized that reducing the emotionality elicited by a given situation may lead to a reduction in the effect of intuitive biases on the decisions made in that situation. Consequently, a reduction in such biases may lead to more objective –from normative view point–decisions.

In a recent study that followed this hypothesis, Keysar, Hayakawa, and An (2012), set out to explore whether the impact of intuitive biases on decision making is reduced if a given problem is presented in an individual's foreign language (FL) as compared to her native language (NL). The logic behind this study is based on the assumption that the emotional resonance elicited by a FL seems to be lower than that elicited by a NL (Caldwell-Harris & Aycıçeği-Dinn, 2009; Degner et al., 2011; Opitz & Degner, 2012; Pavlenko, 2005; Shi Min & Schirmer, 2011). For example, it has been shown that talking about embarrassing topics is easier in a foreign than in a native language (Bond & Lai, 1986) and that swear words provoke lesser physiological arousal when experienced in a FL (Dewaele, 2004). Studies using electrodermal monitoring have revealed that skin conductance amplitudes are reduced when bilinguals process emotional words or short phrases in their FL (Harris, 2004; Harris, Aycıcegi, & Gleason, 2003). Note, however, that emotional resonance in a FL seems to be affected by factors such as proficiency, age of acquisition, and exposure (Conrad & Jacobs, 2011; Eilola, Havelka, & Sharma, 2007; Harris, 2004; Sutton, Altarriba, Gianico, & Basnight-Brown, 2007).

The origin of the reduction in the emotionality elicited by FL is very likely related to the context in which such a language was learned and used. If the FL is fundamentally learned and used in a class-room context, it is likely that the emotional connotation tied to the specific lexical items is not as rich as that of the lexical items of the native language, which are used in daily-life interactions with relatives and friends. In other words, the emotionality elicited by linguistic expressions may be tied to the actual experiences in which such representations have been put at play. This is especially relevant when considering high emotion laden expressions or words, which are usually acquired very early in life and are related to childhood experiences (e.g., reprimands, forbidden swear words). Hence, if these expressions are learned late in life and are commonly used in a relatively emotional–neutral experiential

contexts, then it is reasonable that when they are encountered they elicit milder emotional reactions, despite their literal meanings. In this framework, if decision making biases are stronger when the elicited emotionality is high, then they should impact participants' decisions less when the problem is presented in a FL – which is likely to elicit a milder emotional reaction. Indeed, the results of their study, which looked at problems related to loss aversion, supported this hypothesis.

The aim of the present study is to advance our understanding of the foreign language effect (FLe) by exploring its impact on other contexts of decision making. This will allow us to assess the generalizability of the effect (and its potential boundaries), and ask whether it is also present in contexts in which the problem does not involve loss aversion biases. This is important, since up to date the FLe has only been explored in the context of loss aversion biases, therefore we do not currently know whether the use of a FL in decision making has more pervasive effects on the relative involvement of intuitive and rational processes more broadly. Finding more pervasive effects would have consequences not only for correctly characterising and explaining the FLe, but may also have practical consequences for individuals' everyday life.

1.1. Keysar et al.'s (2012) study

Given that our study was inspired by Keysar et al.'s (2012), let us describe it in detail. The FLe on decision making was tested using different contexts where loss aversion is known to have a strong effect. Loss aversion refers to people's tendency to outweigh negative outcomes as compared to positive ones (Erev, Ert, & Yechiam, 2008; Ert & Erev, 2008; Hochman & Yechiam, 2011; Tversky & Kahneman, 1991). This leads people to make different choices when evaluating the same outcome depending on whether it is presented as a gain or a loss. That is, people are willing to choose risky options in order to avoid negative outcomes, but become much more conservative when evaluating the same magnitude but involving positive outcomes.

In their first study, Keysar et al. explore loss aversion in the context of framing effects. In Tversky and Kahneman's (1981) seminal article, the authors review several cases in which people's choices changed according to seemingly irrelevant changes in the way a given problem was presented. For example, in the well-known Asian disease problem, participants are faced with one of the two versions of the following problem:

1.1.1. Asian disease problem

Recently, a dangerous new disease has been going around. Without medicine, 600,000 people will die from it. In order to save these people, two types of medicine are being made.

Gain frame version

If you choose Medicine A, 200,000 people will be saved. If you choose Medicine B, there is a 33.3% chance that 600,000 people will be saved and a 66.6% chance that no one will be saved.

Which medicine do you choose?

Loss frame version

If you choose Medicine A, 400,000 people will die.
If you choose Medicine B, there is a 33.3% chance that no one will die and a 66.6% chance that 600,000 will die.
Which medicine do you choose?

Despite the fact that the two versions are identical in terms of outcomes (the same results in terms of causalities are expected), participants' choices are far from being identical. Indeed, the safest option, the one in which the casualties are certain (Medicine A), is chosen more often when the problem is presented in the gain frame than in the loss frame version. People tend to take more risks when the problem is framed in terms of losses (400,000 people will die) than in terms of gains (200,000 people will be saved), revealing the loss aversion bias (see [Kahneman & Frederick, 2006](#); for a review). The striking observation from Keysar et al. is that when this problem was presented in a FL to relatively low-proficient speakers, participants' choices were no longer affected by the way the problem was framed. That is, whether participants chose the safe option (Medicine A) or decided to be more risky (Medicine B) was not affected by the problem frame. This result was interpreted as probably stemming from the lower emotional reaction elicited by the FL, which in turn reduces the loss aversion bias. In other words, to the extent that the framing effect arises because of emotionally driven biases, decisions in a FL would be less affected by framing effects. Note that this is not to say that people become more or less risk seeker depending on the language in which the problem is presented, but rather that whatever their decision is, it is more affected by the way the problem is framed when presented in their native than in their foreign language.

[Keysar et al. \(2012\)](#) further tested this FLe in other decision making problems involving loss aversion. In their second study, participants were presented with 18 equal-odds (50–50), positive-expected-value bets (50% win 10\$ or 50% lose 8\$) that could result in either a gain or a loss, and they were asked to accept or reject each bet. Interestingly, participants were about 20% more likely to accept the bets when these were presented in their FL than in their NL. Finally, in their third study, participants confronted a number of positive-expected-value bets where they could either keep \$1 bill for themselves, or risk it in a 50–50 lottery rendering either \$2.50 or \$0. Here, again, participants were much more inclined to take the lotteries when performing the task in a FL, which appears to be the more logical choice.

1.2. The foreign language effect: emotional content, cognitive fluency and cognitive load

The modulation of the loss aversion bias when the problems were presented in a FL led the authors to make the following empirical generalization and conclusion: “*In general, then, decision biases that are rooted in an emotional reaction should be less manifest with a foreign language than*

with a native language. (p. 7)” Note, however, that although this interpretation is in terms of emotional reaction, the authors also left open the possibility that the FLe might be driven by other factors. Identifying more precisely the potential factors that can contribute to the FLe, requires first assessing its generalizability to other contexts beyond loss aversion (being those contexts emotional or not). This is precisely the goal of the studies presented in this article, in which we investigate whether FL also reduces heuristic biases in other settings that do not involve loss aversion.

Indeed, there are other reasons beyond emotional resonance that might contribute to the FLe. As mentioned above, the heuristic biases in decision making reveal the workings of the fast and intuitive processes of the so-called System 1, which override the slower and demanding processes of the logical System 2 (e.g., [Kahneman, 2011](#)). However, in some conditions, this more logical/rational System 2 can kick in, reducing the impact of intuitive biases on the final decision. Although this is certainly a simplification of how decision making functions, it does suggest that on many occasions both systems are at play. And, indeed, there are certain conditions (other than emotional content) that may favour one system over the other. Two such conditions are relevant in relation to the FLe.

First, it has been argued that cognitive fluency is an important determinant of the extent to which intuitive processes influence decision making ([Kahneman, 2011](#); [Schwarz, 2004](#)). That is, the processes of System 1 (intuitive) impact decision making more in familiar contexts that require little cognitive effort than in contexts that disrupt cognitive fluency. In the later contexts, people tend to raise their attention levels making them more cautious when responding and leaving more room for the more rational System 2 to influence those responses. For example, decreasing fluency of processing, hence decreasing cognitive facility or fluency, by presenting problems in a difficult-to-read print reduces intuitive biases in decision making problems – even in contexts in which no emotional component is present ([Alter et al., 2007](#)). Results of this sort have led [Kahneman \(2011\)](#) to argue that any factor, whatever its origin, that increases cognitive tension and therefore reduces cognitive fluency, would prompt the processes of System 2 and reduce the impact of the fast and quick response provided by System 1.

Consequently, it is reasonable to expect that System 2 will have more of an effect on decision making when problems are presented in a FL compared to a native one. This is due to the fact that processing a FL is usually more costly ([Cook, 1997](#); [Favreau & Segalowitz, 1983](#); [Kotz, 2009](#); [van Heuven & Dijkstra, 2010](#)) and can cause a disruption of cognitive fluency, thus making people more cautious of their responses. In other words, language processing in a FL will prompt the processes sustained by System 2, no matter the type of problem presented. On this view, the FLe could be present in contexts other than those where emotional content induces loss aversion biases.

A second relevant factor is the cognitive load. Under conditions of high cognitive load participants' decision tend to be more affected by heuristic biases ([Benjamin, Brown, & Shapiro, 2006](#); [Forgas, Baumeister, & Tice, 2009](#); [Whitney, Rinehart, & Hinson, 2008](#)). That is, when

cognitive load taxes System 2, the rational processor cannot check or control the intuitive answers given by System 1. Hence, to the extent that reading in a FL increases cognitive load, one might expect heuristic biases to affect participants' responses to a larger extent when the problem is set in a FL. Again, this would be so in any context in which the problem prompts intuitive responses, regardless of its emotional connotation.

