The impact of foreign language processing on judgments, decisions and emotions

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A l'Albert, que m'acompanya allà on vaig

Agraïments

Al final, el gran secret per acabar la tesis és aguantar a un mateix lloc el temps necessari. Si ho aconsegueixes, acabaràs escrivint quelcom que rebrà el nom de tesis. Però ho has d'aconseguir. Durant aquests quatre, cinc anys, hi ha un conjunt de gent que m'ha ajudat a fer-ho, sense els quals res d'això hagués estat possible. Més important que això, sense ells tampoc hauria tingut massa sentit. Per això, per donar sentit a una cosa que moltes vegades dubtes de si en té, els hi agraeixo haver fet aquest camí amb mi.

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Abstract

Foreign language processing is hard, sometimes the right words do not come out, sometimes phonemes are incompressible. Words also lose their emotional appeal in a foreign language. How does this affect people's lives? A recent line of research suggests that it changes their decisions and moral judgments, the so-called foreign language effect. We aim to shed some light on the pervasiveness and origin of the effect. We did so by exploring the foreign language effect on the outcome bias (Chapter I), the representativeness heuristic (Chapter I), and intertemporal choices (Chapter II). In the third chapter, we went a step further and explored how foreign language processing affected emotionality not directly caused by language. Results revealed that: 1) Foreign language processing is unlikely to affect decisions that are independent of emotion (Chapters 1 & 2), 2) Once emotion is relevant to the decision at hand, a foreign language effect is present (Chapter II), and 3) Although a foreign language is less emotional, its use does not regulate emotional arousal (Chapter III). Overall, the prevalence of the foreign language effect might be reduced to emotional contexts, emotions that are not reduced in a foreign language when they are not directly caused by the language.

Resum

Processar una llengua estrangera és difícil, a vegades no surten les paraules exactes, a vegades els fonemes són incomprensibles. A més, les paraules perden la seva força emocional en una llengua estrangera. Com afecta això la vida de les persones? Una línia d'investigació recent suggereix que canvia les seves decisions i judicis morals, l'anomenat efecte de llengua estrangera. L'objectiu de la tesis és explorar com de generalitzat és l'efecte així com el seu origen. Per aconseguir-ho, vàrem explorar l'efecte de llengua estrangera en "l'outcome bias" (Capítol I), l'heurística de representativitat (Capítol I), i les decisions intertemporals. En el tercer capítol, vàrem anar un pas més enllà i vàrem explorar com processar una llengua estrangera afectava les emocions no causades directament pel llenguatge. Els resultats revelen que: 1) El processament d'una llengua estrangera probablement no afecta les decisions no relacionades amb emoció (Capítols I & II), 2) Una vegada l'emoció és rellevant per la decisió, existeix efecte d'una llengua estrangera (Capítol II), i 3) Tot i que una llengua estrangera és menys emocional, el seu ús no ajuda a regular les emocions (Capítol III). En general, la prevalença de l'efecte de llengua estrangera podria reduir-se en contextos emocionals, emocions que no es veuen reduïdes en una llengua estrangera quan no estan directament causades per la llengua.

Preface

People are talking heads. We are constantly talking; to our friends, colleagues, and family. Even when we are alone, we talk; we talk to ourselves. Thus, a considerable amount of time is spent using language, inside or outside our heads. When we are not talking, we are probably making decisions. People are decision-making machines, constantly facing mundane decisions (what to wear, how to get to work, what to eat) and sometimes critical ones (what to study, which work to apply to, whether to have children or not). Thus, we are talking heads and decision-making machines. Crucially, some people are bilinguals, not only do they talk in one language, they talk in two. Does getting to the decision-making homunculus in one language or the other affects people's decisions?

This is the main question we try to answer in this dissertation. Previous work has established that using a foreign language, that is, a language acquired later in life, probably in a classroom setting, and with a lower proficiency than the native language, affects people's judgments and decisions. Long story short, it prevents people from suffering from the framing effect and from being less risk-seeking (Costa, Foucart, Arnon, Aparici, & Apesteguia, 2014; Keysar, Hayakawa, & An, 2012), and it changes people's views on moral dilemmas (Corey et al., 2017; Costa, Foucart, Hayakawa, et al., 2014; Geipel, Hadjichristidis, & Surian, 2015). Thus, using a foreign language is another *a priori* irrelevant thing (Thaler, 2015) that influences judgments and decision-making. But the prevalence and origins of the foreign language effect are questions still waiting for an answer. This dissertation tried to tackle them by exploring the

foreign language effect in contexts in which the current accounts of the foreign language effect made opposite predictions. By doing so, we both contributed to the study of the pervasiveness of the effect and shed some light on its origins. We explored whether there was a foreign language effect on outcome bias and representativeness heuristic (Chapter I), and intertemporal choices (Chapter II).

Language and emotions are closely linked; people tend to share more emotional aspects of their life than neutral ones (Rime, Mesquita, Philippot, & Boca, 1991). The foreign language effect does also link the two: the most popular account for the effect is a reduced emotionality associated with processing a foreign language (Costa, Vives, & Corey, 2017). For this reason, emotion is a crucial aspect of this dissertation. First, we tried to include it in the first and second chapters as a relevant experimental factor—to advance the results, it caused a major difference in the second chapter but not in the first one. Finally, we went one step further in the last chapter, in which we directly tested the impact of foreign language processing on emotional processing. Specifically, we assessed whether labeling emotions in a foreign language would have a similar effect as when it is done in a native language, that is, a down-regulation of emotion (Lieberman et al., 2007). It did not; foreign language is less emotional, but it does not reduce emotions that are not directly caused by language.

Overall, when looking at the larger picture, the foreign language effect on judgments and decision-making might be less prominent as previously thought. Furthermore, the field has suffered

from a lack of theoretical work, a general problem in behavioral sciences (Muthukrishna & Henrich, 2019). In the discussion, we attempt a first, cautious, amendment to this.

Foreign languages might not vastly change our decisions, the effect being solely found in contexts in which emotions are crucial, but it still supposes an interesting research question, an enigma: who can predict where a foreign language effect is going to be found? With the origins of the effect yet to be known, predictions still remain informed guesses after this dissertation.

CONTENTS

1. GENERAL INTRODUCTION

At work, mostly English, although also Spanish and a little bit of Catalan; when shopping, Spanish; with friends, all three languages together; at home, Catalan. Today, this multilanguage craziness is the daily experience of a lot of people: in Europe, multilinguals are more frequent than monolinguals (53% vs. 47%, Eurobarometer, 2012). Not only can most people speak more than one language; a substantial number uses them every day (25%, Eurobarometer, 2012). Arguably, the present time is the historical period of multilingualism: never have humans spoken more languages and more frequently than today.

Dealing with more than one language involves an individual struggle (Costa & Sebastián-Gallés, 2014). There are also sociological implications—how the presence of two languages affects the interaction between two linguistic groups—, and linguistic ones—how the grammar of one language affects the grammar of the other language. In this dissertation, we explored a relatively new issue related to the bilingual experience: its implications for decision-making and emotions. Simply put, we aimed to answer the following question: are people's decisions and emotions shaped by the language in use?

In principle, to the extent that the content in a foreign language is understood to a similar degree as in a native language, neither person's emotional experiences nor decisions should change. That is, native and foreign languages should activate the same conceptual

representation, creating the same appraisal of the situation, and therefore leading to the same decision and emotion. However, there are cognitive processes influenced by processing a foreign language that are also key for decisions and emotions (see Costa, Vives, & Corey, 2017; Hayakawa, Costa, Foucart, & Keysar, 2016 for reviews). By disrupting these processes, using a foreign language *could* change people's decisions and emotions.

Before reviewing those cognitive aspects, it is important to clarify how we conceptualize a *foreign language*. As we understand it, a foreign language is *any* language that is: 1) Acquired later in life (after 6-7 years old), 2) mostly in a classroom setting, and 3) with a lower proficiency than the native one. This thesis is not about the effect of using one specific language over another; it is about the effect of using any language that shares the aforementioned factors over the native one. It goes without saying that this type of bilingualism, unbalanced bilinguals—is only one portion of a larger picture of the bilingual experience, where there are seemingly almost as many types of bilinguals as bilinguals themselves (balanced bilinguals, sequential bilinguals, etc., see Costa, 2017 for a discussion on the issue), depending on a whole plethora of factors (age of acquisition, context and frequency of use of each language). Here, we focused on unbalanced bilinguals because the characteristics of their foreign language processing will most likely be the ones to interfere with decision-making and emotions in a nuanced way. Thus, we left the factorization of age of acquisition, frequency of use, etc., outside of the scope of this dissertation.

1.1 Foreign language processing is cognitively demanding—or how to assure you will get a headache

People are closely waiting for you to say something. Meanwhile, you are going through your mental lexicon almost at the speed of light, discarding one word and another, trying to find the most precise term to describe what you want to say. Running out of time, you choose, although mildly dissatisfied: there was a better word, one with a subtlety that got lost with your final lexical decision. This process, common in all languages, is more costly in a foreign language. Speech production is slower, that is, it takes more time to translate a concept in its lexical counterpart in a foreign language (Ivanova & Costa, 2008). Furthermore, people struggle more to come up with the right words in their foreign language, that is, they suffer more tip-of-tongues—the feeling that the word one wants to say is about to come up, but it does not (Gollan & Acenas, 2004). Thus, speaking in a foreign language is slower and more costly.

Speech perception is also more costly in a foreign language. Specifically, people read more slowly, with shorter eyes saccades and more fixations in a foreign language than a native one (Cop, Drieghe, & Duyck, 2015). Speech segmentation in oral speech is also affected. It is a common experience by learners of a foreign language to perceive that language as being spoken at very fast rate, when, in fact, most languages are spoken at similar rates (Coupé, Oh, Dediu, & Pellegrino, 2019). More relevant, there is cumulative evidence showing that foreign language processing is more cognitively

demanding. Processing a foreign language activates areas related to cognitive control (Branzi, Della Rosa, Canini, Costa, & Abutalebi, 2016), and increases physiological measurements that index cognitive load, such as skin conductance (García-Palacios et al., 2018), and pupil dilation (Iacozza, Costa, & Duñabeitia, 2017). In general, processing a foreign language, be it passively (comprehension) or actively (articulation), requires more time and a higher cognitive load than processing a native one.

a) A foreign language is cognitively demanding: implications for decision-making

In general, a high cognitive load has a detrimental effect in performance: it decreases the quality of judgments (De Neys, 2006), decisions (Benjamin, Brown, & Shapiro, 2013), and memory (Naveh-Benjamin, Craik, Gavrilescu, & Anderson, 2000). Thus, in principle, using a foreign language should cause a similar burden. This is probably true for people for whom using a foreign language requires a great deal of cognitive effort, that is, low proficiency speakers. However, as proficiency increases, the cognitive effort associated with foreign language processing decreases (Abutalebi, 2008; Serafini & Sanz, 2016). Crucially, it is not the case that a higher cognitive load is always negative. Indeed, there is a degree of cognitive load associated with a level of activation and arousal positive for cognitive performance (Hoffmann, von Helversen, & Rieskamp, 2013; Kim, Kim, & Chun, 2005; Park, Kim, & Chun, 2007). Therefore, it is plausible that the higher arousal associated with foreign language processing causes people to reach that degree

of activation, potentially improving people's judgments and decisions.

Alternatively, foreign language processing might improve people's decisions through another cognitive process. Specifically, the slowness caused by using a foreign language might prevent mistakes associated with fast responses and misguided intuitions (these are often common, see Hogarth, 2001 for a discussion). Therefore, in those contexts where slowing down leaves room for improvement, foreign language might be a good nudge to induce that. This alternative process would lead to the same outcome—an improvement in decisions and judgments. Again, this would only hold true under the condition that the cognitive burden associated with the language is not unbearable. For this reason, people tested in this dissertation were generally high-proficient foreign language speakers. Therefore, either due to the increase in arousal, the decrease in fast-inaccurate responses, or both, processing a foreign language might have what we posit as the *cognitive enhancement* effect in judgments and decision-making. The first and second chapters are devoted to the effect of foreign language in those contexts. Specifically, its effects in the outcome bias (Chapter I), the representativeness heuristic (Chapter I), and intertemporal choices (Chapter II).

b) A foreign language is cognitively demanding: implications for emotions

If a high cognitive load can change cognitive processing in general, there might be spillover effects of foreign language processing across the entire amalgam of cognition apart from judgment and decision-

making. To a certain degree, this seems to be the case: foreign language processing affects memory (Baus, Bas, Calabria, & Costa, 2017), the illusion of causality (Díaz-Lago & Matute, 2018) and aversive conditioning (García-Palacios et al., 2018). As such, emotions might be another cognitive process (see Ledoux, 2015 for a discussion) that could also be affected by foreign language processing. In this line, previous work has shown that amygdala activation, a region classically related to emotionality, is decreased when cognitive load is high (Pessoa, McKenna, Gutierrez, & Ungerleider, 2002). Foreign language use might have the same effect. Simply put, in a foreign language context, a substantial amount of cognitive resources could be already devoted at processing the language, not leaving enough cognitive resources for emotional processing to take place. However, it is known from another line of research that downregulation of emotion requires the engagement of frontal areas (Lieberman et al., 2007). These areas might be sensitive to high cognitive load, which would lead to the opposite prediction: foreign language processing might disrupt downregulation of emotions. The third chapter is devoted to this issue.

Although little work has explored the effect of foreign language processing on emotions in general (see García-Palacios et al., 2018 for a first approach), a great deal has been studied related to how a foreign language affects processing of emotional language, with a clear conclusion: a foreign language is understood, but it is felt less.

1.2 Foreign language processing is less emotional—or how swearing becomes suddenly less rude

Swearing words are first heard and acquired in a context with a set of characteristics, that is, in a highly emotional, probably negative and reprimanding situation. Furthermore, the learning is not totally accomplished with the acquisition of the words; it continues with learning how to strategically use them (Timothy & Janschewitz, 2008). This is a lesson that children struggle with—although the first swear words are acquired around age two, children reached adult-like use around 12 years-old (Jay & Janschewitz, 2012). Thus, the first utterances of swear words might be accompanied by reprimand from a grown-up (Jay, King, & Duncan, 2006). This experience is completely different from how people usually acquire swear words in a foreign language, which would be probably later in life, driven more by curiosity and amusement, without real exposure to the actual factors that cause people to swear. Thus, foreign swear words are acquired frequently without the inherent socialization that is experienced when acquiring those words in a native language.

This neutrality, almost artificiality, in acquiring swearing words in a foreign language is what is postulated to cause the emotional loss these words suffer in a foreign language (Harris, Gleason, & Ayçiçeği, 2006). As any unbalanced bilingual has noticed, swearing in their foreign language does not feel as bad—or as good—as doing it in their native one. Mounting evidence from self-reported questionnaires supports this claim: people find easier to

swear in a foreign language and do it more frequently (Dewaele, 2004, 2010) than in a native language. Furthermore, there is a decrease in arousal when hearing swear words in a foreign language in comparison with a native one as indexed by skin conductance reactivity (Harris, Ayçiçeği, & Gleason, 2003).