The combination of these two factors “cognitive fluency” and “cognitive load” makes it difficult to draw strong predictions about the potential effects of FL on decision making contexts. This is because both factors might work in opposite directions during FL processing; one reducing the impact of heuristic biases (i.e., cognitive fluency) and the other promoting it (i.e., cognitive load). Therefore, the question of whether dealing with a problem in a FL will reduce heuristic biases in a more pervasive manner (and beyond problems with an emotional connotation) is an open experimental issue of theoretical relevance. In addition to assessing the effect of these two forces on decision making, the presence of a FLe in decision making has important implications in our multilingual world in which many people interact and make decisions in non-native languages. From policy makers in the European parliament, through financial traders to immigrants – many people in today's world interact and make decisions in a FL making it crucial to understand how decisions are affected by language. In this paper, we aim to both establish the reliability and replicability of [Keysar et al.'s \(2012\)](#) observations, and assess their generalizability to other decision making contexts affected by heuristic biases.

1.3. Outline of the present study

In the first section, we aim at replicating [Keysar et al.'s](#) observation regarding the FLe on loss aversion. We do so by assessing participant's choices in the Asian disease problem and in another framing problem that, arguably, involves somewhat less emotional content (the Financial crisis problem).

In Section two, we assess the presence of a FLe in framing problems that involve psychological accounting biases rather than gain/loss dichotomies. Although, these contexts tap essentially in the way people categorize economic outcomes, they can also involve an emotional reaction to some degree.

In the third section, we study several key aspects of the theory of decision making under risk and uncertainty. In particular, we first evaluate the FLe on the attitude towards risk by using the influential Holt–Laury test ([Holt & Laury, 2002](#)). This test does not involve so much of an emotional connotation based on losses, since all conditions lead to positive outcomes, albeit of different magnitudes. However, given that the test involves choices under risk, and given that attitudes towards risk may involve an emotional reaction, this test would allow us to generalize the presence of a FLe beyond loss aversion. We then move to explore the presence of a FLe in, arguably, the two most influential experiments in the study of decision making under risk and uncertainty, the Allais and Ellsberg paradoxes ([Allais, 1953](#); [Ellsberg, 1961](#)). The two paradoxes

study different aspects of the decision making theory, and have triggered a number of highly influential alternatives to expected utility theory (for a textbook treatment, see, e.g., [Gilboa, 2009](#)). The studies in this section clearly go beyond loss aversion bias and the emotional component associated with it, and they also let us assess people's consistency when making decisions (see below). For example, the Allais and Ellsberg's paradoxes have been used to show that people are inconsistent when making decisions. That is, when presented with successive problems, a given individual may choose two options that are incoherent from a rational point of view. Hence, showing an effect of FL on these problems would reveal that such an effect not only reduces heuristic biases, but indeed make people more coherent in their own choices.

Finally, in Section four, we explore participants' performance in the Cognitive Reflection Test (CRT; [Frederick, 2005](#)). The CRT explicitly assesses individuals' ability to suppress intuitive incorrect answers to logical problems. The three problems included in the test are constructed in such a way that they prompt an intuitive, fast and incorrect response to the problems. Hence, in order to respond correctly, participants have to resist choosing the intuitive response prompted by System 1, and let System 2 engage in the reflection to generate the correct solution. Importantly, none of these problems have an emotional connotation. Hence, evaluating the presence of a FLe in this test can help us to further assess its generalizability to emotionally neutral decision making contexts.

2. The present study

2.1. General method

2.1.1. Participants

In all the current studies, participants were students from several universities in Barcelona, Spain (with the exception of an additional group of participants tested in Israel for the Asian Disease problem, and a group of English native speakers living in Seville and having Spanish as FL, see below for details). They were all native speakers of Spanish or had learned Spanish before the age of 4 and had native like proficiency. They all lived and studied in Spain, and used Spanish daily (e.g., for conversing, listening to the radio, reading, watching TV, etc.). Participants who performed the task in the FL (i.e., English) had to fill in a questionnaire about their language background. Participants who were included in the study had acquired English mainly in a classroom environment and did not have a parent whose native language was English. They were also asked to self-assess their level of English from 1 (very poor) to 7 (excellent). Participants who had spent more than 10 months in an English speaking country were discarded. At the end of each problem, participants were asked to rate their understanding of the problem (regarding English language); those who rated it less than 50% were excluded from the study. That is, participants who reported understanding less than 50% of the problem were excluded (less than 2%). Thus, all participants had a moderate level of English. Spanish participants' details are reported in

Appendix A for the different problems. Arabic and English participants' details are reported in Appendices B and C, respectively.

2.1.2. Materials and procedure

Materials, originally written in English, were translated into Spanish and back-translated into English by bilingual speakers to guarantee that the meaning conveyed in both languages was identical (Brislin, 1970). The studies were conducted in different classrooms of more or less 50 students from various backgrounds (e.g., psychology, neuroscience, criminology, linguistics, media, architecture, education). Participants were randomly presented with a problem either in their native language, Spanish, or in their foreign language, English (but in the same language for all the students within a classroom). The instructions were given in the language corresponding to the version of the problem participants were assigned. It was emphasised that there were no correct or incorrect answers but that the choice had to be personal. The experimenter stayed in the classroom during the whole session.

2.2. Study 1: Foreign language effect on loss aversion

2.2.1. Method

In this study we explore two types of framing problems. First, we try to replicate previous observations on framing effects involving loss aversion bias by means of two different framing problems. The first version is the well-known Asian disease problem. The second version is identical to the Asian disease problem but the losses and gains were represented by money rather than by human lives (Liberman, Samuels, & Ross, 2004), potentially reducing the emotional connotation of the problem.

2.2.2. Participants

Asian disease problem. Two hundred forty-seven students took part in the experiment (mean age: 20.6 years; 61 males) and performed the task either in Spanish (native condition, $N = 124$ [gain version, $N = 62$; loss version, $N = 62$]) or in English (foreign condition, $N = 123$ [gain version, $N = 61$; loss version, $N = 62$]). An additional group of 129 Arab native speakers with Hebrew as a FL also completed the problem (mean age: 22.4 years; 55 males). These participants were students at the University of Haifa, Israel (Hebrew is the language of study at the University). For each problem, they were randomly assigned either the Arabic (native condition, $N = 69$ [gain version, $N = 34$; loss version, $N = 35$]) or the Hebrew (foreign condition, $N = 60$ [gain version, $N = 30$; loss version, $N = 30$]) version. All participants filled out a questionnaire about their knowledge of Hebrew (reading, writing, spoken). Participants who performed the task in a FL had to translate the Asian Disease problem into their NL following completion of the task. Participants whose translation was not accurate were discarded from the analysis. Arabic participants' details are reported in Appendix B.

Financial crisis problem: Two hundred and eighty Spanish students participated in this experiment (mean age: 20.1 years; 63 males) and were randomly allocated the problem in Spanish ($N = 140$ [gain version, $N = 69$; loss version, $N = 71$]) or in English ($N = 140$ [gain version,

$N = 70$; loss version, $N = 70$]). See Appendix A for a description of the sample.

2.2.3. Procedure

Participants were presented with only one version of each problem, either in Spanish (or Arabic) or in English (or Hebrew). They were asked to answer the problem using only the boxes provided (e.g., A or B). The *Asian Disease problem* was presented preceded by the *Ellsberg paradox* (see below for details), and the *Financial crisis problem* was preceded by the *Ticket/Money loss problem* reported below. Participants who completed the *Financial crisis problem* were presented with either of the two following versions:

Recently, a serious financial crisis has started. Without any action, the company you manage will lose 600,000 euros. In order to save this money, two types of actions are possible.

Gain version:

If you choose Action A, 200,000 euros will be saved.
If you choose Action B, there is a 33.3% chance that 600,000 euros will be saved and a 66.6% chance that no money will be saved.
Which action do you choose?

Loss version:

If you choose Action A, 400,000 euros will be lost.
If you choose Action B, there is a 33.3% chance that no money will be lost and a 66.6% chance that 600,000 euros will be lost.
Which action do you choose?

2.2.4. Results

The results of the two different problems will be presented separately.

Asian disease problem: Participants who performed the experiment in the NL showed a clear framing effect (see Table 1). When presented with the gain version, they chose the safe option (A) more often than the risky option (B), while the opposite was true when presented with the loss version. Participants who performed the experiment in the FL showed a somehow different pattern. As with the other group, when presented with the gain version they chose the safe option more often than the risky option; however, safe and risky options were chosen similarly in the loss version (50% each). Hence, for the FL group, although the distribution of responses was modulated by the way the problem was framed, there was no reversal in the distribution. Indeed, the difference between the response distributions in the two frame versions for the FL group barely reached significant values (Gain vs. Loss distribution $\chi^2(1, N = 123) = 3.7, p = .05$), and was much smaller than when the task was performed in the NL (Gain vs. Loss distribution $\chi^2(1, N = 124) = 14.2, p = .001$). Thus, although participants show a tendency to be affected by the frame when responding in a FL, this bias was smaller than when responding in the NL. Indeed, the framing effect considered in terms of the differences in the frequency with which the

Table 1

Percentage of Safe Responses (option A) in the Asian disease problem for the Spanish/English group (AD 1, native condition, $N = 124$; foreign condition, $N = 123$), for the Arab/Hebrew group (AD 2, native $N = 69$, foreign $N = 60$), and for the Financial crisis problem (FC, native condition, $N = 140$; foreign condition, $N = 140$).

Study	Native condition				Foreign condition					
	Gain	Loss	Gain	Loss	Gain	Loss	Gain	Loss		
Asian dis. (1)	42	68%	21	34%	34%**	41	67%	31	50%	17%*
Asian dis. (2)	26	76%	15	43%	33%**	22	73%	19	63%	10%
Fin. crisis	49	71%	40	56%	15%	47	67%	43	61%	6%
Mean		71%		44%	26%		69%		58%	11%

* $p < .05$.

** $p < .005$.

safe option (A) is chosen in the gain than in the loss condition, was double in the NL condition (34% vs. 17%).

Similar results were observed for the Arabic-Hebrew group (see Table 1). When presented with the gain version in the NL, they chose the safe option (A) more often than the risky option (B), while the opposite was true when presented with the loss version. Interestingly, participants in the FL condition did not show this reversal, and they preferred the safe option in both the gain and the loss version. The difference between the response distributions in the two frame versions for this group was not significant (Gain vs. Loss distribution $\chi^2(1, N = 60) < 1$), while it was significant when the task was performed in the NL (Gain vs. Loss distribution $\chi^2(1, N = 69) = 8.08, p = .001$). Indeed, the framing effect considered in terms of the differences in the frequency with which the safe option (A) is chosen in the gain than in the loss condition, was much larger in the NL condition (33% vs. 10%).

Financial crisis problem: Participants who performed the experiment in the NL showed a clear framing effect. When presented with the gain version, they chose the safe option more often than the risky option, but the difference between the two choices was much smaller in the loss version (see Table 1). Participants who performed the experiment in the FL showed a qualitatively similar pattern but with a different magnitude. As with the other group, when presented with the gain version, they chose the safe option more often than the risky one, and when presented with the loss version, the safe option was still preponderant. Indeed, the difference between the response distributions in the two frame versions for the FL group did not reach significant values (Gain vs. Loss distribution $\chi^2(1, N = 140) < 1$), while it approached significance when the task was performed in the NL (Gain vs. Loss distribution $\chi^2(1, N = 140) = 3.2, p = .07$).

Given that the Financial Crisis and the Asian disease problems have the same structure, we decided to combine responses from both studies to gain power. The results revealed a clear framing effect for the NL (Gain vs. Loss distribution $\chi^2(1, N = 333) = 22.51, p < .001$) but a reduced effect in the FL (Gain vs. Loss distribution $\chi^2(1, N = 323) = 4.1, p = .04$). Indeed, as can be appreciated in Fig. 1, participants' choices reversed depending on the frame version when the task was conducted in the NL.

However, such a reversal in the choice preference was absent in the FL even though a modulation of the responses was also present.

2.2.5. Discussion

The results of these two experiments replicate previous observations regarding framing effects on decision making. When performing the task in a NL, participants' choices about identical problems in terms of outcomes, were affected by the way the problems were framed. That is, participants tended to seek more risk (or be less conservative) when the choices were presented in terms of losses than when they were presented in terms of gains.

In both experiments the framing effect was reduced when the problem was presented in the FL. This does not mean, however, that the choices were completely unaffected by the frame in the FL condition. In fact, in both problems, participants' choices tended to be more evenly distributed between the options in the loss version than in the gain version. However, the difference in the response distributions between the two frame versions barely reached significant values in the Asian disease problem and was far from significant in the Financial crisis problem. When analysing the results of the two problems together, the distribution of responses in the gain and loss versions was significantly different only in the NL condition.

These results are in agreement with the conclusion reached by Keysar et al.'s (2012) that loss aversion is less manifest in a FL. Our contribution here is not only the replication of such discovery but also the observation that this effect is present not only when the problem involves human lives (either in terms of deaths or jobs) but also when it involves economical gains and losses, that is, in a context that potentially reduces participants' emotional reaction.

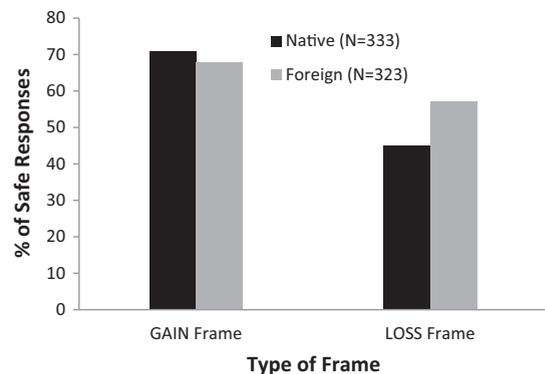


Fig. 1. Percentage of responses for the different versions and languages of the three groups of participants combined.

A potential caveat when interpreting these results refers to whether participants were skilled enough in the FL to understand the problems properly. We believe they were. The fact that responses in the gain version of the problem were very similar in both language conditions suggests that participants' understanding of the text was good enough. That is, the gain version could serve as a control. And indeed, participants only showed a FLe in the version (loss version) where loss aversion was supposed to be revealed. Also, in the case of the Arabic speakers, we had an independent measure that suggests that their understanding of the problem was good enough, since we asked them to translate the problems after their choices were made. Moreover, as mentioned before, Hebrew is the language of study at the University of Haifa, which implies that the students' level of Hebrew was high enough to attend courses in this language. Hence, it is unlikely that this effect arises because of a poor understanding of the text.

In the following study we aim to explore whether other sorts of decision problems, also affected by framing effects, are sensitive to this FLe.

2.3. Study 2: Foreign language effect on psychological accounting

The framing problems presented above manipulated the way the outcomes were described, either in terms of gains or losses, provoking a change in participant's choices. In this section, we aim to assess whether the FLe is present on the psychological (or mental) accounting of outcomes. Psychological accounting refers to the way people categorize economic outcomes, and the effects that such categorization processes may have on economic decision making. Indeed, the way people categorize outcomes is different from an ideal rational accounting, and is sensitive to the way a given economic situation is set, therefore eliciting biases. Let us exemplify this by considering global and minimal accounts. According to [Tversky and Kahneman \(1981\)](#), when accounting for the consequences of an act, individuals tend to adopt minimal rather than global accounts. Consider the following two examples, the *Ticket/Money lost Problem* and the *Discount Problem*.

2.3.1. Ticket/money lost problem

Ticket lost:

A woman has bought two tickets to go to the theatre. Each ticket costs 80 euros. When she arrives at the theatre, she opens her bag and discovers that she has lost the tickets. Do you think she will buy the tickets to enter the theatre?

Money lost:

A woman goes to the theatre and wants to buy two tickets that cost 80 euros each. She arrives at the theatre, opens her bag, and discovers that she has lost the 160 euros with which she was going to buy the tickets. She could use her credit card. Do you think she will buy the tickets to enter the theatre?

Both situations are identical in economic terms. That is, economically speaking, if the woman buys another ticket she will spend 160 euros, and the fact that she has previously lost 2 tickets or 160 euros should be irrelevant for her decision. Hence, strictly speaking and in terms of global accounting, the two situations are identical. However, typically, when presented with this problem, participants are more likely to say the woman would buy the ticket in the second version (when she has lost the money) than in the first version (when she has lost the tickets). This is because people seem to categorize the economic outcomes of their decisions differently depending on how the problem is framed. The favoured interpretation of these results is that while in the first scenario the ultimate price for the theatre tickets is psychologically accounted to be 320 euros, and regarded as too expensive, in the second scenario this is not the case, and the loss of the 160 euros is not accounted as part of the price for the tickets. Hence, the 160 euros for the tickets in the second scenario continue being acceptable. That is, in the first case a global accounting of the economic situation is made while in the second case a minimal account is made. This illustrates how the psychological accounting categorizes economical outcomes, which may lead to different decisions in situations that are economically identical.

Another way to explore this issue is by considering the following *Discount problem* introduced by [Tversky and Kahneman \(1981\)](#).

2.3.2. Discount problem

Discount on 15 euros:

Imagine that you want to buy a jacket for 125 euros and a calculator for 15 euros. The salesman tells you that the calculator you want to buy is on offer for 10 euros at their other shop, located 20 min drive away. Would you make the trip to the other shop?

Discount on 125 euros:

Imagine that you want to buy a jacket for 15 euros and a calculator for 125 euros. The salesman tells you that the calculator you want to buy is on offer for 120 euros at their other shop, located 20 min drive away. Would you make the trip to the other shop?

The two versions of the Discount problem are identical in economic terms. That is, if the trip to the other store is made the person will save 5 euros out of a global cost of 140 euros (15 euros + 125 euros). Therefore, people's choices (whatever they are) should not be affected by whether the discount is offered on the expensive or the cheap product. In other words, according to global accounting people's choices should be identical. However, the standard results here are that more participants would choose to make the trip to save 5 euros out of the 15 euros of the calculator (first scenario), than to save 5 euros out of the 125 for the jacket (second scenario). These results suggest that participants, instead of evaluating the global consequences of the discount (5 out of 125), locally account

the discount only over the discounted product. Hence, a discount of 1/3 of the price (5 euros out of 15) in the first case appears much more attractive than a discount of 1/25 of the price (5 euros out of 125) in the second case.

The decision making changes in these two problems are driven by the way individuals make the account for different amounts that can be considered either together or separately. Hence, they reveal the psychological biases associated to the way we tend to perform joint (global) or separate (minimal) accounts for losses (ticket problem) or potential gains (discounting problem).