However, perhaps harder to explain for the learning experience account, a foreign language is not less emotional only for swear words; it is also less so for emotional words in general (Harris et al., 2003). Thus, although in Harris and colleagues found the strongest reduction in people's skin conductance for swear words in a foreign language, activation was also reduced for other kinds of emotional words, a finding that has been replicated using another measurement of arousal, pupil dilation (Iacozza et al., 2017). More specific to our interest, amygdala activation while reading positive passages in a foreign language is decreased in comparison with reading it in the native language (Hsu, Jacobs, & Conrad, 2015). It has been argued these effects might be caused by the slowness and decrease in fluency foreign language processing imposes (Opitz & Degner, 2012). However, this is still an open question (see Caldwell-Harris, 2015 for a review). In any case, the evidence is converging; a foreign language is understood, but it is felt less than a native one.

a) A foreign language is less emotional: its implications for decision-making

Emotions—we refer to emotions in its looser definition, like general affect (see Scherer, 2005 for one among hundreds of available discussions on the term)—are a fundamental aspect driving people's

lives. People tend to repeat behaviors that lead to positive emotions and avoid behaviors that lead to negative ones (Thorndike, 1898). Furthermore, affective forecasting, that is, predicting how taking a course of action would make you feel, highly predicts people's final course of action (see Wilson & Gilbert, 2005 for a review). Judgments and decisions are no exception; they are also highly influenceable by people's emotions, either through independent emotional states that affect the decision—called incidental emotions (Lerner, Li, Valdesolo, & Kassam, 2015)—, or through the emotion elicited by the specific decision at hand —called integral emotions (Lerner et al., 2015; Phelps, Lempert, & Sokol-Hessner, 2014).

Incidental emotions do not have a generalizable effect on people's judgments and decisions; it depends on the specific emotion that is felt (see Lerner et al., 2015 for a review). For example, anger increases risk-taking, while fear decreases it (Lerner & Keltner, 2001). Regarding integral emotions, they can influence decisions through multiple routes. On the one hand, people can use emotions elicited by each available option as a cue to guide their decisions — the so-called affect heuristic (Slovic, Finucane, Peters, & MacGregor, 2007). Simply put, the heuristic transforms the decision space into the following question: "*How do I feel about this option? And this other?*". Then, one simply decides the option that creates — or it is expected to create —a more positive emotional response. This simple rule-of-thumb has strong predictive power on people's decisions (see also Loewenstein, Hsee, Weber, & Welch, 2001 on how emotions have predictive power on people's risky decisions).

On the other hand, a strong emotion elicited by the decision-context can prompt a specific route of action. For instance, offering an unequal distribution of goods when deciding how to allocate money between two parties usually elicits anger (Sanfey, Rilling, Aronson, Nystrom, & Cohen, 2003). People, in response of the emotion, decide against settling down (Van't Wout, Kahn, Sanfey, & Aleman, 2006). Thus, in this context anger is thought to be a direct cause of the failure to reach an agreement. It is hard to generalize which decisions incidental emotions are going to prompt, probably because it heavily depends on the context —in one context anger might prompt a course of action and in another one the exact opposite one. However, it is generally thought that decisions caused by emotionality are fast and intuitive, not slow and declarative (Kahneman, 2011).

Foreign language is understood but it is felt less. In an emotional decision, such as a doctor explaining alternative medical procedures, processing a foreign language would decrease the emotionality of the situation. This might decrease the capacity of emotions to impact the final decision: if emotions are not present, decisions cannot be affected by them. In general, the emotional decrease caused by foreign language processing will cause emotionality to play a lesser role in people's decision. This emotional decrease can have positive consequences for people when high emotionality leads to inaccurate judgments and decision biases. At the same time, it can be negative when high emotionality leads to accurate judgments and good decisions. Evaluations aside, the *emotional detachment* hypothesis predicts that foreign language

processing should reduce the overall impact of emotions in people's decisions. Foreign language processing will affect decisions, but only the ones directly caused by emotions. The relationship between foreign language effect on decision-making and how it relates to its reduced emotionality is addressed in the first and second chapter.

b) A foreign language is less emotional: its implications for emotions beyond language

In principle, the lower emotionality caused by being in a foreign language context is confined to situations in which emotions are directly caused by emotional words. Beyond that, the foreign language coldness should not impact emotional processing that is language independent. For example, during a conversation, an emotional face should provoke the same affective response regardless of the language in use. Nevertheless, perhaps related to the incapacity of a foreign language to move people, there is the notion that a foreign language can be used as a psychological barrier when a situation is becoming too emotional—the so-called detachment effect (Marcos, 1976). In other words, using a foreign language might distance people from the situation at hand, whatever that situation is. In fact, tentative evidence suggests that a foreign language is not as associated to the self as a native one (Ivaz, Costa, & Duñabeitia, 2016). Crucially, distancing oneself from the situation is a successful technique to regulate emotions (Ayduk & Kross, 2008). Therefore, foreign language processing could be used to downregulate strong emotional experiences. Were this to be the case, it will have relevant implications for clinical practice, since therapists could make use of this feature to help regulating patients' strong emotions. Indeed,

tentative work has already been conducted with this objective, with relative success (García-Palacios et al., 2018). We followed up on this line of research by exploring how the positive impact of putting feeling into words (Lieberman et al., 2007) is affected by doing it in a foreign language.

Putting feelings into words—affect labeling—reduces people's arousal (Hariri, Bookheimer, & Mazziotta, 2000; Lieberman et al., 2007). Thus, there is already preliminary evidence that people can use language to reduce emotionality. So far, affect labeling has been studied in a native language, so it is unknown whether labeling emotions in a foreign language causes the same effect as doing it in a native one. Perhaps foreign language causes an extra layer of distancing, thus reducing even more emotionality, perhaps the cognitive burden associated with foreign language disrupts affect labeling. We addressed this issue using functional magnetic resonance imagining (fMRI) in the third chapter.

1.3 The foreign language effect in judgment and decision-making

We have argued that foreign language can influence judgment and decision-making at least through two routes: the cognitive enhancement and emotional detachment hypotheses. But, is there evidence of a foreign language effect on decision-making or is it just a theoretical postulation? Until recently, the answer would have been a simple "there is no evidence". But, in 2012, Keysar and colleagues found the first evidence: foreign language use was able to eliminate

one of the most classical biases in judgment and decision-making: the framing effect (Tversky & Kahneman, 1981).

The framing effect is elegant evidence —among many (Kahneman, 2011)—that people do not meet the necessary criteria to be considered as rational decision-makers. Specifically, framing effects cast considerable doubts in one indispensable condition for rationality: invariance (Tversky & Kahneman, 1986). Invariance refers to the postulation that people's preferences must be independent of how they are described. However, plenty of evidence suggests otherwise: choices are indeed heavily biased depending on how they are described (see Kühberger, 1998 for a review). Tversky and Kahneman (1981) made use of the fact that people are risk-seeking when facing losses and risk-averse when facing gains (Kahneman & Tversky, 1979), to prove that people do not comply with the invariance condition. To do so, they created what is now known as the classical Asian disease problem (Tversky & Kahneman, 1981). In this problem, people either see the prospects of two options described in terms of gains or losses. Importantly, the two options have the same expected value; the only difference lies on the variability in its outcomes—one option is riskier than the other. Simply stating the prospects in terms of gains or losses changed people's choices. From vastly preferring the non-risky option for the gain frame, people went to vastly preferring the risky option for the loss frame, clearly dismantling the invariance axiom.

Surprisingly, when people stated their preferences in the Asian disease problem in their foreign language, they did not change depending on how the prospects were framed (Keysar, Hayakawa, &

An, 2012). Simply put, people demonstrated insensitivity to framing. Thus, their choices in a foreign language comply with rational models of decision-making. To stress the point, yes: if anything, people were behaving more according to rationality in their foreign language than their native one. Importantly, Keysar and colleagues replicated the foreign language effect three times with samples that had different combinations of native and foreign languages. This was crucial to avoid other confounds. First, languages are usually associated with cultures—see (Ramírez-Esparza, Gosling, Benet-Martínez, Potter, & Pennebaker, 2006) for how using one language makes bicultural bilinguals respond personality tests more in line with the culture associated with that language. Thus, certain cultures through language priming could promote more careful thinking than others. Testing the effect inverting which language is the native and which one is the foreign addresses this issue. It is also strong evidence that the effect cannot be interpreted as language specific, but rather it is probably caused by the specific properties of the languages acquired under certain circumstances, that is, foreign languages.

Furthermore, Keysar and colleagues found that a foreign language increased risk-taking behavior in a context in which the risky option would lead to a better payoff in the long run than the safe option (but see Hayakawa, Lau, Holtzmann, Costa, & Keysar, 2018), showing again more normative behavior in a foreign language context than in a native one. Costa and colleagues replicated and extended these findings (2014). They found that using a foreign language increased payoff maximizing decisions in risky prospects in the Holt-Laury test—a classical method to elicit people's risky

behavior (Holt & Laury, 2002)—, reduced ambiguity aversion and sunk-cost fallacies. Again, the same striking pattern: using a foreign language made people more normative in their decisions. Relatedly, it was found that a foreign language protected people from the hot-hand fallacy (Gao, Zika, Rogers, & Thierry, 2015)—the belief that the probability of a successful event increases after the occurrence of a sequential stream of the same event. In the same line, foreign language use also decreased superstition (Hadjichristidis, Geipel, & Surian, 2017) and the illusion of causality (Díaz-Lago & Matute, 2018). Overall, nearly all findings suggest a higher decision-making normativity in a foreign language context.

If the previous results were already surprising, they were probably not as surprising as the ones from the moral domain. If anything, one would think that something as relevant as morality will be independent of language. It is not. When faced with the footbridge dilemma, a dilemma in which people must decide between saving the life of five by killing someone against letting the five people die to avoid killing someone, the percentage of people who opted for saving the five lives doubled in a foreign language; it went from a classical baseline of 20% in a native language, up to more than 40% in foreign language (Costa, Foucart, Hayakawa, et al., 2014). Thus, as the authors put it, "your morals depend on language."

This increase in utilitarianism—deciding to maximize the greater good (still hotly debated issue in moral psychology literature about how to best capture it)—in a foreign language has been replicated a substantial amount of times in a plethora of languages: Spanish as native / English as foreign and vice versa, Italian as native

/ English and German as foreign (Geipel, Hadjichristidis, & Surian, 2015b), thus the finding appears to be real. Furthermore, experiments conducted with small modifications of the original scenario, such as stating the group membership of the people involved, or similar dilemmas that capture the same tradeoff between morality and the greater good, all have found the same converging result: people opt more for the greater good in their foreign language (Corey et al., 2017).

However, people will probably never be confronted with the sort of hypothetical moral dilemmas in which the foreign language effect has been found. In fact, the actual meaning in relation with real behavior and morality in general of hypothetical dilemmas has been put into question (see Białek, Turpin, & Fugelsang, 2019; and Bostyn, Sevenhant, & Roets, 2018 for a recent discussion on the topic). The same critique has not been raised to the study of hypothetical moral transgressions though, probably because of its higher ecological validity: most people will probably never decide between killing one and saving five, but they do judge those moral actions all the time. Arguably, the capacity to judge others, never ourselves, and create social norms is one of the main purposes morality serves (Haidt, 2001). And again, they do not escape the foreign language effect. People judge moral transgressions to be less severe in a foreign language than in a native one (Geipel, Hadjichristidis, & Surian, 2015a). Furthermore, they seem to rely more on consequences and less on intentions when judging moral actions in a foreign language (Geipel, Hadjichristidis, & Surian, 2016), a result that was only partially replicated (Costa et al., 2018).

Overall, morality is highly vulnerable to whether the language used is one's native or foreign language, which is concerning since, for example, people can be a juror in some countries like the United States without a test of their English proficiency.

1.4 But…why? The origins of the foreign language effect

As we have seen, there is plenty of evidence that foreign language processing does shape judgments, decisions and morality. Now the question is, which of the two hypotheses better account for the findings, the cognitive enhancement or the emotional decrease? Or is it both, since they are not mutually exclusive? One easy method to disentangle which hypothesis is more likely to be true is checking how well they predict the effects found. Without going finding by finding, there was a clear trend for judgments and decision-making: processing a foreign language made people more normatively alike.

Regarding morality, it is harder to argue from a normative standpoint—indeed, philosophers have been trying for centuries. However, it is still possible to draw parallelisms between judgment, decision-making and moral dilemmas by looking at the cognitive processes that underlie the three. In general, utilitarianism is related to activation of cognitive control areas (Greene, Sommerville, Nystrom, Darley, & Cohen, 2001; Greene, Nystrom, Engell, Darley, & Cohen, 2004; van Baar, Chang, & Sanfey, 2019), which has been argued to be an index of deliberation (Miller & Cohen, 2001; Wan Lee, Shimojo, & O'Doherty, 2014), the same process that is thought to be related to more normative judgments and decisions (see

Stanovich, 2011 for an overview of how deliberation impacts judgments and decisions). Thus, to a certain degree, at least cognitively, foreign language processing does also produce more thoughtful outcomes in the moral domain.

The cognitive enhancement hypothesis predicted the set of results found; the slowness and higher arousal caused by processing a foreign language will cause an enhancement of judgments and decision-making. However, there is a characteristic shared across almost all contexts in a foreign language effect: emotion. Emotion is posited to cause the framing effect (De Martino, Kumaran, Seymour, & Dolan, 2006), and it makes people choose to opt for the non-killing option in the moral dilemma (Greene et al., 2001). Simply put, a reduction of emotionality would predict the set of results found in a foreign language.

An easy approach to disentangle between the two hypotheses is exploring situations in which the hypotheses would predict different results. Neutral situations, with little or no emotion present, are one kind of these situations. Surprisingly, previous research has been mostly conducted in emotional contexts, such as gambling (risk taking, hot-hand fallacy), or decisions between life and death (moral dilemmas, the framing effect). Only twice the foreign language effect has been tested in neutral contexts, with mixed findings. On the one hand, foreign language processing did reduce the illusion of causality (Díaz-Lago & Matute, 2018). On the other hand, it did not improve accuracy in the cognitive reflection test (Costa, Foucart, Arnon, Aparici, & Apesteguia, 2014)—a classical test created to measure the degree to which people engage in deliberation (Frederick, 2005).

Thus, it is still an open question which of the two hypotheses causes the foreign language effect. The first chapter addresses this issue by exploring the foreign language effect in three neutral contexts: the outcome bias, the base-rate neglect and the conjunction fallacy. The objectives were two: 1) A descriptive one, in terms of completeness of the foreign language effects that have been explored 2) A theoretical one, in terms to be able to at least discard one hypothesis depending on the results.

To advance the results, we did not find any effect of foreign language processing in those contexts, which led us to conclude that once emotionality is removed from the equation, it is unlikely that foreign language effect is found. Therefore, we went on exploring situations in which emotion is likely to be relevant. In the second chapter, we did so by studying temptation. Specifically, we explored whether foreign language processing will make people more patient in intertemporal choices—choices that affect the present but also the future (Loewenstein, Frederick, & O'donoghue, 2002). In a foreign language, things might sound less appealing, making it easier to wait for the future-greater payoff. Indeed, tentative evidence suggested that people are less affected by temptation in a foreign language—people chose the unhealthy dessert less in that language than in the native one (Klesse, Levav, & Goukens, 2015).

In the third chapter we studied a pure emotional situation to see how foreign language processing would interact with emotional processing. Specifically, whether the effect of affect labeling, that is, the reduction of emotionality due to putting feeling into words, would be enhanced or reduced in a foreign language. Indeed, tentative

evidence suggests that foreign language processing can influence emotionally laden stimuli that is language independent (García-Palacios et al., 2018), which could have relevant implications for clinical practice.

All in all, language is used in all places; at home, at work, at the bank, with an entire set of purposes; to share, to reason, to argue. Bilinguals make use of their languages in all those places for all those purposes. The aim of the thesis is to complete our understanding in how the language in use can affect decisions and emotions in those places for some of the purposes: reasoning (Chapter I), avoiding temptation (Chapter II), and regulating emotions (Chapter III).

2. CHAPTER I. The limits of the foreign language effect on decision-making: the case of the outcome bias and the representativeness heuristic.

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3. CHAPTER II. Money is *dinero* but health is not *salud*: The foreign language effect on intertemporal choices

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Money is *dinero* but health is not *salud*: The foreign language effect on intertemporal choices

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Abstract

We tested in more than 1,000 subjects the effect of using a foreign language on intertemporal choices in two different domains, money and health. Results across three experiments (Experiments 1, 2 & 4) revealed that foreign language use does not substantially affect intertemporal choices in the money domain. However, when the effect was tested in the more emotional context of health (Experiment 3), people were significantly less impatient in the foreign language than in the native one. Consistent with a decreased emotionality account, foreign language use affects people's intertemporal choices, but only when emotion plays a central role.

Key words: Decision-making, Intertemporal choices, Foreign language effect, Bilingualism.

Introduction

"It's late at night and I'm watching TV and I stay up late because I'm night guy. Getting up after 5-hour sleep? That's morning guy's problem. That's not my problem, I'm night guy." Jerry Seinfeld, comedian.

The night-guy / morning-guy tragedy is a recurrent dilemma in everyone's life that can be formulated as a question: How much pleasure do you want to have now at the expense of your future self? The expense can vary from waking up after a long night, working extra hours to compensate a low-performance day, or working out today to burn yesterday's dessert. All these sorts of trade-off decisions belong to the family of intertemporal choices, that is, choices that impact us here-and-now but also later in time (Frederick, Loewenstein, & O'Donoghue, 2002; Lempert & Phelps, 2016).

People's intertemporal choices have been shown to be inconsistent and biased towards immediate rewards (Laibson, 1997; Loewenstein & Prelec, 1992; Mischel, Shoda, & Rodriguez, 1989; Thaler, 1981). They are also susceptible to several contextual factors. For instance, when choosing between a smaller-sooner reward and a larger-later one, people's decisions are affected by the physical presence of the rewards (Mischel & Ebbesen, 1970), default options (Madrian & Shea, 2001), whether time intervals are subdivided or not (Read, 2001), the use of round versus inexact numbers (Fassbender et al., 2014), or whether the time to obtain the reward is described in

dates (e.g., July 12th) instead of number of days (e.g., 90 days) (Tu & Soman, 2014). In this paper, we explore a different aspect: how language affects intertemporal choices, focusing on the effect of using a foreign language.

It is already known that foreign language use affects a variety of decision-making tendencies. People using a foreign language are more risk seeking (Keysar, Hayakawa, & An, 2012; but see Hayakawa, Lau, Holtzmann, Costa, & Keysar, 2018) and insensitive to framing effects (Costa, Foucart, Arnon, Aparici, & Apesteguia, 2014; Keysar et al., 2012). They also tend to lie less (Bereby-Meyer et al., 2018) and be more utilitarian in moral dilemmas (Costa, Foucart, Hayakawa, et al., 2014). In general, these effects have been related to the reduced emotionality caused by a foreign language in comparison to a native one (see Costa, Vives, & Corey, 2017; Hayakawa, Costa, Foucart, & Keysar, 2016, for reviews).

Despite the broad range of contexts in which foreign language effects have been found, the domain of intertemporal choices remains unexplored. There are two (non-mutually exclusive) mechanisms that would predict an effect in the direction of a foreign language making people more willing to wait for future rewards. The first mechanism is related to the reduction in emotionality associated with foreign language processing (Dewaele, 2004; Hsu, Jacobs, & Conrad, 2015; Iacozza, Costa, & Duñabeitia, 2017). This reduced emotionality might make immediate rewards less tempting, thus increasing people's patience to wait for the delayed reward. Tentative evidence supports this notion, as people in a foreign language context chose

more healthier desserts than in a native language context (Klesse, Levav, & Goukens, 2015).

The other mechanism is related to cognitive load. Processing a foreign language is more cognitively costly than processing a native one (Hasegawa, Carpenter, & Just, 2002). Thus, using a foreign language can be thought of as a cognitive load manipulation. Interestingly, there is evidence suggesting that a high cognitive load increases self-control thanks to a reduced processing of the more gratifying option, which makes it less appealing and thus easier to avoid (Van Dillen, Papies, & Hofmann, 2013). Foreign language processing might have a similar effect. Either because of cognitive load or the reduction in emotionality, using a foreign language might influence intertemporal choices by making people more patient.

We explored this question in four experiments and in two domains: money and health. In Experiment 1, we used a standard procedure to elicit people's time preferences for money and found no-effect of foreign language use. In Experiment 2, a more language-based elicitation procedure was used, and we replicated the same null-findings. In Experiment 3, we tested the foreign language effect in the domain of health and found that the foreign language made people significantly more patient. Finally, since a different elicitation procedure was used in Experiment 3 than in the other experiments, in Experiment 4 we used the same procedure again, but this time with money instead of health, and we replicated one more time the null effect of language on monetary intertemporal choices. Overall, we provide consistent evidence that foreign language does not affect

monetary intertemporal decisions, but it has an effect when decisions are related to health.

General Method

All experiments were conducted using the same general method. The shared characteristics are explained first. Any variation from the general method is specified in the corresponding section for each experiment.

Participants

We chose our sample sizes in order to have at least 80% power to detect small to medium effect sizes (d = 0.2-0.4), which is what one would expect from previous results. For Experiment 1, we collected data from 240 participants, 120 per language condition (d = 0.4, power = 88.3%). The lack of a significant effect in Experiment 1 made us increase the sample size for the next experiments. We tested at least 340 participants per experiment (517 in Experiment 2, 371 in Experiment 3, and 340 in Experiment 4), which assured an 80% power-threshold with d = 0.3. All participants were bilingual and had learned their foreign language (English) in classrooms, not at home. They were paid 5€ for their participation and gave their consent before the experiment. All studies were approved by the university ethics committee.

We excluded participants applying standard criteria followed in this type of research. First, participants could not have lived in an English-speaking country for more than 12 months. Second, their native language had to be Spanish. Third, they had to report an understanding higher than 50% regarding the English language. Only

participants who met these three criteria were kept for analysis. Other exclusion criteria are detailed in the corresponding sections.

Procedure

Participants were randomly assigned to a native or foreign language condition. The entire session was conducted in the assigned language by a proficient bilingual speaker. All experiments—except for a portion of the sample in Experiment 2—were conducted in the laboratory in groups of 15 – 25 participants. Spanish was always the native language and English the foreign one. Materials were translated from English to Spanish and back-translated to ensure language equivalence (Brislin, 1970). Participants were seated in independent cubicles and asked to follow the instructions on the screen silently. If participants had any questions, the researcher always replied in the language being tested at that moment.

Experiment 1: Real Money Decisions

Asking questions such as "do you prefer 40€ now or 50€ in two weeks?" (so-called canonical taks, see Cubitt & Read, 2007) is one of the most widely used methods to elicit people's intertemporal preferences. By repeatedly asking this type of question and varying the amount of money and waiting time (e.g., choosing between now and later, or between two different moments later in time), it is possible to estimate the two parameters of the following discount function:

$$d(t) = \begin{cases} 1 & \text{if } t = 0 \\ \beta \cdot \delta^t & \text{if } t > 0 \end{cases}$$

Where t is the time delay to receive the reward. Parameter β captures the so-called present bias, that is, the degree to which one gives prevalence to the present over the future; and parameter δ is the discount factor, that is, how much the value of money is discounted between different future moments. β is bound to be between 0 and 1, with values lower than 1 producing time-inconsistent behavior. This parametrization is known as the quasi-hyperbolic discount function, which has been shown to successfully characterize people's intertemporal choices in a number of studies (e.g., Laibson, 1997; Lerner, Li, & Weber, 2013; McClure, Laibson, Loewenstein, & Cohen, 2004). By using this approach, we can conduct a deeper analysis and divide our inquiry into two questions. First, does using a foreign language affect intertemporal choices? And, if so, which parameter is more affected, the present bias or the discount factor? A number of patterns documented in intertemporal choices have been shown to be related to a drive for immediate gratification (Frederick et al., 2003; Mischel et al., 1989), which should be captured by the present bias parameter, rather than the discount factor. Indeed, parameter β is associated with activation in parts of the limbic system classically related to emotional processing (McClure et al., 2004). For these reasons, we expect the present bias parameter to be more affected by using a foreign language than the discount factor.

Method

Participants

Two hundred forty-two participants were recruited. Two participants were excluded because they failed to answer an attention check

correctly (e. g., “would you rather get 12€ or 10€ in two weeks?”), five because they reported having lived more than 12 months in an English-speaking country, and six because Spanish was not their native language, leading to a final sample of 229 participants (65% women, average age = 19.53 years, *SD* = 1.11).

Procedure

We used a set of 40 binary decisions (McClure et al., 2004). In each decision, participants had to choose between a smaller monetary amount sooner or a larger one later. We included comparisons between the present and the future as well as between different moments in the future (e.g., “which option do you prefer, 10€ now or 12€ in a week?”; “10€ in a week or 12€ in two weeks?”, respectively). This allowed us to estimate participants’ present bias and discount factor separately. Participants first responded to an attention check in which the delayed option was also the smallest amount. Then, they were randomly presented with the 40 decisions one-by-one. In each session (15 – 20 people), one participant was selected and one of his/her choices was paid out according to his/her response using an Amazon gift certificate.

Results and discussion

We estimated each participant’s present bias and discount factor by maximum likelihood using the quasi-hyperbolic function. Dovetailing with previous work (see Frederick et al., 2002), most participants showed a present bias (71.61% of βs were lower than 1), resulting in an average β parameter of $M = .94$, $SD = .11$. Participants’

time discounting parameters were also in line with previous work, with an average of M = .20, SD = .29.

Regarding the effect of using a foreign language, participants' intertemporal choices were unaffected by it: 1) in both languages, they showed a very similar degree of present bias: $t(165.85) = -.33$, $p = .74$; $M_{Native} = .94$, $SD_{Native} = .14$; $M_{Foreign} = .95$, $SD_{Foreign} = .06$; and 2) they discounted the future very similarly: $t(227) = .63$, $p = .63$; $M_{Native} = .21$, $SD_{Native} = .30$; $M_{Foreign} = .18$, $SD_{Foreign} = .29$. Therefore, the language context does not seem to affect how people weight the present over the future.

This null finding suggests that people's intertemporal choices are insensitive to the use of a native or foreign language. However, there might be an alternative explanation for the lack of a foreign language effect. We used a standard task from the field of inter-temporal choice that required little language processing in order to complete it. In each trial, the only parameters that changed were time and money, with the rest of the sentence remaining constant throughout the task. Thus, one only needed to attend to the numbers in order to answer, without even having to read the sentence. Indeed, foreign language effects have been shown to disappear in contexts with minimal language processing (Winskel, Ratitamkul, Brambley, Nagarachinda, & Tiencharoen, 2016).

In order to disentangle these two possibilities—a true null-finding vs. an insufficient language manipulation—, in Experiment 2 we elicited people's temporal preferences using scenarios that required greater language processing. As a downside, these

intertemporal decisions were hypothetical, although previous work shows that hypothetical intertemporal choices are highly correlated (Johnson & Bickel, 2006) and do not significantly differ (Baker, Johnson, & Bickel, 2003) from intertemporal choices with actual consequences. Indeed, hypothetical intertemporal choices predict real impatient behavior, such as amounts of cigarettes smoked (Ohmura, Takahashi, & Kitamura, 2016) or alcohol consumption (Vuchinich & Simpson, 1998).

Experiment 2: Adding more language processing

We selected a battery of scenarios that still focused on monetary intertemporal choices but required substantially more language processing. To cover more ground, we explored two types of scenarios: choice situations, in which participants had to select between options that varied in terms of waiting time and amount of money received; and allocation scenarios, in which participants were hypothetically endowed with money and had to allocate it among options that varied in how present- or future-oriented they were (e.g., spending money on leisure activities vs. retirement savings).

If the result from Experiment 1 was due to the minimal language processing required to complete the task, then we expect that, since this task is more language-dependent, we will obtain a foreign language effect here. If the result was a true null-finding, then we should replicate the previous result with this different method, which would add robustness and validity to the null-finding.

Method

Participants

Five hundred and forty-one participants were recruited (209 in the laboratory and 332 in regular classrooms). Thirteen participants were excluded because they reported having lived more than 12 months in an English-speaking country, 10 because Spanish was not their native language, and one because she reported having understood less than 50% regarding the English language, leading to a final sample of 517 participants (61% women, average age = 20.49 years, *SD* = 3.50).

Procedure

Participants responded to four choice scenarios and five allocation ones. In the choice scenarios, people had to choose between: 1) asking for money to the bank to buy a car or waiting until they had saved enough, 2) four options that varied in the amount of money (500€, 600€, 800€, 1000€) and waiting time (now, in 1 month, in 6 months, in 12 months) to receive an extra bonus at work, 3) three grants that varied in the amount of money received (1,000€, 1,150€, 1,300€) and the waiting time (now, in 4 months, in 8 months), and 4) two investment plans, one with less revenue but sooner (100€ in a month) and the other with more revenue but later (250€ in three months). In the allocation scenarios, people had to decide how they wanted to allocate money among different options, some present-oriented (e.g., leisure, food), and others future-oriented (e.g., pension plan, saving account), with the money coming from different sources: 1) your first salary of 2,000€, 2) a lottery prize of 10,000€, 3) an

inheritance of 20,000€, 4) an extra profit for a company of 10,000€, and 5) a revenue from the stock market of 6,000€.

People in regular classrooms only responded to the choice scenarios, since the allocation ones required some mental arithmetic, which is harder in a foreign language (Frenck-Mestre & Vaid, 1993; Marsh & Maki, 1976). Therefore, we tested these scenarios only with the help of computers in the laboratory.

Results and discussion

Before the analysis, we merged the choice scenarios to create an intertemporal-preference index. For each scenario, the most present-oriented answer was assigned a value of zero, while the most future-oriented answer was assigned a value of one. Answers that were intermediate were assigned a proportional value (e.g., if there was a middle option between the more and less impatient one, we assigned to it a value of 0.5). After this transformation, we added the participant's answers to each scenario together, leading to an index that varied from 0 (most impatient—all choices were present-oriented) to 4 (most patient—all choices were future-oriented).

In general, participants were more drawn towards the future than towards the present in both languages: the index is closer to the most patient boundary (4) than to the most impatient one (0) (M = 2.92, SD = 0.94). Analyses reveal that intertemporal choices were not significantly affected by language context: $t(515) = 1.68$, $p = .092$; $M_{Native} = 3.00$, $SD_{Native} = .88$; $M_{Foreign} = 2.85$, $SD_{Foreign} = 1.00$, with the mean even slightly (but not significantly) higher in the native condition. So, we conceptually replicated the results from

Experiment 1: processing a foreign language does not substantially affect intertemporal choices.

We followed a similar logic to analyze the allocation scenarios. First, allocation options were classified as being present- or future-oriented (e.g., leisure time vs. pension plan). Then, the percentages of money that participants allocated to the options of the same class were added for each scenario and averaged across participants to obtain a present- and a future-orientation index. Some scenarios had unclassifiable options (e.g., "other"), which were not considered for analysis of either of the two indices. Finally, we subtracted the present-orientation index from the future-orientation one, which informed us on the degree to which each participant favored the future over the present or vice versa. A positive value on this index indicates favoring the future while a negative one indicates favoring the present.