In principle, these two problems do not seem to involve loss aversion, since the two presentations in both problems involve exactly the same numbers. However, this does not necessarily mean that the problems do not involve some sort of emotional component. Indeed, one could argue that a discount of 5 euros out of 15 euros feels more important than a discount of 5 euros out of 125 euros. Consequently, participants might feel that turning down this discount is a bigger loss in the former than in the later case. Following this reasoning, one would expect a FLE in these problems too. Note, however, that this experiment goes beyond the problems in Study 1, since they do not specifically contrast gains and losses

2.3.3. Methods

2.3.3.1. Participants. Ticket/money lost problem: The same two hundred and eighty students that participated in the *Financial crisis problem* took part in this study (Spanish version $N = 140$; English version $N = 140$).

Discount problem: Two hundred eighty-two students took part in the experiment (mean age: 21 years; 81 males) and performed the task either in Spanish ($N = 142$) or in English ($N = 140$). These participants did not take part in any other study reported in this article.

2.3.3.2. Procedure. The experimental session followed the general procedure reported above. The *Ticket/Money Lost Problem* was presented preceding the *Financial crisis problem* (counter-balancing the different versions of each problem).

2.3.4. Results

The results of the two different problems will be presented separately.

Ticket/money lost problem: Participants who performed the experiment in the NL showed a clear framing effect (see Table 2). When presented with “ticket lost version” they chose to buy a ticket significantly less often than participants presented with the “money lost version” ($\chi^2(1, N = 140) = 5.4, p = .02$). The same pattern of results was observed in the FL condition ($\chi^2(1, N = 140) = 5.71, p < .02$).

There was a decrease of 19% in the number of participants who made the decision to buy a ticket in the NL and of 20% for the FL in the Ticket version as compared to the Money version. Hence, no FLE is present in this problem.

Discount problem: Participants in the NL condition showed a clear framing effect ($\chi^2(1, N = 142) = 15.5, p < .001$), responding affirmatively more often when presented with the version in which the 5 euros discount was applied to 15 euros (38%) than when the same 5 euros discount was applied to 125 euros (10%) (see Table 3). Importantly, for the FL condition, the framing effect was reduced reaching only marginally significant levels ($\chi^2(1, N = 140) = 3.01, p = .08$). Participants still tended to respond affirmatively more often when the 5 euros discount was applied to 15 euros (46%) than to 125 euros (31%), but the difference was not as large as in the NL (28% vs. 15%). Indeed, the distribution of responses for the discount on the 15 euros was similar in the two language conditions ($\chi^2(1, N = 141) < 1$). In contrast, in the 125 euros condition participants tended to respond affirmatively more often in the FL condition ($\chi^2(1, N = 141) = 10.03, p = .001$).

2.3.5. Discussion

The results of these two experiments clearly show framing effects. However, the FLE was present in only one of these two problems.

In the ticket problem, participants tended to say that they would buy the ticket significantly more often in the version in which the money was lost than in the version in which the ticket was lost. This replicates previous findings and supports the notion that people make minimal accounts rather than global ones (Thaler, 1980, 1985). Importantly, the FLE was completely absent in Ticket/Money lost problem.

The results regarding the Discount problem also reveal a clear framing effect: participants were much more inclined to make the trip to the other store in order to save 5 euros when such discount was applied to the product that costs 15 euros than to the product that costs 125 euros. However, the magnitude of this effect was larger in the NL than in the FL, in this latter case reaching only marginally significant levels. To the extent that the choices in this problem reveal people’s tendency to make minimal rather than global accountings, it seems that such tendency is reduced when performing the task in a FL.

The reason why the FLE in accounting is present in the Discount problem and not in the Ticket problem is unclear. Note, however, that a potential explanation of why the effect is not present in the Ticket problem relates to the fact that the problem described a situation involving a third person and did not directly address the participant. This may have reduced their emotional involvement,

Table 2

Percentage of positive responses in Ticket/Money lost problem (native condition $N = 140$; foreign condition $N = 140$).

	Native condition			Δ T–M	Foreign condition					
	Ticket	Money			Ticket	Money	Δ T–M			
%Yes	17	24%	30	43%	–19	23	33%	37	53%	–20

* $p < .05$.

Table 3Percentage of positive responses in the Discount problem (native condition, $N = 142$; foreign condition, $N = 140$).

	Native condition			Foreign condition						
	Dis. on 15€		Dis. on 125€	Dis. on 15€		Dis. on 125€	Δ 15–125			
%Yes	27	38%	7	10%	28%**	38	46%	22	31%	15%

* $p < .05$.** $p < .005$.

potentially reducing the foreign language effect. This is certainly a tentative explanation that deserves further experimentation.

Having established the presence of a FLE in contexts other than those involving loss aversion biases, we now turn to the issue of whether the effect is also present in decision making under conditions of risk and uncertainty.

2.4. Study 3: Foreign language effect on decision making under risk and uncertainty

In the following studies we ask whether the FLE is present in three fundamental decision making contexts that involve risk and uncertainty. Importantly, in all these contexts, the problems always involve positive outcomes, albeit of different magnitudes.

In Study 3a, we assess how people make decisions in risky contexts in which the outcome probabilities are known by means of the Holt–Laury test (Holt & Laury, 2002). This will give us an index of the attitude that people have in face of risky situations, and to what extent such attitudes vary depending on the language in which the problem is presented. For example, what would people's decision be if confronted with the following question: would you prefer a lottery that gives 2.00€ 6 out of 10 times and 1.60€ 4 out of 10 times, or a lottery that gives 3.85€ 6 out of 10 times and 0.10€ 4 out of 10 times? The first lottery involves a lower expected value as compared to the second one. However, the first lottery assures getting at least 1.60€ while the second one only guarantees a gain of 0.10€. Depending on the decision maker's attitude towards risk, she will prefer one or the other: the first lottery if she is more risk averse, and the second lottery if she is less risk averse. Note that in the absence of any risk aversion bias, and according to objective outcome calculation only, participants should always choose the lottery with the highest expected value, in this example the second one. Following the same logic as in the other studies, to the extent that risk aversion is prompted by some sort of emotional reaction to risk, then we hypothesize that in a FL participants will be less risk averse, and hence will choose the lottery with the highest expected value more often.

In Study 3b we further explore decision making under risk in the context of known probabilities. In this case we assess the extent to which participants are consistent in different situations, and whether FL processing favours consistent behaviour. We do so by studying the choice consistency with respect to the independence axiom of the theory of decision making under risk. The independence axiom is a key property in the theory of expected utility,

conceivably the most influential theory in the study of decision making under risk (Allais & Hagen, 1979; Von Neumann & Morgenstern, 1944). In a nutshell, this axiom implies that the probabilities of occurrence of different outcomes are treated linearly. For example, if an individual prefers a given prospect A over another B, then she should also prefer a combination of prospect A with another prospect C, than the same combination of prospect B with C. That is, the evaluation of any two prospects (A and B) should be independent of a third prospect (C). However, people often violate this axiom and they do not treat the combination of prospects in an independent way. This leads to inconsistent responses within the same participant. We will explore whether the violation of this axiom is reduced when the task is conducted in a FL. We will do so by means of the Allais Paradox (Allais, 1953; see below), that directly tests for this axiom.

In Study 3c, we explore decision making when the probabilities of the outcomes are unknown, that is, under uncertainty. In particular, we test people's attitude towards ambiguous outcomes, by using the Ellsberg paradox (Ellsberg, 1961). In this paradox, people show what is called 'ambiguity aversion', directly violating expected utility theory. The main findings reveal that people tend to show a preference in favour of options involving objective probabilities over options involving unknown or subjective probabilities, leading on occasions, to systematic inconsistencies. The Ellsberg paradox tests those inconsistencies in a simple and powerful experiment, and consequently is a good tool to assess whether FL processing aids consistent behaviour when making decisions under uncertainty.

2.4.1. Study 3a. Foreign language effect on risk aversion: the Holt–Laury test

In order to assess the FLE on risk aversion we implement one of the most widely used tests for this purpose, the Holt–Laury test (Holt & Laury, 2002). In this test, participants are presented with ten lottery pairs, and they have to choose one lottery from each pair (see Table 4). Each lottery pair is composed of an A and a B-type lottery. Every A-type lottery involves potential gains of 2€ and 1.60€, while every B-type lottery involves potential gains of 3.85€ and 0.10€. In addition, for each given lottery pair there is the same probability of winning the larger price (2€ in A and 3.85€ in B) and the lower one (1.60€ in A and 0.10€ in B). The first lottery pairs involve a relatively low probability of getting the larger gain, 1/10, and hence a relatively large probability of getting the smaller gain, 9/10. Then, the probability of winning the larger gain in each lottery increases with each new pair, in steps of 1/10.

Table 4

Percentage of responses corresponding to the first member of the lottery pairs, broken by condition (native $N = 150$; foreign $N = 150$). As it can be appreciated, the main differences between the conditions correspond to the 5th and 6th pair.