Overall, we found that people had a general tendency to favor the future (M = 0.41, SD = 0.20). Our analysis revealed one more time that decisions to allocate money between the present and the future were not significantly affected by language context: $t(197)$ = 1.84, p = .06; M_{Native} = .44, SD_{Native} = .20; $M_{Foreign}$ = .39, $SD_{Foreign}$ = .19, again with the mean even slightly (but not significantly) higher in the native condition. Thus, we again conceptually replicated the same result as in Experiment 1 using a different method, which adds robustness and validity to the finding.

In general, foreign language effects in decision-making have been found in contexts where emotion is thought to play a crucial

role, such as moral dilemmas or risk-taking decisions (see Costa et al., 2017, for a review). Arguably, intertemporal choices do also share this characteristic, since people's emotions have predictive power over their temporal preferences (Lerner et al., 2013). However, money is an abstract concept, even more so if it is not physically present, as in our case. Furthermore, it has been suggested that people respond to monetary intertemporal choices by applying simple cognitive rules-of-thumb that have little or no relationship with emotions (e.g., "accept later option when money is larger than amount X, take earlier one if it is smaller") (Marzilli Ericson, White, Laibson, & Cohen, 2015). In contrast, other intertemporal choice domains, such as health, have been posited to be more emotionally laden (Hardisty & Weber, 2009). Given that the foreign language effect emerges mainly in highly emotional contexts, it might influence intertemporal choices when tested in a more emotional domain. This was the motivation for Experiment 3.

Experiment 3: The Health Domain

Many health decisions are intertemporal in nature. For instance, undergoing a medical treatment can be understood as an intertemporal dilemma: one needs to incur a substantial loss in the present, such as a painful treatment, to obtain a reward in the form of recovery in the future. Indeed, long-lasting treatments tend to have a high dropout rate (Osterberg & Blaschke, 2005), and people (aware of the struggle) devise strategies to be able to keep up with the treatment (Ariely, 2009). Other examples include going for a run to improve one's health or having a dessert after lunch that will increase future sugar and fat levels.

At the same time, health is also one of the most crucial and emotional aspects of life. In fact, physical displeasure is frequently reported as one of the main factors associated with unhappiness (Dolan, Peasgood, & White, 2008). Health decisions are also something that everybody experiences in everyday life, and often (e.g., in the case of immigrants or travelers) in a foreign language. Thus, we had two motivations to explore the foreign language effect on intertemporal choices in the domain of health. First, it taped into the key factor we wanted to test, the impact of foreign language under conditions of higher emotionality. Second, many people are currently making health decisions in a foreign language, which adds real-life relevance to the study, beyond its theoretical value.

Method

Participants

Three hundred and nighty-four participants were recruited to be tested in the laboratory. Fourteen participants were excluded because they reported having lived more than 12 months in an English-speaking country, six because Spanish was not their native language, and two because they reported having understood less than 50% regarding the English language, leading to a final sample of 372 participants (63% women, average age = 21.44 years, *SD* = 3.56).

Procedure

Participants read a description of a hypothetical illness they were suffering that involved headaches, general pain, and loss of appetite, among other symptoms (Chapman, 1996). After this, they had to answer the following question:

"*Imagine that there are two drugs, Drug A and Drug B. Drug A is going to recover your full health for one year (Drug A's efficacy) and is going to have an effect right now. Drug B is going to recover your full health for ____ years but it will take one year (waiting time) to have an effect. How long should Drug B recover your full health to make it as attractive as Drug A*?"

Participants were shown multiple scenarios in which we manipulated two variables: drug A's efficacy (1, 2, 4, 8 years) and the waiting time for drug B to have an effect (1, 3, 6, 12 years). Each participant was presented with the full set of decisions, leading to the presentation of 16 questions in a randomized order.

Results and discussion

We calculated the annual discount rate (*r*) for each participant applying the following formula:

$$r = \left(\frac{v_t}{v_0}\right)^{1/t} - 1,$$

where v_d is participant's response, v_0 is the magnitude of the immediate outcome, and *t* is the delay between the immediate and the delayed option (Chapman, 1996). Then, we averaged the annual discount rate across conditions (drug A's efficacy and drug B's waiting time) for each participant to obtain a general index of time discounting. A positive value on this index indicates that value is discounted across time, 0 indicates time-insensitivity, and a negative value indicates favoring the future.

Dovetailing with previous work, participants discounted value across time. In order to be indifferent between the two treatments,

they required on average drug B to be more than twice as effective, in terms of years, as drug A (M = 113.81%, SD = 185.52).

This time, language did affect intertemporal choices: participants discounted the future less in the foreign language than in their native one: $t(310.51) = -2.74$, $p = .006$; M_{Native} = 139.71%, SD_{Native} = 221.01; $M_{Foreign}$ = 87.64%, $SD_{Foreign}$ = 136.56 (see Fig. 1A). It seems that, once the foreign language effect is tested in a less abstract, more emotional context, such as health, using a foreign language does impact intertemporal choices, by making people request less health in order to make the future as attractive as the present.

This result is in line with the notion that foreign language effects are mostly found in emotion-eliciting contexts. However, there is an alternative, perhaps more parsimonious, explanation for the effect. In this experiment, we elicited people's intertemporal preferences using a different method than in Experiments 1 & 2. Thus, the effect found could be because of this difference rather than because of the supposedly higher emotionality produced by the health domain. For instance, in order to complete the task, participants had to come up with numbers. Foreign language use could interfere with the numeric system, which is a possibility given the strong link between numeracy and language (Gelman & Gallistel, 2004), and this could bias people towards reporting smaller numbers. Experiment 4 was conducted to tackle this alternative explanation.

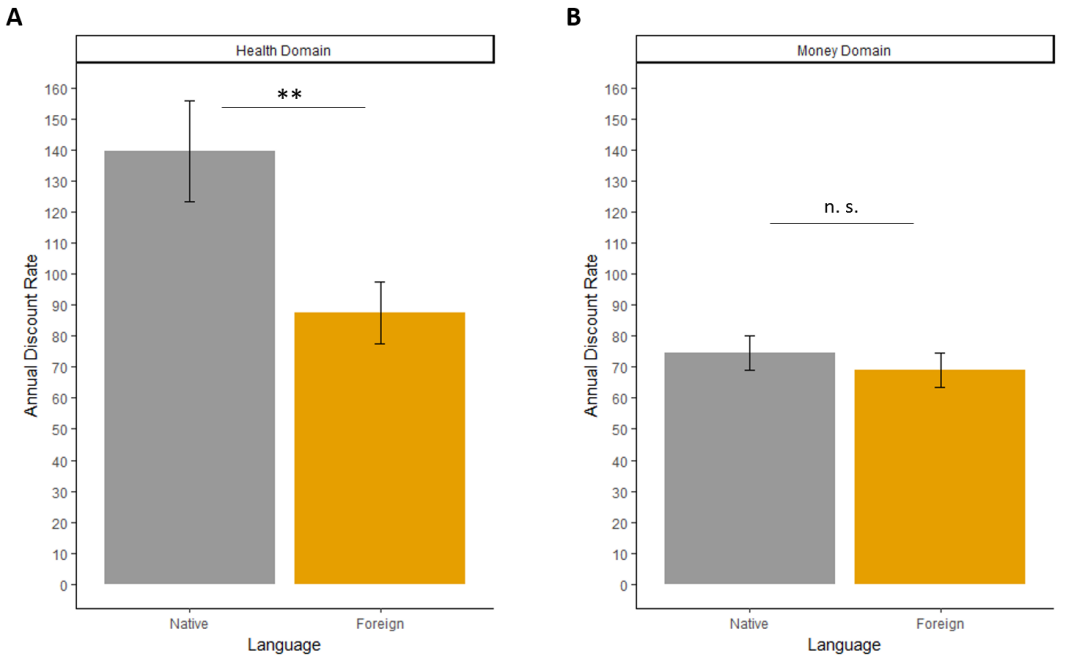

Fig. 1. Results of Experiments 3 (Health) and 4 (Money). Average participants' annual discount rate is depicted split by language. In the health domain (**A**), foreign language had a significant effect (**, $p < 0.01$) on annual discount rate, such that participants in a foreign language were on average more patient than in their native language. In the money domain (**B**), replicating Experiments 1 and 2, annual discount rates were independent of language ($p > .4$).

Experiment 4: Is it the health domain or the elicitation procedure?

So far, we have found a consistent set of results regarding money: foreign language use does not modify intertemporal choices in this domain. However, when we tested another domain—namely, health—results changed: people discounted value less across time when asked about their temporal preferences in a foreign language than in their native one.

We posit that the foreign language effect in health but not money is probably due to the former being more emotionally charged than the latter. But there is an alternative explanation. The elicitation procedure used to estimate people's health temporal preferences was substantially different from the ones used to estimate people's temporal preferences for money. While in the first two experiments participants were faced mostly with choice scenarios, in the third one they were required to come up with numbers to complete the task. Moreover, they were asked to determine an indifference point between the treatments offered. To rule out this alternative explanation, in Experiment 4 we used the same elicitation procedure as we did for health in Experiment 3, but for money.

Method

Participants

Three hundred and fifty-six participants were recruited to be tested in the laboratory. Three participants were excluded because they reported having lived more than 12 months in an English-speaking country, 10 because Spanish was not their native language, and three because they reported having understood less than 50% regarding the English language, leading to a final sample of 340 participants (66% women, average age = 20.41 years, *SD* = 2.27).

Procedure

Participants first read a paragraph asking them to imagine that they had won a monetary prize (Chapman, 1996). Then, their task consisted in stating how much a delayed Prize B should be to make it as attractive as a sooner Prize A. Equivalently to Experiment 3, we

manipulated the value of Prize A (500€, 1000€, 2000€, and 4000€) and the waiting time for Prize B (1, 3, 6, 12 years). Again, each participant was presented with the full design, leading to the presentation of 16 questions in a randomized order.

Results and discussion

We calculated the annual discount rate following the same formula as in Experiment 3, but this time using money instead of years of health. Following the same logic as before, we averaged the annual discount rate for each participant to obtain an individual measure of impatience, where a positive value represents favoring the present, 0 time-insensitivity, and a negative value favoring the future.

As expected, participants discounted value across time and favored the present; they required that Prize B was on average 71.65% more valuable than Prize A in order to perceive it as equally attractive. Regarding language, participants discounted value to the same degree in their native and foreign language: $t(338) = -0.71$, $p = .48$; $M_{Native} = 74.51\%$, $SD_{Native} = 70.10$; $M_{Foreign} = 68.98\%$, $SD_{Foreign} = 73.33$ (see Fig. 1B). So, when the same elicitation procedure is used for money, it leads to the same consistent results obtained in Experiments 1 and 2. Foreign language use affects intertemporal choices for health, but not money.

General Discussion

Foreign language effects in judgment and decision-making have been documented in a variety of contexts. Foreign language use affects risky decision-making (Costa, Foucart, Arnon, et al., 2014; Gao, Zika, Rogers, & Thierry, 2015; Keysar et al., 2012), judgments of

benefits and causality (Díaz-Lago & Matute, 2018; Hadjichristidis, Geipel, & Savadori, 2015), magical thinking (Hadjichristidis, Geipel, & Surian, 2017), and decisions about moral dilemmas (Corey et al., 2017; Costa et al., 2018; Costa, Foucart, Hayakawa, et al., 2014; Geipel, Hadjichristidis, & Surian, 2015). Here, we explored the effect of foreign language use on people's intertemporal preferences for money (Experiments 1, 2, & 4) and health (Experiment 3).

Results revealed that foreign language use does not affect monetary intertemporal choices. The consistency of the results, diversity of the methods applied, and high power of each of the experiments led us to conclude that monetary temporal preferences are not affected by foreign language use in a substantial way. In contrast, people were less impatient in a foreign language when making intertemporal choices regarding their health (Experiment 3). The foreign language effect is mostly present in decision-making contexts where emotion plays a causal role in shaping people's decisions, and we posit that the divergence between these two contexts relies on the higher emotionality of the health domain. However, this account is still open for direct testing in future research.

Monetary intertemporal choices have been conceptualized as belonging to a class of decision-making tendencies that are the product of an inhibitory failure (Stanovich, 2011). In other words, a preference to receive a payoff here-and-now rather than a greater one later is conceived as an inability to override the present-based temptation. Decision-making tendencies posited to belong to the same class by Stanovich (2011) are also unaffected by the use of a

foreign language, such as the outcome bias and the representativeness heuristic (Vives, Aparici, & Costa, 2018). Although processing a foreign language is more costly than a native one (Hasegawa et al., 2002), it seems that once a certain level of proficiency is achieved, its processing does not impair or benefit cognitive processes arguably related to inhibitory function. This might be relevant more generally for language control theories and how they overlap with cognitive control (Calabria, Costa, Green, & Abutalebi, 2018).

However, once the foreign language effect was tested in a more emotionally laden context, it did affect people's temporal preferences. The fact that we find an effect in health but not money goes in line with previous work suggesting that intertemporal choices in these domains might depend on different mechanisms. This argument is based on the finding that people's discount rate in one domain is not significantly correlated with their discount rate in the other domain (Chapman, 1996), and the discount rate is usually higher for health than money (Hardisty & Weber, 2009), a result that we also replicated. Moreover, our results suggest that health intertemporal choices might rely to some extent on language-dependent processes. Further research could elucidate to what degree this is the case. A potential alternative would be that in a native language people experienced a higher emotionality when reading the illness description. This then had a long-lasting impact on people's intertemporal choices, an impact that was reduced in a foreign language because the emotionality elicited by the illness description was lower. Further research could shed light on this alternative explanation.

Emotion is thought to be the key component driving the foreign language effect. This account relies mainly on an inverse inference with the following two premises: 1) most of the effects are present in relatively emotional contexts, and 2) once emotionality is not present in the context, almost no foreign language effects are found. However, no direct test in the form of correlating physiological measurements of emotion and the degree to which a foreign language effect is present has been performed yet. Until then, questions can be raised—another component, unidentified as of now, could be driving the effect. This issue is not addressed by the work presented here, neither do we provide direct evidence that the health domain was more emotional than the monetary one. Our focus was more descriptive—to establish whether there was an effect or not—than mechanistic. Further research could address this shortcoming by directly testing the posited relationship.

Finally, the foreign language effect in the health domain opens a new avenue for research with potentially important real-life consequences. Future work could elucidate to what extent other health decisions, such as choosing to undergo a certain treatment or screening, are affected by the language in which the information is presented. If this line of research produces clear effects, it will mean that daily foreign language users, such as immigrants, might make important health decisions that are affected by the language in use. Translations and interpreters seem crucial in order to avoid these unintended contextual effects.

As more and more evidence accumulates, policymakers and institutions need to realize that mastering a language will not be

enough to prevent possible side effects of processing a foreign language on other cognitive processes, such as memory, moral judgments, or decision-making. In a globalized world where people know on average more than one language, a complete understanding of how this affects decisions seems crucial, since it might have an impact on people's lives, not only here-and-now, but also later in time.

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3. CHAPTER III – Foreign language undermines affect labeling

Vives, M.-L., Costumero, V., Ávila, C., & Costa, A. (*submitted*). Foreign language undermines affect labeling. *Nature Neuroscience*.

Foreign language undermines affect labeling

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Abstract

Affect labeling reduces amygdala activation. It is unknown whether doing so in a foreign language has the same effect. We found that affect labeling in a foreign language increased amygdala activation in contrast with affect labeling in the native language. Foreign language undermines affect labeling, suggesting that words might need first to evoke an affective response in order to reduce people's emotions.

Keywords. Affect labeling. Foreign language. Bilingualism. Emotions.

Communicating our thoughts and emotions helps organizing our experiences while finding consolation from our peers. At the same

time, it regulates own's physiological arousal. Previous research shows that labeling emotions, even in the absence of social interactions, decreases known markers of physiological arousal, such as amygdala activation and skin conductance[1–3]. Furthermore, the beneficial effect of exposing people to their fears is enhanced when patients label their emotions[4]. Thus, the reduction of emotionality when labeling emotions appears to be robust in a native language (see Torre and Lieberman for a review[5]). But, in daily life bilinguals not only communicate in their native language; they also do it in their foreign one. Foreign languages tend to be more cognitively taxing and less emotional[6], thus, it remains unclear whether affect labeling would have the same effect in a foreign language or the characteristics of foreign language processing will interfere with affect labeling.

Psychological therapy led to the observation that bilinguals sometimes make a strategic use of their languages. Freud reported that certain patients would switch to a foreign language once the exchange became too emotional for them to handle[7]. Following this notion, Marcos posited the so-called detachment effect, that is, the phenomenon by which people feel detached from themselves when expressing their feelings in a foreign language[8]. This accords with mounting evidence showing that a foreign language is less emotional than the native one. Simply put, a foreign language is understood, but it is not felt—or it is felt less[9–11].

Intuitively, expressing one's feelings in a foreign language can be used as a "barrier" to emotionally distance oneself from the situation. Thus, it might be adaptive to switch and communicate in

one's foreign language if the goal were to reduce emotionality. We posited this as the *regulatory enhancement hypothesis*[12]. Indeed, tentative work shows that a foreign language reduces the physiological arousal created by a potentially threatening situation. Specifically, people instructed in a foreign language of the association between a stimulus and an electric shock were less conditioned than people instructed in their native language[12].

Previous evidence suggests that a foreign language protects people from aversive conditioning. However, there is an alternative interpretation. Namely, that a foreign language does not protect people but rather has *less suggestive power*. Ultimately, it is not adaptive to be less conditioned when instructed from a potential threat. Thus, what might be lost is the power of words to cause cognitive changes; the power to persuade people—a lesson known in marketing research[13]. Furthermore, using a foreign language supposes a cognitive burden, leading to more recruitment of cognitive control areas[14]. This might impar people's capacity to downregulate their emotions. Therefore, expressing emotions in a foreign language might not reduce emotionality. We posited this as the *regulatory detrimental hypothesis*.

Here, we contrast the enhancement and detrimental hypotheses by asking participants to label emotional faces in their native or foreign languages while undergoing functional magnetic resonance imaging (fMRI). The regulatory enhancement hypothesis predicts a stronger reduction of amygdala activation when labeling emotions in a foreign language, while the detrimental hypothesis predicts that foreign language will not reduce amygdala activation.

We created a version of the affect labeling task[2] for bilinguals. Depending on the block, participants had to match two stimuli applying one out of four matching rules: 1) The affect labeling-match, where they had to match an emotional face with its linguistic label, 2) The gender-match, where they had to match a male or female face (depicting emotions) with its name-gendered label, 3) The affect-match, where they had to match an emotional face with another emotional face, and 4) The shape-match, where they had to match a shape with a shape. The first two matching rules were implemented in participants' native (Spanish) and foreign language (English), leading to six experimental conditions. Following previous work[2], the analyses were focused on investigate BOLD signal changes in amygdala region of interest (ROI; see Fig. 1A).

Behavioral results revealed that participants were similarly accurate in both languages for all tasks (all *ps* > .05). Then, we compared amygdala activation across conditions with the baseline neutral condition, that is, the shape-match task. As expected, all conditions in which emotional faces were presented showed a higher activation of the amygdala when contrasted with the shape-match task (all *ps* < .001). We then ran a repeated measures ANOVA for the right and left amygdala with the type of matching task—affective and gender label—, and the language used—native and foreign language—, as factors in the model.

First, neither type of matching nor language showed a main effect (all *ps* were > .05). However, we found a significant interaction between type of matching and language significant for the right amygdala: $F(1,25) = 8.91$, $p = .006$. The same interaction was close

to significant for the left amygdala: $F(1,25) = 3.62$, $p = .06$. We then ran post hoc comparisons only for the right amygdala (see Fig. 1B). Results revealed that in a foreign language activation was significantly higher for affect labeling than for gender labeling in that language: $t(25) = 3.06$; $p = .005$, that is, the opposite result obtained in previous research conducted in a native language[2]. The contrast between affect labeling in native and foreign language reveal a similar pattern: labeling emotions in a foreign language showed a greater amygdala activation: $t(25) = 2.60$; $p = .01$.

Regarding the specific contrasts for native language, we did not replicate the original finding of affect labeling reducing amygdala activation. That is, the contrast between affect labeling in the native language and gender-labeling in the same language was not significantly different: $t(25) = -.92$; $p = .36$. However, we replicated the original effect[1,2] when affect labeling was contrasted with emotional faces matching such as affect labeling this time did significantly reduce amygdala activation*:* $t(25) = -2.30$; $p = .03$. Importantly, activation was not significantly different between affect labeling in a foreign language and affective matching: $t(25) = 0.37$; $p = .71$. Further research could elucidate if the non-replication in a native language for the contrast between gender and affect labeling is directly related to the fact that participants had to use two languages during the experiment[15].

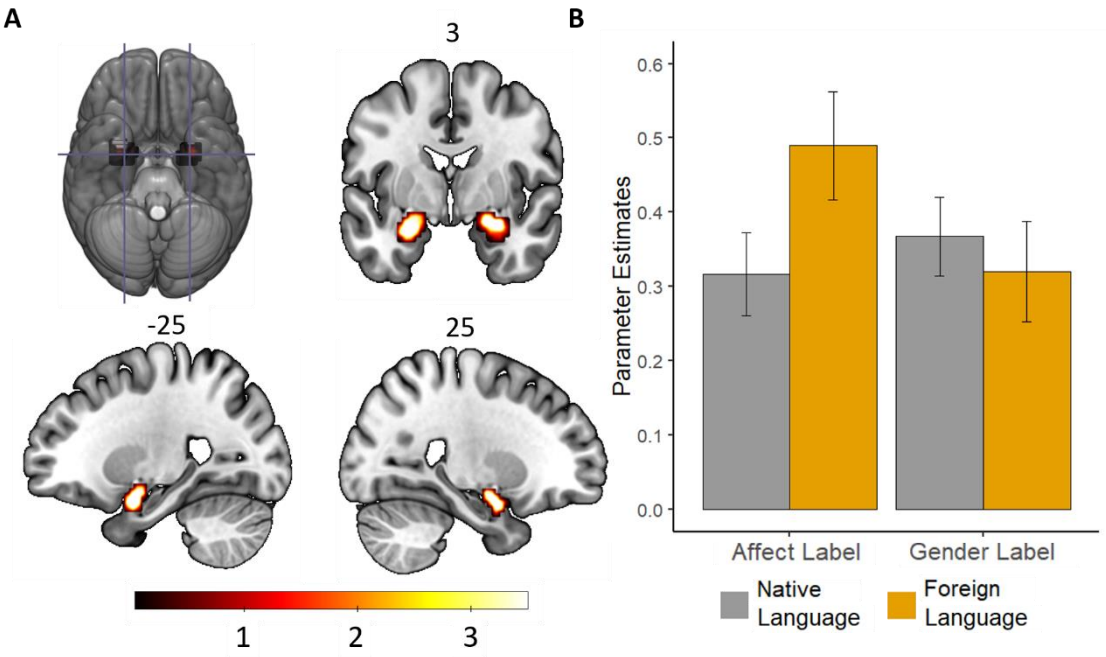

Fig. 1. A) Region of interest (ROI) was identified using affect-match condition as a localizer in contrast with the shape-match condition. Illustration depicts significant voxels within amygdala using the whole sample. Individual ROI masks were defined using Leave-one-subject-out cross validation method (see Statistical testing in the Method section). The color bar represents the t-value applicable to the image and the values above slices the MNI coordinate. **B)** Parameter estimates of the averaged activity for the amygdala ROI are depicted for affect and gender label split by language.

Expressing our emotions might help us cope with them. However, in line with the *regulatory detrimental hypothesis*, we observed that emotional labeling in a foreign language does not lead to a reduction of arousal. First, amygdala activation when labeling emotions in a foreign language was similar to the one observed during affective matching. Second, we even observed a higher amygdala activation when compared with the native language and gender labeling in a foreign language. Although these findings could

be interpreted as contradicting previous evidence[12], the regulatory detrimental account allows for a reconciliation of these findings. Specifically, affect labeling in a foreign language might not occur because of their lower suggestive power. This may be partly because some subtleties in word meaning for any given language are lost to non-native speakers. If anything, semantic processing in a foreign language might induce enhanced arousal generally due to greater effort and uncertainty inherent to dealing with a language other than the native one.

Although there is cumulative evidence suggesting that affect labeling does induce a reduction of emotionality, its mechanisms remain unknown (see Torre and Lieberman for a current review on the alternative accounts[5]). The degree to which these accounts can explain our findings is a good test for their validity. The work presented here suggests that a potential factor that these accounts should consider is the necessity for the words used during affect labeling to actually evoke affective reactions. In other words, if one cannot feel it, using those words might not alleviate one's emotions. For instance, swearing usually happens in high-arousing moments as a regulatory mechanism, and any bilingual speaker knows that when that happens, nothing feels as good as the mother tongue.

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Methods

Participants. We selected participants from the Center for Brain and Cognition database. Thirty participants were recruited. Four participants were excluded, one due to incidental findings in MRI images and three due to excessive head movements (more than 2 mm/degrees in any of the six directions). After exclusions, we analyzed data from 26 participants (*M* age= 21.85, *SD* = 2.33, 65% women). Participants could not have lived more than 12 months in an English-speaking country. 50% of participants presented an intermediate level of English and 50% a high level (certified from Cambridge English Qualifications). All participants started learning the language at school, after the age of 5 years. Participants gave written consent before partaking in the study, which was approved by the local ethics committee CEIC Parc de Salut del Mar (Universitat Pompeu Fabra) and was in accordance with the Declaration of Helsinki.

Procedure and design. Participants were given detailed instructions of the task and responded to a practice trial before scanning. During the task, three stimuli were simultaneously presented on the screen[2]: one on the top, one on the left-center, and a parallel one on the right-center. In each trial, participants had to select which of the two stimuli, the right or the left one, matched the one on the top by pressing the corresponding remote control placed on their left or right hand. There were four matching rules participants had to follow: 1) The affect labeling-match, where the rule was to match an emotional face with its corresponding emotional label (angry, scared, happy, surprised), 2) The gender-match, where the rule was to match an emotional face with its corresponding gendered name; 3) The affect-match, where the rule was to match an emotional face with another face showing the same emotion and 4) The shape-match, where the rule was to match depictions of geometric shapes (square – square, triangle – triangle). Two versions were created for the affective label and gender match: one in participants' native language (Spanish) and another in their foreign language (English), leading to a total of six experimental conditions presented in a block design. Emotional faces were obtained from The NimStem Set of Facial Expressions[16]. Before each block, a phrase indicating to participants which rule they had to apply was presented for 2.5 seconds. Each block compromised 5 experimental trials (4 seconds each). After experimental trials, a white screen with a black fixation point was presented for 10 second. Overall, each block lasted 32.5 seconds and were presented three times in a pseudorandomized order. In total, the task lasted 9 minutes and 45 seconds.

Data acquisition. fMRI data were collected with a Philips Ingenia 3-Tesla. For each participant, we recorded 372 T2*-weighted gradient-echo echoplanar images (EPI, 46 slices, 3 × 3 × 3.1-mm resolution, no gap, interleaved order, matrix =76 x 76, TR=1600 ms, TE=35 ms, flip angle=70°). Slices were aligned parallel to orbitofrontal cortex and covered the whole brain. In addition, a high-resolution T1-weighted image was acquired (190 sagittal slices, 1 mm thickness, RT=9.8 ms, TE=3.52 ms, flip angle=8°, matrix =240 x 240).

fMRI preprocessing. Image processing was carried out using SPM12 (Wellcome Trust Center for Neuroimaging, London, UK). Preprocessing functional scans included realignment to correct for motion-related artifacts, spatial normalization after extracting normalization parameters from the segmentation of each participant's high-resolution anatomical acquisition and smoothing with an 8-mm (FWHM) Gaussian kernel.

Univariate analyses of sample-related activity. We used general linear model as implemented in SPM12 to perform within subject fMRI analyses[17]. The model included separate regressors for each of the six experimental conditions which were convolved with the canonical hemodynamic response function. The estimated head motion parameters were also included. Data were high pass filtered (128 s) and temporal autocorrelation was controlled by an AR(1) process. Contrast estimates were computed by subtracting shape matching condition from the other conditions to control for the general effect of matching.

Statistical testing. Given the hypothesis of the study, group analyses were focused on investigate BOLD signal changes in amygdala ROIs. Following the study of Lieberman et al.[2], amygdala ROIs were performed using affect-matching condition as functional localizer. Specifically, we performed a whole-brain one sample t test for the affect-matching - shape matching contrast at a threshold of $p<0.05$ FWE corrected at cluster-level, using voxel-level primary threshold of $p<0.001$ uncorrected (see supplementary results). Then, the resulting spatial map of significant results was masked with the left and right amygdala templates from the Anatomical Automatic Labeling atlas[18] to determine amygdala voxels responding to emotionally evocative stimuli. Finally, the averaged activity within these amygdala voxels (left and right separately) was calculated for each contrast comparing labeling condition with shape-matching condition. Leave-one-subject-out cross validation method was used to avoid possible non-independence bias[19]. Subsequent analyses were performed in R, v .3.5.1. These analyses consisted in two-way repeated measures ANOVA including condition (affect labeling and gender labeling) and language (L1 and L2) as factors. Equivalent analyses performed in SPM12 to investigate whole brain voxel-wise main effects and interaction effects of the previously described ANOVA are reported in supplementary results.

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5. GENERAL DISCUSSION

5.1 The facts

Maribel went to the bank to decide how to invest her money. She was given the last outcomes of her portfolio and planned accordingly. Investment plans differed in their interest rate and in the time she had to wait to obtain profits. Patient as she is, she maximized the interest rate against time. Right after, Maribel had a doctor appointment—she had been feeling under the weather lately. The doctor offered her two options: 1) Drug A, which would immediately recover her full health, but with a high likelihood of suffering a relapse after a year, and 2) Drug B, which would take a year to have an effect, but without the danger of suffering a relapse. After choosing Drug A—she could not bear the headache any longer—, she went to hang out with her friends. She has been waiting all week to explain how miserable and helpless she had felt because of the illness.

As it happens, Maribel is an unbalanced bilingual; she could have used any of her two languages during her busy day. Which situations would have been significantly different, had she used her native or her foreign language? Luckily, we now have the beginning of an answer.