		Native condition		Foreign condition		Nat-for %
		<i>N</i>	%	<i>N</i>	%	
1/10 of 2.00€, 9/10 of 1.60€	1/10 of 3.85€, 9/10 of 0.10€	140	93	144	96	–3
2/10 of 2.00€, 8/10 of 1.60€	2/10 of 3.85€, 8/10 of 0.10€	139	93	140	93	0
3/10 of 2.00€, 7/10 of 1.60€	3/10 of 3.85€, 7/10 of 0.10€	135	90	138	92	–2
4/10 of 2.00€, 6/10 of 1.60€	4/10 of 3.85€, 6/10 of 0.10€	122	81	126	84	–3
5/10 of 2.00€, 5/10 of 1.60€	5/10 of 3.85€, 5/10 of 0.10€	95	63	76	51	12
6/10 of 2.00€, 4/10 of 1.60€	6/10 of 3.85€, 4/10 of 0.10€	63	42	53	35	7
7/10 of 2.00€, 3/10 of 1.60€	7/10 of 3.85€, 3/10 of 0.10€	35	23	29	19	4
8/10 of 2.00€, 2/10 of 1.60€	8/10 of 3.85€, 2/10 of 0.10€	15	10	17	11	–1
9/10 of 2.00€, 1/10 of 1.60€	9/10 of 3.85€, 1/10 of 0.10€	16	11	9	6	5
10/10 of 2.00€, 0/10 of 1.60€	10/10 of 3.85€, 0/10 of 0.10€	12	8	7	5	3

The logic behind this test is as follows. In the first lottery pairs there is a substantial probability of winning the smaller prize. Since the smaller price is larger in lottery A than in lottery B, it seems logical that most people would prefer the former. Gradually, the probability of getting the larger prize increases, and hence, lottery B becomes more and more attractive. Depending on the participant's tendency towards risk, the switch from lottery A to lottery B will occur at one lottery pair or another. For example, if the participant is risk neutral (e.g., her decisions are not affected by risk aversion), that is if she is only concerned with the expected value of the lottery, she would switch from lottery A into B in the 5th lottery pair, since it is precisely at this pair when the lottery B starts to have a larger expected value than lottery A. However, if the participant dislikes (likes) risk, she will switch later (earlier).

It is therefore the case that the point at which the participant switches from lottery A to lottery B can be taken as a measure of the individual's attitude towards risk, and how such attitude affects more objective decision making. Previous results (Holt & Laury, 2002) have shown that participants choose lottery A consistently in lottery pairs 1, 2 and 3. In this context, lottery A has the highest expected value and also guarantees the safest smaller price. However, interestingly, participants do not switch systematically to lottery B when they reach the 5th lottery-pair. In fact, for the 5th and 6th lottery pairs, in which the expected value is larger in lottery B, participants still choose lottery A 70% and 50% of the times, respectively. That is, participants tend to choose the lottery of the pair with the lower expected value, but the one that assures the highest smaller price. This was interpreted as an indication of participants' risk aversion.

Following these results, we should not expect differences between NL and FL conditions in lottery pairs 1, 2, 3, 4 and 7, 8, 9, 10. This is because for these pairs, either lottery A (in pairs 1, 2, 3, 4) or lottery B (in pairs 7, 8, 9 and 10) have a clearly higher expected value, and should therefore be preferred regardless of the language. The critical lottery pairs are those around the switching point (i.e., lottery pairs 5 and 6), at which the higher expected value switches from lottery A to lottery B. Given this scenario, the prediction is clear. If FL reduces the emotional reaction that prompts risk aversion, then participants performing

the task in a foreign language will tend to prefer the lottery with the highest-expected value more often (lottery B more often than lottery A), in the 5th and 6th lottery pairs, than when performing the task in the NL condition. It is important to recall that the risk aversion tested here does not involve, strictly speaking, losses since all the lottery pairs have positive expected values. However, this does not necessarily mean that the problem is emotionally neutral. Indeed, one could argue that the poor choices, in terms of expected value, prompted by risk aversion stem from the emotional reaction to risk itself.

There is a second measure that is also of great interest here. Previous studies have shown that on certain occasions some participants switch from lottery A to lottery B and then back to lottery A (Holt & Laury, 2002). That is, regardless of the expected value of their choices, they do not show a consistent pattern. This is inconsistent with the rational theory of choice. We will therefore check, in addition to the evaluation of the risk attitudes, whether there is a FLE in choice consistency.

2.4.1.1. Methods. Participants: Three hundred students took part in the experiment (mean age: 20 years; 111 males) and performed the task either the native-Spanish ($N = 150$) or foreign-English ($N = 150$) language.

Procedure: The experimental session followed the general procedure reported above (see Section 2.1) with the difference that participants had to choose an option (A or B) for 10 lottery pairs instead of a single problem. The problem was presented preceded by the Allais paradox (reported below).

2.4.1.2. Results and discussion. We first evaluate whether the language of presentation affects the number of participants giving an inconsistent choice pattern, namely, switching back and forth between lottery A and B. In the NL condition there were more inconsistent participants than in the FL (24% vs. 12%; $\chi^2(1, N = 300) = 7.3, p = .001$).

We now look at the effect of the language on the risk attitudes of the participants. Table 4 reports the percentage of responses corresponding to lottery A². As expected, for

² In this analysis we included all participants regardless of whether or not they show a consistent pattern of responses. However, an additional analysis including only consistent participants led to very similar results.

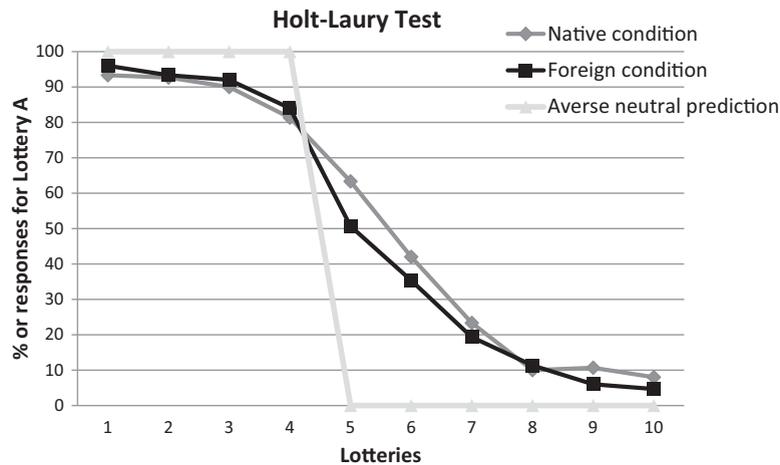


Fig. 2. Percentage of responses for lottery A of each lottery pair for each condition and also for the risk neutral expected performance.

lottery pairs 1, 2, 3, 4, and 7, 8, 9, 10, participants behave remarkably similarly regardless of the language in which the test was performed. Most people regarded lottery A as more attractive in the first four lottery pairs, and lottery B in the last four lottery pairs. These lottery pairs afford uncontroversial decisions, since the expected value of one of the lotteries (either A or B) is clearly larger than the other. Note, however, that responses for the FL were more extreme in both of these ends of the distribution.

The difference in the distribution of responses in the FL and NL conditions in the critical 5th lottery pair was significant ($\chi^2(1, N = 300) = 4.91, p = .02$), revealing that lottery A was preferred more often in the NL than in the FL condition. As argued above, choosing lottery A goes against the expected value of the lottery pair, and can be taken as a measure of risk aversion. Thus, it appears that conducting the task in a FL reduces such a risk aversion bias. As seen in Fig. 2, descriptively speaking the differences in the distribution of choices between the language conditions was still present in the 6th and 7th lottery pairs in which participants performing the task in the FL condition seemed to be less risk averse.

Two main results in relation to the FLe were observed in this study. First, participants' choices across the 10 lottery pairs are more consistent in the FL condition. Second, participants' choices in the lottery pairs with relatively small differences in expected values (pairs 5th and 6th), they are less risk averse (hence they conform more to expected values) in the FL condition. Together, these results suggest that performing the task in a FL: (a) aids intra subject consistent choices, and (b) reduces risk aversion, hence promoting the selection of the more objective highest expected value option.

Importantly, this FLe cannot be attributed to a poor understanding of the problem. This is because responses in the most extreme lottery pairs were very similar in the two language conditions, revealing that understanding in the FL was good enough.

2.4.2. Study 3b. Foreign language effect and the independence axiom: the Allais Paradox

We further assess the presence of a FLe on risk aversion by means of the Allais paradox. This is a test designed to study the empirical validity of the independence axiom, a centerpiece in the theory of expected utility. According to the independence axiom, if the decision-maker regards a given lottery A as more desirable than another given lottery B, she should also find the combination of lottery A with a third lottery C more desirable than with lottery D. In other words, the axiom imposes that probabilities should be taken linearly. Allais (1953) designed an experiment to test the empirical validity of this axiom, showing that a large proportion of participants violated the axiom. These findings, now called the Allais paradox, have been extremely influential, generating an immense empirical and theoretical literature in individual decision making (e.g., Gilboa, 2009; Tversky & Kahneman, 1981).

In Study 3b we replicate Allais paradox to investigate whether the mere fact of presenting the lotteries in a FL reduces the inconsistency with the independence axiom. Participants were presented with the following two questions.

Question 1:

Consider the following two options, and select the one you prefer:

Option A: gives 500 euros with probability 100%.

Option B: gives 2500 euros with probability 10%, 500 euros with probability 89%, and 0 euros with probability 1%.

Question 2:

Consider the following two options, and select the one you prefer:

Option C: gives 500 euros with probability 11%, and 0 euros with probability 89%.

Option D: gives 2500 euros with probability 10% and 0 euros with probability 90%.

According to expected utility, if one chooses A (alternatively B) in question 1, she should choose C (alternatively D) in question 2.³ However, the literature has systematically shown that there is a sizeable proportion of subjects choosing A and D or B and C, which violate the independence axiom (e.g., Huck & Muller, 2007; and the papers cited therein). Moreover, the A and D combination is much more prevalent than the B and C one. The standard interpretation for the inconsistent A and D combination is that participants in the choice from A and B seem to value the certainty of getting \$500. Then, in the choice from C and D there is no safe option, and participants seem to reason that both options entertain an analogously large probability of getting \$0, while option D involves the possibility of getting a much larger price than option C only at a slightly lower probability.

The following predictions can be tested in relation to the Allais problem and the FLe. First, responses to question 1 allow us to further study the FLe on risk aversion. Note that in this question, option B (695 euros) has a higher expected value than option A (500 euros), and hence it should be preferred. However, choosing A more often than B reveals a preference for the safe outcomes over more uncertain ones, and hence some sort of risk aversion. If FL reduces the impact of risk aversion, participants' biases towards A would be reduced in the FL condition. That is, in the first question participants would tend to choose option A more frequently in the NL than in the FL condition. Second, responses to the second question should, in principle, be unaffected by FL, since option D appears to be much more attractive having a higher expected value than option C (55 euros vs. 250 euros), and both options have a very high risk value. Third, the FLe may reduce how often the independence axiom is violated. That is, participants in the FL condition may be more consistent with such an axiom and treat probabilities linearly. This will be indexed by fewer inconsistent choices when performing the task in a foreign than in a native language. This will be so if indeed the FL aids the involvement of more logical reasoning, regardless of whether the problem carries or not emotional content. This is because, in principle, whether or not participants treat probabilities linearly does not seem to be driven by any emotional reaction to the problem itself, but rather to a better engagement of the logical system.

2.4.2.1. Method. Participants: Three hundred students took part in the experiment (mean age: 20 years; 111 males) and performed the task either in Spanish ($N = 150$) or in English ($N = 150$).

Procedure: The experimental session followed the general procedure reported above (see Section 2.1). The Allais paradox was followed by the Holt–Laury test.

³ The formal argument is as follows. Suppose an expected utility maximizer, with $u(x)$ denoting the utility of getting \$ x . Then, if one chooses A over B, one reveals that $u(500) > .10u(2500) + .89u(500) + .01u(0)$, then adding $.89u(0) - .89u(500)$ to both sides of the inequality one obtains $.11u(500) + .89u(0) > .10u(2500) + .90u(0)$, which implies that C is preferred to D.

Table 5

Percentage of choices broken by consistent and inconsistent choices and condition in the Allais problem (native condition, $N = 150$; foreign condition, $N = 150$).

	Native		Foreign		Native–foreign diff. (%)
Consistent choices					
Option A–C	14	9%	12	8%	1
Option B–D	84	56%	94	63%	–7
Inconsistent choices					
Option A–D	43	29%	31	20%	9
Option B–C	9	6%	13	9%	–3
Total consistent	98	65%	106	71%	–6
Total inconsistent	52	35%	44	29%	6

2.4.2.2. Results and discussion. The distribution of responses broken by choice combination and condition are presented in Table 5. The distribution of responses for question 1 were marginally different between the two language conditions ($\chi^2(1, N = 300) = 2.9, p = .08$). Indeed, participants chose more often the safe option A in the NL than in the FL condition (38% vs. 28%). On the contrary, the distribution of responses for question 2 was very similar in both conditions.

The number of participants showing inconsistent responses (that is, A–D or B–C choices) and hence violating the independence axiom was substantial in both conditions. Although there was a tendency for participants to be more consistent when performing the task in the FL than in the NL (71% vs. 65%), the difference failed to reach significance. Thus, the language in which the task is performed does not significantly affect the likelihood with which participants violate the independence axiom.

The results of this experiment partially replicate those on risk aversion reported in Study 2. Indeed, participants chose the safe option for question 1 marginally more often in the NL than in the FL. To the extent that choosing such option is driven by some sort of risk aversion (since choosing option B leads to highest expected value), then it seems that FL reduces such aversion. Furthermore, and as expected, responses to the second question were very similar in the two language conditions. This was expected given that the two options offer similar risk but one of them is more appealing in terms of gains (option D). Finally, and interestingly, there were no differences between the language conditions regarding how often the independence axiom was violated. This shows that FL does not affect the way probabilities are treated, at least in relation to the independence axiom. This could be taken as an indication that FL does not necessarily prompt logical thinking in all decision making contexts.

2.4.3. Study 3c. Foreign language effect and ambiguity aversion: the Ellsberg Paradox

In this experiment we aim at assessing whether the FLe has an impact on decision making problems involving uncertainty and subjective probabilities. The key experiment in this context is the Ellsberg paradox (Ellsberg, 1961). The results observed in the Ellsberg paradox show how participants violate expected utility theory. In this

case, decision makers have an inconsistent attitude towards ambiguity. That is, people seem to have a bias against options involving indefinite information, i.e., options which do not involve objective probabilities. This is typically known as ambiguity aversion.

Consider for example the following problem:

Box 1: Contains 50 red tokens and 50 black tokens.

Box 2: The number of red and black tokens is unknown. It could be any number between 0 red tokens (and hence 100 black tokens) and 100 red tokens (and hence 0 black tokens).

Please, answer to the following two questions.

Question “Red Token”. One token will be randomly selected from the box that you choose. Suppose that if the token is red you win \$100, while if it is black you win nothing. Which box do you choose?

Question “Black Token”. One token will be randomly selected from the box that you choose. Suppose that if the token is black you win \$100, while if it is red you win nothing. Which box do you choose?

The tokens will be drawn at the end of the experiment. After each drawing, the token is put back into the box.

Typically, a large fraction of participants chooses Box 1 in the two questions, which is inconsistent with an additive treatment of subjective probabilities. If in the first question one selects Box 1, one is revealing that she believes that Box 2 contains fewer red tokens than black tokens. Hence, choosing Box 1 again for the second question would reveal that one believes Box 2 has fewer black than red tokens. Clearly, both beliefs are inconsistent with each other (either Box 2 has more red tokens or more black tokens) and with the additive treatment of subjective probabilities, which implies a direct violation of expected utility. The standard interpretation of the results is that people do not tend to choose Box 2, neither in the first nor in the second question, because they dislike the lack of objective probabilities there. That is, people do not like the ambiguity in the composition of Box 2 (where the distribution of black and red tokens is unknown), and hence opt for Box 1 for both questions. In other words, participants appear to be averse to the ambiguity produced by unknown probabilities. Given our previous results, and to the extent that ambiguity aversion has an emotional component, then we can predict a reduction in the rate with which participants make inconsistent choices when the Ellsberg paradox is presented in the FL. Furthermore, we

can make a more fine-grained prediction about the distribution of choices. There are two potential inconsistent choices: choosing the box with the known distribution in the two occasions (Box 1 & Box 1), or choosing twice the box with the unknown distribution (Box 2 & Box 2). If FL reduces inconsistent responses because of a reduction in the ambiguity aversion, this should reveal itself as a reduction in the first type of inconsistent responses. That is, participants presented with the FL should show a reduction in inconsistent responses especially of the sort Box1–Box1.

2.4.3.1. Method. Participants: The 245 Spanish students who completed the Asian Disease problem also took part in this experiment (see p.8 for a full description of the participants).

Procedure: The experimental session followed the general procedure reported above (see Section 2.1).

2.4.3.2. Results and discussion. The distribution of responses broken by choice combination and condition is presented in Table 6. Although consistent choices (switching boxes) were very low in both language conditions, participants were significantly more consistent in the FL than in the NL condition (12% vs. 4%; $\chi^2(1, N = 245) = 5.7, p < .02$).

Recall that the critical condition revealing ambiguity aversion is that in which Box 1 is chosen for both questions. This combination of choices shows ambiguity aversion that leads to always choose the box with known probabilities, and avoiding choosing Box 2 where the probability distribution is unknown. Indeed, choosing Box 1 for both questions was the preferred combination for both groups of participants (native = 81% vs. foreign 68%). However, participants in the NL condition chose this combination more often than participants in the FL condition. ($\chi^2(1, N = 245) = 5.3, p < .02$). No differences between the language conditions were observed in the distributions of the other responses.

Another way to look at this data is to ask how many of the participants who chose Box 1 for the first question chose Box 2 for the second. Thus, here we only consider a subset of participants, those who choose Box 1 for the first question. In the NL condition, out of the 83% of the participants who chose Box1 for the first question, only 2% chose Box 2 for the second question. In the FL condition, out of the 75% of the participants that chose Box 1 for the first question, 7% chose Box 2 for the second question. This difference in the distribution (Box 1/Box 1, vs. Box1/Box2) between the two language conditions was significant

Table 6

Percentage of choices broken by consistent and inconsistent choices and condition in the Ellsberg problem (native condition, $N = 124$; foreign condition, $N = 121$).

	Native		Foreign		Native–foreign diff. (%)
Consistent choices					
Box1 and Box 2	3	2%	9	7%	–5
Box2 and Box 1	2	2%	6	5%	–3
Inconsistent choices					
Box 1 and Box 1	100	81%	82	68%	13
Box 2 and Box 2	19	15%	24	20%	–5
Total consistent	5	4%	15	12%	–8
Total inconsistent	119	96%	106	88%	8

($\chi^2(1, N = 194) = 4.05, p < .04$). Thus, the main difference between the language conditions seems to be in the number of people who chose Box 1 for questions 1 and 2 (showing ambiguity aversion), and the number of those who chose Box 1 for question 1 and then switched to Box 2 for question 2. This is in accordance with the prediction put forward above. The results of the Ellsberg's paradox reveal that FL promotes consistent choices and reduces ambiguity aversion.

The results of the studies described up to here reveal that presenting problems in a FL seems to reduce several heuristic biases. Although to a different extent, most of the problems tested before could, arguably, prompt an emotional reaction that could be at the basis of the observed heuristic biases. Thus, the interpretation that the reduction of biases could be a consequence of a reduction in emotionality in a FL seems to be consistent with the observations. However, at present we cannot rule out an explanation of the FLe that does not necessarily appeal to a reduction on emotionality, but rather to a promotion of a more rational and logical processing irrespective of the emotionality of the problem. Note, however, that some of the results in the Allais problem would suggest some boundaries of the FLe. Still, it is possible that the FLe is also present in other conditions in which the problem does not carry any emotional component that would prompt heuristic biases. The following study addresses this issue.