Maribel is safe at the bank—at least in relation to language. According to the results in the first chapter (Vives, Aparici, & Costa, 2018), evaluations of outcomes are independent of the language in use. Specifically, people were equally affected by the outcome bias in their native and foreign language (Experiments 1a, 1b and 1c). Although at first glance outcome evaluation might not seem the most

neutral context - emotions are involved when receiving outcomes (De Martino, Camerer, & Adolphs, 2010) - the notion that a bad outcome is generally the result of a bad decision, that is, outcome bias, needs not be caused by emotion *per se*. So far, no direct test has been provided for emotions as the cause of outcome bias. This bias has been classically related to cognitive bias rather than being directly caused by emotions (Baron & Hershey, 1988). Tentatively, the lack of a foreign language effect could be interpreted as evidence against the notion that outcome bias is related to emotionality.

Furthermore, in the first chapter, we found that people rely on the representativeness heuristic to the same degree in foreign and native languages, as indexed by participants' accuracy in the conjunction and base-rate neglect fallacy (Chapter I; Experiments 2a, 2b, and 2c). Thus, had Maribel judged probabilities for her investments, she would have relied on heuristics to the same degree in both languages. Regarding the choice between different investment plans, which belongs to the family of intertemporal choices, the second chapter indicates that foreign language would not have had an effect either (Chapter II; Experiments 1, 2, and 4). We found in three experiments that people favored the present over the future to the same degree in both languages in the money domain. Thus, as long as bank maintains its emotional neutrality, a condition certainly not always met, and decisions are not directly related to risk-taking attitudes (Costa, Foucart, Arnon, Aparici, & Apesteguia, 2014; Keysar, Hayakawa, & An, 2012; but see Hayakawa, Lau, Holtzmann, Costa, & Keysar, 2018), Maribel's choices regarding her

portfolio would not have been different had she used her native or foreign language.

However, things change at the doctor's office. Although monetary intertemporal choices were unaffected by language, foreign language processing changed people's intertemporal choices when in the health domain (Chapter II; Experiment 3). People were more patient in their foreign language than in their native one. Thus, the likelihood of Maribel opting for the more-future oriented option (Drug B) is higher if she communicates with her doctor in a foreign language than in her native one. This, of course, has relevant implications for society, given the number of immigrants who communicate in their foreign language with their doctors. Generally, what we have established is: 1) It is unlikely that there is a foreign language effect on intertemporal choices for money, and 2) Were there to be a foreign language effect on intertemporal choices, health, and possibly other emotional domains, are the most likely candidates to be affected by it. As much of a platitude as it might sound, more research is needed in order to establish that processing a foreign language causes an increase in patience for intertemporal choices related to health.

Finally, it is unknown whether Maribel would have enjoyed her time with friends to the same degree had she used one language or the other—perhaps a question worth exploring. But, thanks to the third chapter, we can shed some light on whether labeling one's emotions is equally helpful in a native and a foreign language. According to previous research (Hariri et al., 2000; Lieberman et al., 2007), affect labeling, that is, the process by which one linguistically

identifies an emotion, helps regulating emotionality. Specifically, it reduces amygdala activation (see Torre & Lieberman, 2018 for a review).

However, we find that labeling emotions in a foreign language does not reduce emotional arousal. Specifically, affect labeling in a foreign language generated a similar amygdala activation as matching emotional faces, contrary to previous results obtained in a native language (Lieberman et al., 2007). In the same vein, amygdala activation was significantly higher for affect labeling in a foreign language than for gender matching in the same language. The same result was obtained when amygdala activation was contrasted with affect labeling in a native language. Thus, affect labeling in a foreign language showed always a higher amygdala activation with any of its linguistically based counterparts. Overall, labeling emotions in a foreign language does not reduce emotional arousal.

Regarding the labeling of emotions in a native language, we did not replicate the original finding. This time affect labeling did not decrease amygdala activation in comparison with gender labeling. In contrast, we did replicate the finding of reduced amygdala activity during affect labeling when compared to face matching. Thus, there was a decrease in emotionality enforced by affect labeling in a native language, although it did not survive the strictest test—its comparison with gender labeling, also linguistically based.

Now, how would all this affect Maribel? First, expressing her feelings in a foreign language would not have reduced her arousal. If she does succeed in reducing her arousal, it will be because her

friends' comments prompted her to reappraise the situation, and not because of foreign language processing. Second, if she had switched back and forth between one language and the other; a common practice among certain bilinguals (and what participants did during the experiment) it might have impaired the downregulation of emotions in her native language. This is more speculative than anything; it was our explanation for not replicating the original effect in a native language. For instance, results might change among bilinguals who are used to switching back and forth between languages—an open empirical question. Thus, to avoid complications, Maribel should stick with her native language in order to reduce arousal. Overall, the mother tongue is at the same time the language that generates emotion and the language that succeeds at regulating them.

5.2 The story behind the facts

The storytelling of this dissertation has been: 1) we are going to explore the foreign language effect in neutral contexts to tease apart which of the two hypotheses—the cognitive enhancement or the emotional decrease one—is more likely to be behind the foreign language effect, and 2) Once no effect of foreign language was found in neutral contexts (Chapter I), we discarded the cognitive enhancement account, opting to study foreign language effects in emotionally laden contexts (Chapters 2 and 3). Although at first glance this line of reasoning appeared valid to us, we critically fell into a fallacy in the first premise of the argument. It is critical because this fallacy led us down a specific path, namely, the one in premise

two. Had we realized that our conclusions drawn in the first chapter were flawed, perhaps we might have chosen another path.

The fallacy went as follows: we implied that the lack of evidence in favor of the cognitive enhancement hypothesis was evidence in favor of the emotional decrease hypothesis. This is the implicit assumption we followed in the entire chapter (Vives et al., 2018), an assumption that does not hold: proving or disproving one hypothesis does not automatically validate the alternative one that has not been tested. There might be alternative accounts for the foreign language effect that have not been considered yet. In this dissertation, we had a more descriptive-based approach than a theoretical one; we focused on exploring the limits and boundaries of the foreign language effect rather than testing its mechanism directly. This was our empirical approach for two main reasons.

The first reason concerned the complexity in measuring independently the two processes that were posited to be behind the foreign language effect, cognitive load and emotion. As hard as it already is to delineate which cognitive processes cause certain behaviors, it is even harder when there is no clear method to independently differentiate between those cognitive processes. Indeed, cognitive load and emotional arousal are classically measured using the same physiological methods: pupil dilation and skin conductance. Thus, because processing a foreign language has an influence on both emotions and cognitive load, it complex to disentangle which process is causing which variation in the measurement. Nonetheless, there is one method to address the conflation of both processes—at least that we could think of.

The method is to capture separately the variance caused by the higher cognitive load associated with foreign language processing and the variance caused by emotionality. In order to do so, a neutral language condition is needed. That condition can be used to compute the amount of variance associated with a higher cognitive load caused by foreign language processing. Then, when emotionality is added, and assuming additivity without crosstalk between cognitive load and emotionality—already a risky assumption (see Van Dillen & Derks, 2012)—, the new variance can be attributed to emotionality. Indeed, this was the logic followed by Palacios et al. (2018). They found that instructed aversive conditioning is reduced in a foreign language. To draw this conclusion, they measured participants' pupil dilations and contrasted a foreign language neutral condition with a foreign language emotional condition. And still, there is a problem with the interpretation of the results. They might have hit a ceiling in their measure. That is, pupil dilation and skin conductance have certain limits beyond which they cannot capture any differences—a pupil cannot get bigger and bigger. Taken together, both processes associated with foreign language processing, cognitive load and emotion, could lead to that ceiling. Consequently, the contrast between the neutral and emotional conditions is smaller in the foreign language than in the native one because of the ceiling, and because the neutral condition had already a higher pupil dilation in a foreign language because of the higher cognitive load. Thus, apart from using functional magnetic resonance imaging, and then running into the inverse inference problem (Poldrack, 2006), no method occurred to us in order to solve this issue.

The second reason is related to the first and probably caused the aforementioned fallacy. Aware of the complexity of the enterprise, we hoped to solve the question regarding the mechanism of the foreign language effect together with the study on the pervasiveness of the effect. That is, delineating the conditions in which there is—and isn't—a foreign language effect will be informative in relation to its mechanism as well. There is certainly nothing wrong with this argument—testing the predictions made by the available explanations is a classical procedure in science. The problem arrives when it precludes scientists from thinking about other theories. This certainly happened. Our descriptive efforts may have blinded us to other potential mechanisms behind the foreign language effect. This had critical consequences; it shaped the future experiments we considered to conduct. Here, I will try to suggest two new mechanisms, once more non-mutually exclusive, of the foreign language effect.

5.3 Alternative theories explaining the foregin language effect

a) Languages are context-encapsulated

The first thing bilinguals learn when meeting someone is the language they must speak with the interlocutor. The interlocutor is then automatically associated with that language (Blanco-Elorrieta & Pylkkänen, 2017). Those first interactions can have a long-lasting impact: the language in which the first interactions unfold will probably be the one used for the rest of the relationship, even if they can communicate in another language. Once the face-language link

is established, the struggle to speak in another language is real (Blanco-Elorrieta & Pylkkänen, 2017). Thus, languages are tied to people.

Critically, languages are also tied to contexts. Swearing is a clear example: once a situation recreates the conditions that prelude swearing, swearing usually comes in one's native language (Pinker, 2007). Another context that is deeply tied to language, this time as a cognitive process, is arithmetic; first learned in a native language and permanently associated with it (Marsh & Maki, 1976). This context encapsulation of a language might be related to the foreign language effect. It may be that the foreign language effect is present in contexts that are deeply tied to a specific language, that is, to the native language. In this case, the strangeness associated with using a foreign language in those contexts might slow people down—and may even cause a decrease in emotionality. Furthermore, memories associated with the context at hand might be less available when a language is being used unexpectedly in context given that memories are associated with the language in use—autobiographical memories are better recollected if the language during encoding matches the language during retrieval (Marian & Neisser, 2000) .

The encapsulation account makes two clear new predictions: 1) a foreign language effect will be present only when contexts have been tied to a language 2) a native language effect similar to the foreign language one could be found if the association previously established with the context was with the foreign language. The encapsulation account has not been empirically tested yet. However, it is still possible to evaluate the degree to which it predicts the

current findings. That is, are the contexts in which a foreign language effect has been found encapsulated with one's native language? Now, establishing if a context is strongly associated with a language already presupposes a problem, and we would not want to fool ourselves by going through the foreign language results without first defining which contexts are more likely to be encapsulated by language.

A very cautious assumption is that contexts in which early socialization is crucial will more likely be associated with the native language (e. g., swearing), mostly because of repetitive exposure between the two—the simplest rule to build an association. Following this logic, morality, the domain in which the most striking results in a foreign language were found (Costa, Foucart, Hayakawa, et al., 2014), is slowly acquired throughout infancy and teenagerhood (Kohlberg & Kramer, 1969) . This is adventurous, but how often did participants discuss issues related to morality in their foreign language before taking part in the study? Probably never, and when they found themselves in such a situation, perhaps their morality rules learned through socialization were less available (a very similar idea to the one stated by Geipel, Hadjichristidis, & Surian, 2015), and thus behavior vastly varied. Simply put, languages are tied to contexts, and when expectations are broken between the situation at hand and the language in use, judgments and decisions change.

Now, risk-taking is also affected by using a foreign language (Keysar et al., 2012), and it seems dubious to link risk-taking attitudes with early socialization and a native language. Nevertheless, the most replicated result regarding risk-attitudes has used the Asian-

disease dilemma, which considers a hypothetical scenario related to life and death, again, a topic that is probably hardly discussed in a foreign language. The foreign language effect on risk-attitudes regarding gambling are more questionable, with mixed results (Hayakawa et al., 2018). Thus, the encapsulation account could also predict the most robust risk-taking result.

As to the new results presented in this dissertation, they could also, albeit cautiously, be reconciled with the encapsulation account. In the first chapter, no foreign language effect was found; scenarios were mostly related to probability judgments and evaluation of outcomes, processes that one would think are more related to classroom settings—and that an undergraduate student at university has probably faced before in their foreign language as well. In the second chapter, a foreign language effect was found in intertemporal choices, but only for health, not for money. That health is more strongly linked to the native language than money seems reasonable enough. Finally, in the third chapter, affect labeling was undermined by foreign language processing. Expressing one's emotions is usually reserved for those we are closest to—in fact, people contact with different people when they need emotional support (Morelli, Ong, Makati, Jackson, & Zaki, 2017). Furthermore, it is sustained by the classical explanations of why a foreign language is less emotional, that is, the classical neutral setting in which the language is learned.

This is not to say that there is clear converging evidence in favor of the encapsulation account—there is not. For as long as the account will not be directly tested, it will remain just that, an alternative account. It is indeed relatively easy to come up with

alternative *post hoc* explanations. However, they are also necessary to move the field forward if they are later backed up with new experiments. In this case, the perfect test of the encapsulation account will be to find the same foreign language effect but this time in a native language when the context in which an effect is tested is originally linked with the foreign language. All this rests on a specific assumption—one shared across all the accounts given so far, which is that both languages create the same understanding of a situation. But, do unbalanced bilinguals truly *understand* the same in both languages?

b) Bilinguals share their semantic representation across languages: Don't they?

This dissertation started with the idea that understanding among unbalanced bilinguals was very similar independently of the language in use (third paragraph of the general introduction). This was based on a long-lasting notion held across bilingual models of language processing: the semantic network of bilinguals is shared across languages. The *only* difference in the bilingual experience is that semantic representations are connected to two mental lexicons, one for each language, rather than one (Kroll & de Groot, 1997; Kroll & Sholl, 1992). This makes intuitive sense; after all bilinguals understand each other even when they change languages back and forth. Empirical work shows, among other findings (see Francis, 2005 for a review) that 1) People are equally fast at making semantic comparisons between words within and between languages (Caramazza & Brones, 1980), 2) Facilitation in processing a word because a prior presentation of a semantic-related word, that is,

semantic priming, happens across languages, although to a lesser degree than within languages (de Groot & Nas, 1991), and 3) Brain regions activated when doing a semantic-task (e.g. Is this a word or a non-word?) is the same regardless of the language in use (Illes et al., 1999).

However, results are far from conclusive: they can easily be reconciled with a model in which semantic nodes are interconnected across languages. In fact, the observation that semantic priming is reduced across languages in comparison with within a language would perfectly fit this model. Furthermore, semantic judgments of the sort "is this a word or a non-word?" are related to knowledge about words, not about their *meaning*, which is the cornerstone of semantics. Moreover, providing evidence of shared activation across languages does not reveal anything about the nature of the representation: activation could be in the same region for both languages, yet reflect different representations.

Obviously, nobody would argue for a complete differentiation between languages at the semantic level. After all, a table is a table and it would be highly redundant to have a repetitive representation of each concept in a second, third, or fourth language. However, it does not automatically follow from this that there is a total overlap between the languages at the semantic level either. There might be special instantiations in which the representation of a concept is specifically linked to the language in which it was acquired, and people were socialized with. For instance, the prototype activated by the concept "guitar" in English, arguably related to rock and electric, is probably very different from that elicited by the same concept in

Spanish “guitarra”, perhaps more associated with acoustic and flamenco. Thus, cultural concepts are a critical example, a notion backed up with the finding that bilinguals process culturally related sentences more easily in the language associated with that culture than in their other language (Ellis et al., 2015). Nonetheless, few attempts have been made to assess how people’s conceptual representation changes depending on the language in use. Exceptionally, Borodkin and colleagues (2016) did assess bilinguals’ semantic networks in both languages. Results show that concepts are differently associated between them depending on the language in use. Specifically, the conceptual map was less complex when recreated in the foreign language than in the native language. Importantly, the relationship between concepts, a critical aspect of a semantic network (Rips, Smith, & Medin, 2012), is not the same in a native and a foreign language.