2.5. Study 4: Foreign language effect on cognitive reflection

In this study we assess whether the problems presented in a FL can reduce intuitive biases and promote more logical reasoning, in a context in which the problem does not carry any emotional component. To do so we present participants with the well-known Cognitive Reflection Test (CRT) (Frederick, 2005). This test was designed to assess people's ability to suppress an incorrect intuitive answer triggered by System 1 to generate a correct logical answer elicited by System 2. The test is composed of three questions that we adapted as follows:

1. A baseball-bat and a baseball-ball cost 1.10 Euros in total. The bat costs one Euro more than the ball. How much does the ball cost?
2. If it takes 5 machines 5 min to make 5 keyboards, how long would it take 100 machines to make 100 keyboards?
3. In a lake, there is an area with flowers. Every day, the area doubles in size. If it takes 48 days for the area to cover the entire lake, how long would it take for the area to cover half of the lake?

Intuitively, people would give the spontaneous incorrect answers 10, 100 and 24 to the three questions, respectively, when the correct answers are actually 5, 5 and 47. Importantly for our purpose, this test does not seem to involve any emotionality and seems to tap purely in logical thinking. If the FLe generally reduces the impact of system 1 in decision making, therefore prompting the contribution of the more rational processes of System 2, participants should be more accurate in the CRT when presented in

their FL. Alternatively, if the FLe only manifests itself in conditions in which the heuristic biases are elicited by the emotional connotation of the problem, then it is likely that the effect will not be present in the CRT.

The presence of a FLe in this test could reveal itself in two different ways: the number of correct responses being higher in the FL condition and/or the number of incorrect "intuitive" responses being lower in the FL condition. That is to say, even if the correct performance in this test is similar across the two conditions, a FLe could still be detected when analysing the type of incorrect responses given by the participants. Indeed, the CRT is designed in such a way that it elicits a fast intuitive incorrect answer to the problems (i.e., 10, 100, and 24). However, participants can give other incorrect responses as well. That is, they may reject the intuitive response elicited by System 1 and still not being able to come up with the right response. Thus, if the presentation of problems in a FL reduces the contribution of the intuitive processes associated to System 1, it is possible that we may detect such an effect in the number of intuitive incorrect responses irrespective of the overall performance.

2.5.1. Methods

Participants: Three hundred and four students took part in the experiment (mean age: 20.1 years; 60 males) and performed the task either the native – Spanish ($N = 153$) or foreign-English ($N = 151$) language (see Appendix A for participants' details).

Procedure: The experimental session followed the general procedure reported above (see Section 2.1). The problem was not presented with any of the other problems reported here.

2.5.2. Results and discussion

The number of correct answers was fairly similar in the two language conditions ($\chi^2(3, N = 304) = 5.31, p < .15$) (see Tables 7 and 8). Furthermore, the number of intuitive incorrect answers was also similar in both conditions, showing that dealing with a problem in a foreign language does not prevent the spontaneous intervention of System 1 ($\chi^2(1, N = 304) = 0.58, p < .45$). Thus, the FLe does not seem to be present in this test.

We further assess this issue by testing another group of participants with English as a NL and Spanish as a FL ($N = 326$, mean age: 20.6 years; 90 males; participant's details are provided in Appendix C). They performed the CRT either in the native ($N = 159$) or the foreign condition ($N = 167$). Again, the number of correct answers was similar in both language conditions ($\chi^2(3, N = 326) = 3.19, p < .75$) and so was the number of intuitive incorrect answers ($\chi^2(1, N = 326) = 0.36, p < .85$).

A potential caveat when interpreting the lack of a FLe in this experiment refers to the difficulty of the problems involved in the CRT task (or if you wish on the difficulty of overcoming the responses prompted by intuitive processes). One could argue that the problems are so difficult that they do not leave room for any modulation associated to the way the problems are presented. However, we believe this is not the case, since other studies have already shown that performance in the CRT test can indeed be

Table 7

Number of correct answers to the CRT for the Spanish/English group (native condition, $N = 153$; foreign condition, $N = 151$) and the English/Spanish (native condition, $N = 159$; foreign condition, $N = 167$).

% of correct answers	Spanish/English		English/Spanish	
	Native condition (%)	Foreign condition (%)	Native condition (%)	Foreign condition (%)
0	59	53	42	43
1	24	26	23	26
2	14	12	23	19
3	3	9	11	13

Table 8

Number of intuitive answers for each question for the Spanish/English group (native condition, $N = 153$; foreign condition, $N = 151$) and the English/Spanish (native condition, $N = 159$; foreign condition, $N = 167$).

% of intuitive answers	Spanish/English		English/Spanish	
	Native condition (%)	Foreign condition (%)	Native condition (%)	Foreign condition (%)
Question 1	73	67	62	53
Question 2	64	58	53	58
Question 3	72	68	39	40

boosted by changing some seemingly irrelevant details of the problem, as already discussed in the Introduction (Alter et al., 2007).

3. General discussion

The aim of this article was to explore the extent to which decision making is affected by the language in which a problem is presented. More precisely, we were interested in assessing whether heuristic biases are modulated by the language of the problem (native or foreign language). This study was inspired by the previous finding that the loss aversion bias appears to be reduced when problems are presented in participants' FL (Keysar et al., 2012). Based on this discovery we aimed at further exploring this so-called foreign language effect (FLe) in other contexts of decision making to assess its generalizability and the potential boundaries of the effect. This is a fundamental step before advancing in our understanding of the phenomenon itself. To this end, we report three main studies in which about 700 participants were tested on different types of decision making problems. In the first study, we aimed at replicating Keysar et al.'s (2012) FLe on framing effects leading to loss aversion bias. In the second study, we assessed whether the FLe is present in other types of framing problems that involve psychological accounting biases and not so much gain/loss dichotomies. In the third section, we studied several key aspects of the theory of decision making under risk and uncertainty. Finally, in the fourth study we assess the presence of a FLe in an emotionally-neutral logical test that prompts intuitive responses. In the following, we first discuss the results of these four different sections separately and then give a tentative global interpretation (see Table 9).

3.1. The foreign language effect on loss aversion bias

In Study 1, participants were presented with the classic Asian Disease problem and with a slightly modified version

Table 9

Summary of the results of the three studies.

Type of problem	Number of participants	Foreign language effect
Study 1. Framing/loss aversion		
Asian disease	376	Yes
Financial crisis	280	Yes
Study 2. Framing/psychological accounting		
Ticket/money lost	280	No
Discount	282	Yes
Study 3. Risk aversion and ambiguity Aversion		
Holt–Laury test	300	Yes
Allais paradox	300	No
Ellsberg paradox	245	Yes
Study 4. Intuitive and logical thinking		
Cognitive reflection test	630	No

in which the problem was set in terms of money losses and gains. The results of this study were clear; framing effects were reduced in the FL condition as compared to the NL one. Thus, the loss aversion bias (a loss frame prompts risky choices) elicited by these problems was reduced (albeit still present) when the problem was presented in the FL. These results replicate Keysar et al.'s (2012) findings and extend them to a problem context that does not involve lives but financial outcomes (the money gain/loss problem). Thus, it appears that we can safely conclude that foreign language reduces loss aversion.

3.2. The foreign language effect on psychological accounting assignment

In Study 2, participants were presented with two different problems assessing biases related to the psychological accounting of outcomes (see Tversky & Kahneman, 1981). The first problem was the Ticket/Money lost problem and the second one was the Discount problem. The results of the first problem revealed that participants' decisions were

affected by the way the problem was framed. Specifically, participants appear to perform a psychological accounting that categorizes economic outcomes in terms of minimal accounts rather than in terms of global accounts, replicating previous studies (Tversky & Kahneman, 1986). This was the case in both language conditions. Conversely, the results of the Discount problem revealed a FLe on psychological accounting. Participants evaluate economic outcomes in terms of global accounts more often in the FL than in the NL condition. The reason why the FLe was present in one problem and not in the other is unclear. A tentative explanation for this discrepancy refers to the way the Money/Ticket problem was presented. Unlike all the other problems in which the participant was asked to perform a choice that will affect him directly, the Money/ticket problem was presented in a third person. That is, the participant had to guess what she thinks another person would do in different a given context. This may have led participants to distance themselves from the situation, consequently reducing their emotional involvement, and shadowing a potential effect of the FL. We acknowledge that this is a rather tentative explanation and further research needs to be conducted to better understand why the FLe is absent in this problem.

3.3. *The foreign language effect on decision making under risk and uncertainty*

In Study 3, participants were presented with three different problems assessing biases when making decisions that involve risk and known or unknown probabilities.

In the first problem, we assessed the so-called risk aversion attitude by means of the Holt–Laury test (Holt & Laury, 2002). The results replicated the well-known risk aversion bias reported before. That is, for the critical lottery pairs, participants tended to choose the lottery with the lower expected value, but the one that assures the highest smaller price. These responses violate expected utility and they signal risk-aversion bias. More importantly for present purposes, the magnitude of risk aversion was reduced when the problem was presented in a FL. In other words, people tend to be more risk neutral, and consequently give more objective responses, when facing a problem in their FL. Also, notably, we showed that the number of inconsistent choice patterns, those involving switching back and forth between the two lotteries across lottery pairs, was significantly lower in the FL condition. Hence, foreign language processing not only makes people more risk neutral but also promotes consistent behaviour.