How all of this relates to the foreign language effect in judgments, decision-making and emotions is still unknown. It could even be argued that it is tangential to it. However, the study of how one’s semantic representation impacts people’s cognition is a promising avenue of research, with new significant contributions. For instance, it seems relatively established that perception of emotional faces heavily relies on how emotional concepts are semantically represented. That is, people who believe that sadness is similar to anger also tend to see a sad face as more similar to an angry face (Brooks & Freeman, 2018). Parallel to it, perhaps people who have a stronger dissimilarity between their semantic representation in a foreign language and a native one, thus indexing different

understanding between languages, are more likely to show a foreign language effect.

The foreign language effect opens a broader, almost philosophical question related to semantics as well. This concerns the actual definition of *understanding*. People do understand what love and dying mean in a foreign language, but perhaps only in a subtle way. What might be crucial for an actual understanding of those terms are the associations, memories and emotions that have been built across the years together with the language. Otherwise, understanding might be achieved, but only at the surface level. This could be related with the result in the third chapter. People were capable of labeling emotions in a foreign language, they had the surface level understanding, but it never accomplished the neural effect; perhaps because a foreign language does not allow for a more profound understanding.

5.4 The lack of theory and the replication crises: its negative effects for studying the foreign language effect

The foreign language effect was the byproduct of a multidisciplinary effort; a mix of linguists, decision-scientists, and cognitive psychologists, all together. When this happens, it is fundamental to be able to rely on theories and robust findings. Thus, one can start to explore the unexplored, not from scratch, but being certain of a series of findings as a result of previous years of work done by others in the field—on the shoulders of giants, as it is commonly said and attributed to Newton. As an example, if how a decision is reached in

a context is completely understood, then predicting how foreign language processing would modify that decision is substantially easier. In contrast, if our understanding of the decision process is scarce, predicting the impact of a foreign language is much more complicated. Following this logic, it is not surprising that the first effect ever reported of processing a foreign language on judgment and decision-making was in the Asian disease dilemma (Keysar et al., 2012), a classical, well-understood cognitive phenomenon (Tversky & Kahneman, 1981). This was continued by a replication and extension of the work by Costa and colleagues (2014), and the surprising effect on the moral domain (Corey et al., 2017; Costa, Foucart, Hayakawa, et al., 2014). After that first explosion, new significant results have been less common, with few exceptions (Díaz-Lago & Matute, 2018; Hadjichristidis et al., 2017; Hayakawa & Keysar, 2018). What has happened? The lack of theories in the field and replication crises might be a partial answer to the question.

The foreign language effect was first associated with two interconnected theories. These are the construal level theory (Trope & Liberman, 2010) and the cognitive disfluency one (Oppenheimer, 2008). The former argues that there is an association between psychological distance, that is, how distant a situation is from oneself, and how that situation is mentally construed in terms of its concreteness and abstraction. Specifically, the theory posits that the closer the situation is, the more concretely and detailed it is mentally construed (and vice versa). On the other hand, cognitive disfluency argues that people use the difficulty in which a given situation is processed as a proxy to decide how much deliberation the situation

requires. That is, people use the rule-of-thumb that as more disfluency is experienced, more deliberation is needed. Intuitively, both theories can be related to the foreign language effect. First, processing a foreign language increases psychological distance (Ivaz et al., 2016), which according to construal level theory, creates a more abstract construal of the situation. Second, processing a foreign language is more difficult, therefore more disfluent, which then will prompt people to deliberate more. Even more encouraging, both theories found effects that were equivalent to the foreign language one: distancing people from the situation, and making the situation more disfluent, both increased utilitarian judgments (Aguilar, Brussino, & Fernández-Dols, 2013; Spears, Fernández-Linsenbarth, Okan, Ruz, & González, 2018). Thus, the question was clear: were construal level theory and cognitive disfluency the answer to the origins of the foreign language effect?

We went on to test it empirically. Results were catastrophic, and not regarding the foreign language effect—we in fact never managed to apply a foreign language—, but for the struggle in replicating the original effects. We did not replicate the finding that a more disfluent type of letter causes higher estimates of distance between oneself and cities (Alter & Oppenheimer, 2008), nor that increasing one's psychological distance makes people think more abstractly—one of the claims of construal level theory. This led us to a dead end: if we are incapable of replicating the original finding, there is no reason to try a foreign language effect based on that finding. Furthermore, our original interest was not to refute any theory, which requires much more empirical work and effort. Thus,

it was unclear how we could make a meaningful contribution to the field, so we opted to drop the projects and move on. Needless to say, we were not very surprised to later find out new research casting doubts on important findings based on both theories (see Meyer et al., 2015 for a non-replication of an effecte based on cognitive disfluency; see Trautmann, 2019 for a non-replication of an effect based on construal level theory).

We faced the same problem with other findings, although not directly related to a general theory. First, it was found that the hot-hand fallacy was influenced by whether people believed that the agent creating the streak of outcome was intentional (Caruso, Waytz, & Epley, 2010). We could not replicate it. Second, it was found that people, theoretically out of disgust, drank less chocolate milk while watching a video of an incest relationship in comparison with the same video when it was described as a regular old—young relationship (Chan, Van Boven, Andrade, & Ariely, 2014). We could not replicate this either. The replication crisis preludes the creation of new knowledge.

Looking back at the empirical work that finally took the form of a publication, it is probably not surprising that it was based on classical work, arguably some of the most reliable phenomena in cognitive science: the outcome bias (Baron & Hershey, 1988), the conjunction fallacy (Amos Tversky & Kahneman, 1983), the base-rate neglect (Bar-Hillel, 1980), and time discounting (G. Loewenstein et al., 2002)—all of which are effects that we replicated. Even the phenomena in which we based the third chapter, affect labeling, which based on functional imaging results, and arguably

with less evidence, has been replicated several times (Torre & Lieberman, 2018).

Probably due to these preliminary struggles, we started arguing that the best foreign language experiment would be one that could answer two questions at once: 1) Assess whether a foreign language effect is present 2) Even if it is not, answer a meaningful psychological question. This was the ideology we have tried to follow in the past years; looking for collaborators that direct us where our knowledge was scarce. We probably never managed to accomplish running an experiment that met the two criteria we had in mind—the closer we came to this was in the third chapter. As an amendment, what follows are two general proposals in which testing a foreign language effect could inform general aspects related to psychology.

The first one is related to the theory of construed emotion (Barrett, 2017). This theory postulates that emotional concepts are a cornerstone of people's emotions. Thus, an emotion is not experienced fully until it is conceptually identified. It is only when this happens, when all the memories associated with the concept color the experience that people end up identifying it as emotional. The degree to which the theory is supported by experimental findings is beyond the scope of this discussion—currently, a hot-topic issue in the field. Nevertheless, foreign language may constitute a good test for it, if we link it with the notion that semantic networks may vary across a native and a foreign language. Showing that the semantic representation of emotional concepts is different across languages, and that because of this, there is a significant change in how people

experience emotion depending on the language context, would be strong evidence in favor of the theory of construed emotion.

The second one is related to the impact of integral emotions during decision-making, that is, emotions elicited by the decision scenario that guide people's behavior. Proving that integral emotions cause certain decision-making tendencies is not a trivial task. The difficulty lies in showing a causal evidence beyond correlational work that link physiological measurements with actual decisions. Classically, patients have been the most used approach to make a causal link between a decision and an emotion (Bechara, Damasio, Tranel, & Damasio, 1997), with the problem that that supposes given that patients might have other cognitive functions impaired. Foreign language effects could be used to test the degree to which a decision-making tendency is the byproduct of integral emotions. Perhaps, it could be argued that finding a foreign language effect in a decision context can be interpreted as evidence of the impact of emotions in that context. This still supposes a risky reverse inference, but it might be worth exploring once the origins of the foreign language effect on judgments and decision-making are better understood.

5.5 What everyone knows but nobody says about the foreign language effect

We have briefly summarized how the replication crisis negatively affected the development of this work. One of the explanations of the replication crisis is the file-drawer effect (Simmons, Nelson, & Simonsohn, 2011), that is, leaving the negative results in the drawer, only publishing the positive ones. This process creates an

overestimation of the published results, since the evidence available is biased towards one end of the spectrum. The foreign language effect is very susceptible to the same problem for two reasons: 1) experiments are simple to conduct—translating materials to a foreign language is an easy manipulation, 2) because of the novelty of the field, there are a lot of avenues to make a meaningful contribution, that is, to run a lot of experiments. The file-drawer effect might be the other explanation for why there has been a downsize in the number of novel findings regarding the foreign language effect.

Although we tried to avoid the file-drawer effect—Chapter I is a published empirical paper with six experiments and no new significant results—the workload capacity we had during these four years made it impossible to transform all the empirical work into a publication. And with the commitment that it will eventually be completed; here is a quick overview of the studies we conducted over these years that have not seen the light yet.

We studied interactions using classical games from behavioral economics (Camerer, 2003). We did not find a clear pattern of a foreign language effect in the ultimatum game. Although we first found a significant effect, such as people accepting more unfair offers in a foreign language, this was not replicated later in a one-shot ultimatum game, so we concluded that the evidence was more in favor of a null effect of foreign language processing. Under the same ground, we also did not find a foreign language effect on the trust game (Berg, Dickhaut, & McCabe, 1995). Participants were endowed with 10€ and had to decide whether they wanted to trust some of their money to a partner. That money would then be quadrupled, and the

partner could decide to give some back or not. Results revealed that people trusted the same amount of money regardless of the language in use. Overall, foreign language processing did not seem to influence how people behaved in games. We also did not find an effect on cost-benefit analysis related to policy decisions. Finally, we tried to replicate the finding that foreign language processing promotes more healthy decisions for food (Klesse et al., 2015), with mixed, inconclusive results—a still ongoing line of research.

After all, the effect of foreign language on judgments, decision-making and emotions might not be as prominent as previously considered. Perhaps, it will never be possible to use it to nudge people towards the best-normative choice, as someone once dreamed of—and accused the author of this thesis of "*lack of imagination"* once all problems and difficulties in applying the idea were pointed to him. Perhaps it is pointless to switch to one's foreign language in the middle of an argument to try to cool down, as he also used to say. However, all of this is irrelevant when considering if one should learn more languages, because as he also used to say: "It is always better to learn more languages, so we can read more poets". And, as I hope we have learned from this dissertation, emotions are only ever truly transmitted in one's native language.

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7. ANNEX I: Supplementary Materials Chapter I

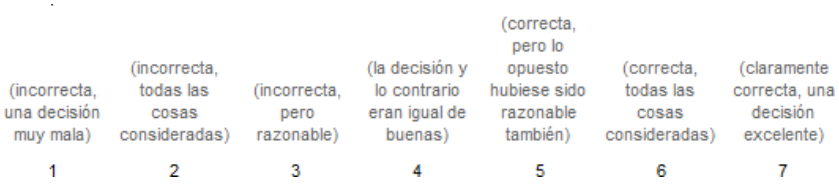
Experiments 1a & 1b

Participants read the following scenario (both conditions in Experiment 1a, only one condition in Experiment 1b) in either their native language (Spanish) or foreign language (English).

Spanish:

Un hombre de 55 años tenía una enfermedad de corazón. Tuvo que parar de trabajar por el dolor que le causaba. Le gustaba su trabajo y no quería parar. El dolor también le había afectado otros aspectos de la vida, como viajar y el ocio. Una operación en el corazón disminuiría su dolor e incrementaría su esperanza de vida de 65 años a 70. No obstante, un 8% de las personas que pasan la operación mueren por la propia operación. Su médico decidió realizar la operación. La operación falló y el hombre murió. (o La operación funcionó bien y el hombre se recuperó.)

Evalúa la decisión del doctor de llevar a cabo la operación en una escala del 1 (muy mala) al 7 (excelente).



English:

A 55-year-old man had a heart disease. He had to stop working because of the pain it caused him. He enjoyed his work and did not want to stop. His pain also interfered with other aspects of his life, such as travel and recreation. A heart operation would reduce his pain and increase his life expectancy from age 65 to age 70. However, 8% of the people who have this operation die from the operation itself. His doctor decided to do the operation. The operation failed, and the man died. (or the operation went well, and the man recovered).

Evaluate the doctor's decision to do the operation on a scale of 1 (very bad) to 7 (excellent):

(incorrecta, una decisión muy mala)	(incorrecta, todas las cosas consideradas)	(incorrecta, pero razonable)	(la decisión y lo contrario eran igual de buenas)	(correcta, pero lo opuesto hubiese sido razonable también)	(correcta, todas las cosas consideradas)	(claramente correcta, una decisión excelente)
1	2	3	4	5	6	7

Experiment 1c

Participants read the following scenario in either their native language (Spanish) or foreign language (English).

Spanish:

Imagina que quieres invertir 5,000€ y tienes que elegir entre dos brókeres, Bróker A y Bróker B. Una inversión exitosa significaría incrementar tus 5,000€ un 15% o más en un año. El Bróker A tiene un 43% de probabilidad de éxito, mientras el Bróker B tiene un 54%. ¿Qué Bróker elegirías?

English:

Imagine that you want to invest 5,000€ and you must choose between one of two brokers, Broker A and Broker B. A successful investment would mean to increase your 5,000€ investment by 15% or more within a year. Broker A has a 43% chance of success, while Broker B has a 54% chance. Which Broker would you choose?

Then, participants completed unrelated tasks for a period of 15 minutes, and after that they either given a positive outcome of their decision or a negative one, and asked to answer the following questions on a scale from 1 (not at all) to 7 (very much):

1. *Do you regret your decision?*
2. *Do you think your decision was a good decision?*
3. *Would you have preferred to choose the other option?*
4. *If you had again 5,000€, which broker would you choose*

now?

Experiment 2a

Participants read the following two scenarios in either their native language (Spanish) or foreign language (English). The order of presentation was counterbalanced between participants.

Spanish:

Escenario 1

Elisa tiene 31 años, es soltera y muy lista. Elisa tiene el grado de filosofía. Cuando era estudiante, Elisa estaba muy preocupada sobre problemas de discriminación y justicia social, y también participó en protestas antiglobalización.

Ordena los siguientes enunciados según su probabilidad de más a menos probable.

☐ *Elisa trabaja en un banco*

☐ *Elisa es activista del movimiento feminista*

☐ *Elisa trabaja en un banco y es activista del movimiento feminista*

Escenario 2

Se realizó una encuesta de salud a una muestra representativa de hombres adultos en Barcelona que incluía todas las edades y oficios. Marc fue incluido en la muestra. Fue seleccionado al azar de una lista de participantes.

¿Cuál de estos enunciados es más probable? Selecciona uno.

a. *Marc ha sufrido uno o más ataques al corazón*
b. *Marc ha sufrido uno o más ataques al corazón y tiene más de 55 años*

English:

Scenario 1

Elisa is 31 years old, single and very smart. She has a degree in philosophy. When she was a student, Elisa was concerned about issues of discrimination and social justice, and she participated in anti-globalization protests.

Order the following statements according to their probability from most to least probable:

☐ *Elisa works in a bank*

☐ *Elisa is active in the feminist movement*

☐ *Elisa works in a bank and is active in the feminist movement*

Scenario 2

A health questionnaire was carried out in a representative sample of male adults from Barcelona that included all ages and professions. Marc was included in the sample. He was randomly selected from a list of participants.

Which of these statements is the most probable? Select one.

a. *Marc has suffered one or more heart attacks*
b. *Marc has suffered one or more heart attacks and is more than 55 years old*

Experiment 2b

Participants read the following scenarios in either their native language (Spanish) or foreign language (English). The order of presentation was counterbalanced between participants.