In the second problem, we further assessed whether language affects decision making under risk (in the context of known probabilities) by means of the Allais Paradox. This paradox directly tests the independence axiom of the theory of expected utility of decision making under risk. Replicating previous observations, a substantial percentage of participants showed an inconsistent choice behaviour that violates the linear treatment of probabilities. Here, we were also able to replicate the modulation of risk aversion associated to a FL. That is, participants in the NL chose the safe option (with a lower expected-value) more often than in the FL condition. However, no robust

FLe was observed regarding the probability of violating the independence axiom. That is, FL does not seem to favour a more logical treatment of probabilities.

Finally, in the third problem, we assessed the foreign language effect on the treatment of unknown probabilities that lead to ambiguity aversion by means of the Ellsberg's paradox. This test involves uncertainty and subjective probabilities. The results of this experiment revealed that participants tended to be more consistent in their choices in a FL. Importantly, the difference between the two language conditions was especially present for that choice that indexes an ambiguity aversion. That is, although participants especially dislike the choice in which the probabilities were unknown in both language conditions, they did so significantly more often in the NL condition. Thus, it appears that foreign language promotes consistent choice behaviour and reduces ambiguity aversion.

3.4. *The foreign language effect on logical thinking*

In Study 4, participants were presented with the Cognitive Reflection Test (CRT), a test composed of three logical problems designed in such a way that they prompt incorrect intuitive answers. Responding correctly to these problems requires overcoming the fast and easily elicited intuitive responses and put at play the more effortful System 2.

Replicating previous studies, participants performed rather poorly in this test. Importantly, however, the performance was not affected by the language in which the problem was presented. This was true not only for the overall correct performance, but also for the type of incorrect responses given. Indeed, the most common incorrect responses were those prompted by intuitive processes, but to the same extent in both language conditions. Hence, it appears that presenting logical problems in a FL does not reduce the impact of System 1 on the participants' decisions.

3.5. *On the origin of the foreign language effect*

Considering the whole set of results, it is clear that using a FL leads to a reduction of heuristic biases in decision making, in some specific contexts. Our findings go beyond those reported before (Keysar et al., 2012), since they extend the FLe beyond the phenomenon of loss aversion. This is important because it reveals that such effect has a pervasive nature, reducing heuristic biases in problems that do not necessarily involve gains and losses. Furthermore, we also show some of the boundaries of the FLe, since it is absent in logical problems that do not involve an emotional component.

Keysar et al. (2012) hypothesized that the FLe stems mainly from an attenuation of the emotional component elicited by the FL. On this view, reducing such emotionality would reduce the involvement of the more intuitive, fast and easily engaged System 1, and consequently reduce the loss aversion bias revealed in the way a problem is framed (gain frame vs. loss frame). This explanation fits well with some of the results reported in this article. Indeed, the problems presented in the first three studies

involved heuristic biases that can be argued to be associated with an emotional reaction. Hence, to the extent that loss aversion, risk aversion and ambiguity aversion are prompted by an emotional negative reaction, then any factor that would reduce such a reaction would then reduce the presence of the biases as well.

In this context, the absence of a FLe in two of the studies presented here is highly informative. First, in the Allais problem FL does not aid a more consistent treatment of probabilities, despite the fact that in the same problem FL does actually reduce risk aversion. This is interesting because whether or not probabilities are treated consistently in this problem does not seem to be related to any emotional reaction, but rather to the ability to use logical thinking. Hence, in the very same problem when the choice to be made can be affected by emotional processing (choosing the box that gives a safe outcome instead the more risky one, in question 1) a FLe is present, while when the choice to be made depends more on logical thinking (consistent behaviour between choices) the FLe is absent. Second, the lack of a FLe on the CRT is also consistent with this interpretation. As argued above, this test taps on the ability to perform logical thinking and the context in which the problems are presented is emotionally neutral. Again, in this case, participants' performance, both in terms of correct responses and in terms of the typology of the erroneous answers is not affected by the language of presentation.

Together, these results allow for the following empirical generalization: Decision making in contexts that elicit heuristic biases grounded in emotional reactions would be sensitive to the language in which the problems are presented. In contrast, when the problems do not carry such an emotional component the FLe would be much more reduced or even absent. It is important to note that this empirical generalization goes beyond the specific observation that FL reduces loss aversion, risk aversion and ambiguity aversion, in the sense that it postulates a common cause behind the effect of FL on these three heuristic processes. This common factor is the reduction on the emotional resonance elicited by the FL that as a consequence dampens the contribution of heuristic biases on participants' choices.

Despite this empirical generalization that favours an interpretation of the FLe in terms of a reduction in the emotionality raised by the problems, we cannot rule out that future studies might reveal other factors that can contribute to it. And, indeed, in most of the studies there was a tendency towards reduced biases in the FL condition. As advance in the Introduction, cognitive fluency and cognitive load are two of these potential factors. Note, however, that the present evidence would suggest that although these factors may modulate the magnitude of the FLe, the emotional connotation of the problems seems to be the critical factor to elicit such an effect.

A reduction in the emotional reaction produced by a given problem can also affect the psychological distance taken by the participant. According to the theory of construal level of psychological distance (Trope & Liberman, 2010), a given situation can be represented at different levels of abstraction. The more abstract the representation of a situation, the less important the superficial aspects of the situation become. Increasing psychological distance from a

given problem helps to construe an abstract representation that may then promote a reduction in the impact of heuristic biases, and a more rational/logical thinking (Amit, Algom, & Trope, 2009). It is possible that the reduction of the emotional reaction prompted by the use of a FL promotes psychological distance, hence reducing the impact of irrelevant details regarding the way a problem is presented (e.g., framing effects) and helping construct an abstract representation to be used by rational processes.

Before concluding it is worth addressing a potential caveat to the studies presented here related to whether the FLe may stem from a poor understanding of the text presented in a FL. Such a poor understanding may have reduced the impact of how the problem was framed. However, we think that this is unlikely, given the pattern of responses observed. As discussed in the corresponding sections of each study, most of the experiments had conditions that were unaffected by the language of presentation, suggesting that the understanding of the problems was good enough for participants to behave as if they were completing the problem in their NL. Consider for example the results in the Holt–Laury test, where responses across the different languages were very similar except for the lottery pairs in which one should expect the effect of risk aversion to be detected. Similar arguments can be put forward to account for the framing effects observed in Study 1, where the FLe was detected only in the distribution of responses in the loss condition. Hence, the fact that the distribution of responses in the gain condition was very similar across the language conditions suggests that participants' comprehension of the text was good enough.

4. Conclusion

The reported results reveal a clear effect of FL on decision making processes. In particular, it appears that choices made when problems are presented in a FL are less subject to intuitive biases. Our main contribution is the demonstration that this effect is more pervasive than previously shown, affecting a wide range of decision making contexts. However, our results also reveal some instructive boundaries of the FLe. Importantly, it seems that the reduction in the contribution of heuristic biases when problems are presented in a FL is limited to contexts in which emotionality is a key factor driving such biases. When problems are emotionally neutral, the involvement of heuristic biases in decision making does not seem to be modulated by the language in which the problem is presented. These observations are consistent with the notion that the foreign language effect arises, at least partially, as a consequence of a reduction on the emotionality produced by a given problem.

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Appendix A. Details of the participants tested in Spain (native language Spanish; foreign language English) for the different problems

	Asian disease problem/ Ellsberg's paradox (<i>N</i> = 123)	Financial crisis/ Ticket-money (<i>N</i> = 140)	Discount (<i>N</i> = 140)	Holt–Laury/ Allais' paradox (<i>N</i> = 150)	CRT (<i>N</i> = 153)
Start age of English instruction	7.1 yrs (3–19)	8 yrs (3–17)	9 yrs (4– 17)	8.3 yrs (4–15)	6.7yrs (4–14)
Immersion duration in an English speaking country	1.2 mths (0–7)	0.75 mths (0–8)	1.52 mths (0–10)	0.7 mths (0–10)	0.5 mths (0–7)
<i>Self-rating level (mean)</i>					
Written comprehension	5.3 (3–7)	5.2 (2–7)	5.3 (3–7)	5.3 (2–7)	5.3 (3–7)
Written production	4.8 (2–6)	4.5 (3–7)	4.6 (2–7)	4.5 (2–7)	4.7 (3–7)
Oral production	4.7 (3–7)	4.1 (2–7)	4.1 (2–7)	4.3 (2–6)	4.2 (2–7)
Oral comprehension	5.3 (3–7)	5.2 (2–7)	5.2 (2–7)	5.2 (2–7)	5.3 (2–7)
Self-rating understanding of the problem (English language)	93.6% (50–100)	93.8% (50–100)	88.4% (50– 100)	91.3 (50–100)	88.2 (50– 100)

Appendix B. Details of the participants who completed the Asian Disease problem in Israel (native language Arabic; foreign language Hebrew)

	Asian disease problem (<i>N</i> = 60)
Start age of Hebrew instruction	6.6 yrs (5–9)
<i>Self-rating level (mean)</i>	
Written comprehension	6.5 (4–7)
Written production	5.9 (2–7)
Oral production	5.9 (3–7)
Oral comprehension	6.5 (4–7)

Appendix C. Details of the English participants who completed the CRT with English as a native language and Spanish as a foreign language

	CRT (<i>N</i> = 167)
Start age of Spanish instruction	12 yrs (3–14)
Immersion duration in a Spanish speaking country	2.8 mths (1–7)
<i>Self-rating level (mean)</i>	
Written comprehension	4.9 (3–7)
Written production	4.6 (2–7)
Oral production	4.1 (2–7)
Oral comprehension	5.1 (3–7)
Self-rating understanding of the problem (Spanish language)	84.7 (50–100)

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