Spanish:

Vas a leer tres descripciones de personas que participaron en estudios distintos. En cada caso tienes que leer cuidadosamente la información dada y decidir cuál de las dos opciones es más plausible.

Caso 1 (Incongruent)

100 personas participaron en este estudio. 90% eran abogados y 10% eran ingenieros. Javier fue uno de los participantes del estudio.

Javier tiene 36 años. No está casado y en cierto modo es introvertido. Le gusta pasar su tiempo libre leyendo ciencia ficción y escribiendo programas de ordenador. ¿Qué es lo más probable?

a. Javier es abogado
b. Javier es ingeniero

Caso 2 (Congruent)

100 personas participaron en este estudio. 90% tenían un tatuaje y 10% no tenían ninguno. José fue uno de los participantes del estudio.

José tiene 29 años. Ha pasado un corto período de tiempo en la cárcel. En este momento lleva 2 años viviendo por su cuenta. Tiene un coche antiguo y escucha música punk. ¿Qué es lo más probable?

a. José no tiene un tatuaje
b. José tiene un tatuaje

Caso 3 (Neutral)

100 personas participaron en este estudio. 90% tocaban la trompeta y 10% tocaban el saxofón. Toni fue uno de los participantes del estudio

Toni tiene 20 años. Está estudiando en Barcelona y está soltero. Se acaba de comprar un coche de segunda mano con sus ahorros. ¿Qué es lo más probable?

a. Toni toca la trompeta
b. Toni toca el saxofón

English:

You will read three descriptions of people who participated in different studies. In each case you have to read the information given carefully and decide which of the two options is most plausible.

Case 1 (Incongruent)

100 people participated in this study. 90% were lawyers and 10% were engineers. Jack was one of the participants of the study.

Jack is 36 years old. He is not married and is somewhat introverted. He likes to spend his free time reading science fiction and writing computer programs. What is most likely?

a. Jack is a lawyer
b. Jack is an engineer

Case 2 (Congruent)

100 people participated in this study. 90% had a tattoo and 10% had none. Jay was one of the participants of the study.

Jay is 29 years old. He has served a short time in prison. He has been living on his own for 2 years now. He has an old car and listens to punk music. What is most likely?

a. Jay has no tattoos

b. Jay has a tattoo

Case 3 (Neutral)

100 people participated in this study. 90% played the trumpet and 10% played the saxophone. Tom was one of the participants of the study.

Tom is 20 years old. He is studying in Barcelona and is single. He just bought a second- hand car with his savings. What is most likely?

a. Tom plays the trumpet

b. Tom plays the saxophone

Experiment 2c

Participants read the following four scenarios in either their native language(Spanish) or foreign language (English). Each participant saw one scenario from each condition (Neutral – Congruent; Neutral – Incongruent; Emotional – Congruent; Emotional – Incongruent). The order of presentation and the specific scenarios was counterbalanced between participants.

Spanish

Scenario Neutral A – Congruent

En una muestra de 1000 personas, 995 son atletas profesionales y 5 son doctores. Erica tiene 22 años. Se pasa la mayor parte de su tiempo entrenando y jugando a baloncesto.
¿Qué es más probable?

a) Erica es una atleta profesional.
b) Erica es doctora.

Scenario Neutral A – Incongruent

En una muestra de 1000 personas, 995 son doctores y 5 son atletas profesionales. Erica tiene 22 años. Se pasa la mayor parte de su tiempo entrenando y jugando a baloncesto.
¿Qué es más probable?

a) Erica es una atleta profesional.
b) Erica es doctora.

Scenario Neutral B – Congruent

En una muestra de 1000 personas, 995 son estudiantes de medicina y 5 son abogados. Juan tiene 25 años. Su sueño es convertirse un día en cirujano cardíaco. ¿Qué es más probable?

a) Juan es abogado.
b) Juan es estudiante de medicina.

Scenario Neutral B – Incongruent

En una muestra de 1000 personas, 995 son abogados y 5 son estudiantes de medicina. Juan tiene 25 años. Su sueño es

convertirse un día en cirujano cardíaco. ¿Qué es más probable?

a) Juan es abogado.

b) Juan es estudiante de medicina.

Scenario Emotional C – Congruent

En una muestra de 1000 personas, 995 tienen cáncer y 5 están sanos. Jessica está en la mitad de sus 40 y visita el hospital dos veces a la semana. ¿Qué es más probable?

a) Jessica tiene cáncer.

b) Jessica está sana.

Scenario Emotional C – Incongruent

En una muestra de 1000 personas, 995 están sanas y 5 tienen cáncer. Jessica está en la mitad de sus 40 y visita el hospital dos veces a la semana. ¿Qué es más probable?

a) Jessica tiene cáncer.

b) Jessica está sana.

Scenario Emotional D – Congruent

En una muestra de 1000 personas, 995 están sanos y 5 tienen anorexia. Hugo tiene 25 años, mide 1.82 metros y pesa 95 kg. ¿Qué es más probable?

a) Hugo tiene anorexia.

b) Hugo está sano.

Scenario Emotional D – Incongruent

En una muestra de 1000 personas, 995 tienen anorexia y 5 están sanos. Hugo tiene 25 años, mide 1.82 metros y pesa 95 kg. ¿Qué es más probable?

a) Hugo tiene anorexia.

b) Hugo está sano.

English

Scenario Neutral A – Congruent

In a sample of 1000 people, 995 are professional athletes and 5 are doctors. Erica is 22 years old. She spends most of her time

training and playing basketball. What is most likely? Erica is a professional athlete.

a) Erica is a doctor.

Scenario Neutral A – Incongruent

In a sample of 1000 people, 995 are doctors and 5 are professional athletes. Erica is 22 years old. She spends most of her time training and playing basketball. What is most likely?

a) Erica is a professional athlete.

b) Erica is a doctor.

Scenario Neutral B – Congruent

In a sample of 1000 people, 995 are medical students and 5 are lawyers. John is 25 years old. His dream is one day to become a heart surgeon. What is most likely?

a) John is a lawyer

b) John is a medical student.

Scenario Neutral B – Incongruent

In a sample of 1000 people, 995 are lawyers and 5 are medical students. John is 25 years old. His dream is one day to become a heart surgeon. What is most likely?

a) John is a lawyer.

b) John is a medical student.

Scenario Emotional C – Congruent

In a sample of 1000 people, 995 have cancer and 5 are healthy. Jessica is in her mid-40s and visits the hospital twice a week. What is most likely?

a) Jessica has cancer.

b) Jessica is healthy.

Scenario Emotional C – Incongruent

In a sample of 1000 people, 995 are healthy and 5 have cancer. Jessica is in her mid-40s and visits the hospital twice a week. What is most likely?

a) Jessica has cancer.

b) Jessica is healthy.

Scenario Emotional D – Congruent

In a sample of 1000 people, 995 are healthy and 5 have anorexia. Hugh is 25 years old,
1.82 m tall and weighs 95 kg. What is most likely?

a) Hugh has anorexia.

b) Hugh is healthy.

Scenario Emotional D – Incongruent

In a sample of 1000 people, 995 have anorexia and 5 are healthy. Hugh is 25 years old,
1.82 m tall and weighs 95 kg. What is most likely?

8. ANNEX II: Supplementary Materials and Results Chapter II

8.1 Supplementary Materials

English

Illness description Experiment 3

Because of your illness, you need to take medication once a day. You must also be very careful about what you eat, so you have to control your diet. You need to visit the bathroom quite often. You often feel tired and sometimes you suffer from insomnia and nightmares. In addition, your mouth feels dry, and food does not taste as it used to. You have lost the desire to have sexual relations. You frequently feel angry or irritated, and it is difficult to concentrate.

Spanish

Illness description Experiment 3

Debido a tu enfermedad, necesitas tomarte medicación una vez al día. También tienes que ser muy cuidadoso con lo que comes, así que tienes que controlar tu dieta. Necesitas ir al baño habitualmente. Te sientes cansado a menudo y a veces sufres insomnio y pesadillas. Además, sientes la boca seca y la comida no sabe cómo antes. Has perdido el deseo de mantener relaciones sexuales. Frecuentemente te sientes enfadado o irritado, y te es muy difícil concéntrate.

8.2 Supplementary Results

Experiment 3

Results for Experiment 3 can be decomposed by condition (Drug A's efficacy and Drug B's waiting time). Our original interest was to contrast people's general annual discount rate across native and foreign language, so we opted for averaging their discount rates across Drug A's efficacy and Drug B's waiting time, as it was previously done in Chapman (1996). Furthermore, we did not have any prediction on how the foreign language effect, if any, would interact with Drug A's efficacy and Drug B's waiting time. Anyway,

for a matter of completeness, we ran the full repeated measures ANOVA by language condition (2), Drug A's efficacy (4), and Drug B's waiting time (4). As expected, there was a significant effect of Drug A's efficacy: $F(3,1110) = 76.41$, $p < .001$, as well as a significant effect of Drug B's waiting time: $F(3,1110) = 80.10$, $p < .001$. In line with the result reported in Chapter II, language had a significant effect: $F(1,370) = 7.45$, $p = .006$. We did find however a significant three-way interaction between Drug A's efficacy, Drug B's waiting and language: $F(9,3330) = 4.77$, $p = .02$ (see Fig. S1).

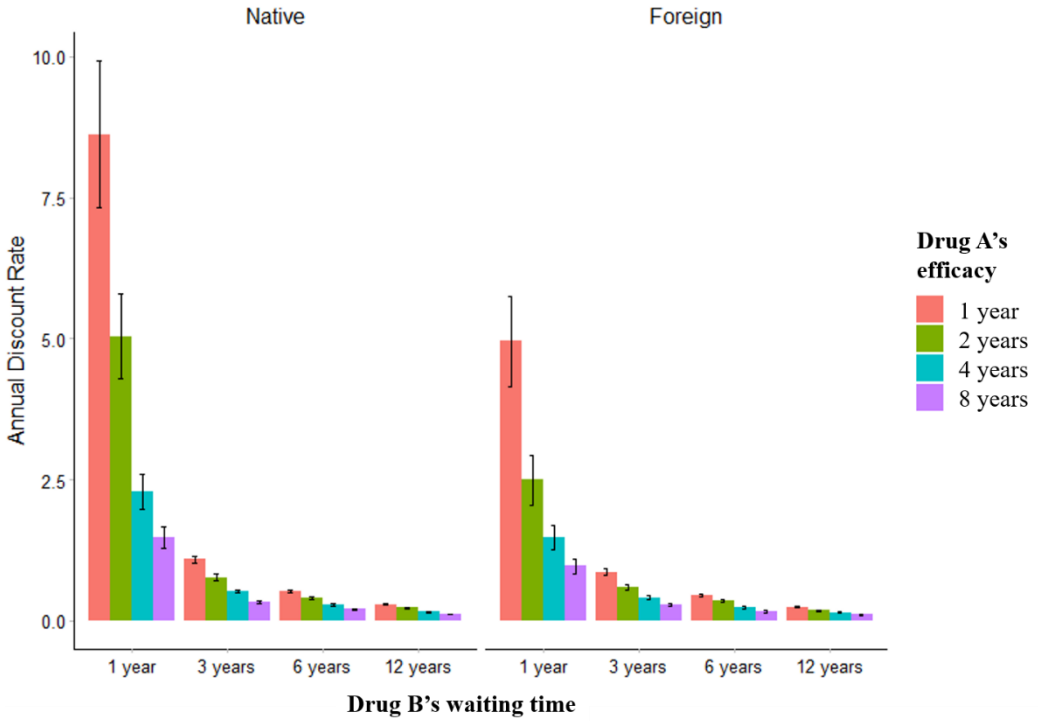


Fig. S1. Results of Experiment 3 (Health). Average participants' annual discount rate is depicted split by language, Drug A's efficacy and Drug B's waiting time.

9. ANNEX III: Supplementary Results Chapter III.

Table 1. Whole brain voxel-wise results.
Table show a summary of the significant results for each contrast of interest. We used a threshold of $p<0.05$ FWE corrected at cluster level, using a voxel level primary threshold of $p<0.001$ uncorrected.

Contrast affect matching > shape matching

Region	MNI coordinates			t value	K	Brodmann area
Occipital Inferior Left	-24	-88	-10	17.00	602	18
Occipital Inferior Right	30	-88	-1	15.13	889	18
Amygdala Right	21	-4	-16	7.52	356	-
Amygdala Left	-24	-1	-22	7.21	85	-
Frontal Middle Right	42	5	35	6.71	406	9
Calcarine Left	0	-73	8	6.30	268	23
Frontal Inferior Opercularis Left	-54	20	32	5.47	155	9

Contrast shape matching > affect matching

Region	MNI coordinates			t value	K	Brodmann area
Postcentral Right	27	-46	62	7.85	2593	5
Temporal Middle Right	54	-25	-7	7.81	75	22
Temporal Middle Left	-60	-61	-4	7.09	43	21
Occipital Superior Right	18	-85	20	7.03	114	19
Temporal Superior Left	-51	-37	17	6.52	700	13
Occipital Superior left	-18	-91	23	6.39	188	19
Frontal Medial Orbitofrontal Right	6	44	-1	6.21	375	32
Frontal Superior Left	-18	14	56	5.58	62	6
Frontal Middle Left	-36	32	44	5.12	88	9

Main effect Language: Contrast foreign language > native language

Region	MNI coordinates			t value	K	Brodmann area
Parietal Superior Right	30	-70	56	5.22	101	7
Frontal Middle Right	48	26	32	4.54	56	9

Main effect condition: Contrast gender labeling > affect labeling

Region	MNI coordinates			t value	K	Brodmann area
Angular Right	48	-70	29	8.31	281	39
Angular Left	-39	-67	35	5.67	271	39
Frontal Superior Right	24	29	53	5.24	112	8
Lingual Left	0	-79	-1	5.04	90	18
Frontal Middle Left	-33	23	50	5.00	95	8

Main effect condition: Contrast affect labeling > gender labeling

Region	MNI coordinates			t value	K	Brodmann area
Supplementary Motor Area Right	3	8	59	7.67	243	6
Frontal Inferior Triangularis right	42	26	2	6.02	357	47
Temporal Superior Right	48	-25	-1	3.85	89	22
Frontal Inferior Triangularis right	-33	26	-1	6.75	414	45
Thalamus Left	-6	-13	2	6.46	72	-
Occipital Middle Left	-30	-88	-1	6.40	271	18
Occipital Middle Right	27	-88	8	5.59	182	18

Interaction effect: Contrast affect labeling foreign language & gender labeling native language > affect labeling native language & gender labeling foreign language

Region	MNI coordinates			t value	K	Brodmann area
Paracentral Lobule Left	-15	-31	71	6.00	52	3
Cingulum Middle Left	0	-34	44	5.68	65	31
Cingulum Posterior Right	9	-40	23	4.95	135	23
Precuneus Left	-9	-73	41	4.05	52	7

10. ANNEX IV: On Language Processing Shaping Decision Making

Costa A, Vives M, Corey JD. On Language Processing Shaping Decision Making. Current Directions in Psychological Science. 2017;26(2):146-151. DOI: 10.1177/0963721416680263

11. ANNEX V: Does bilingualism really affect social flexibility?

Vives M, Repke L, Costa A. Does bilingualism really affect social flexibility? Bilingualism: Language and Cognition. 2018;21(5):952-956. DOI: 10.1017/S1366728918000123