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Prospective memory in bilinguals: Recalling future intentions in first and second language contexts

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Abstract

Recalling future intentions (i.e., prospective memory, PM) plays an essential role in everyday life, but sometimes, if the person is involved in a demanding ongoing task, PM is unsuccessful. This is especially relevant for bilinguals who, in many situations, have to recall intentions while performing a task in their second language (L2). Our aim was to explore whether PM is modulated by the linguistic context in which PM takes place. In this study, bilinguals performed a PM task in their first (L1) or second language (L2). We also manipulated the demands of the ongoing task (early/late updating) and the PM cue (focal/non-focal). In general, results showed an overall impairment in the recall of future intentions when the task was performed in L2. This impairment was especially evident in the more demanding conditions, suggesting that increments in attentional demands due to L2 processing hinder the processes required for prospective remembering.

1. Introduction

Daily, bilingual people confront the need to control their languages and also the challenge of having to perform many tasks in their second language. A large body of research suggests that bilinguals access information from their two languages even in situations where only one language is required (Blumenfeld & Marian, 2007; Dijkstra & Kroll, 2005; Hoshino & Thierry, 2011; Kroll, Dussias, Bice & Perrotti, 2015; Kroll & Stewart, 1994; Macizo, Bajo & Martín, 2010). As a result, bilinguals need to negotiate their languages to avoid competition and must select the more appropriate language for a given context (Morales, Gómez-Ariza & Bajo, 2013; Morales, Yudes, Gómez-Ariza & Bajo, 2015; Green & Abutalebi, 2013). This, in turn, influences language production and comprehension (Ma, Li & Guo, 2016; Pérez, Hansen & Bajo, 2019; Roessel, Schoel, Zimmermann & Stahlberg, 2019). Thus, there is a vast literature on second language (L2) reading comprehension indicating that bilinguals are less efficient and/or poorer comprehenders in their second than in their first language (L1; for a revision see Melby-Lervåg & Lervåg, 2014). Most of this literature has focused on exploring the underlying abilities related to reading comprehension such as word reading, vocabulary, and working memory (Droop & Verhoeven, 2003; Geva & Siegel, 2000; Lesaux, Koda, Siegel & Shanahan, 2006), but also high cognitive processes such as prediction or updating that may also determine the success and/or the cost of comprehending in L1 and L2 (Foucart, Romero-Rivas, Gort & Costa, 2016; Pérez et al., 2019). The results of the later studies suggest that the cognitive patterns shown in L2 discourse comprehension are similar to those shown in L1 comprehension, but that there are qualitative differences in the ERP components elicited by incongruent information, indicating extra processing in updating information in L2 comprehension (Foucart et al., 2016). In addition, Pérez et al. (2019) also found that differences in executive control differentially affected L1 and L2 text comprehension, with higher proactive control being predictive of L2 comprehension compared to the L1, which required a more balanced proactive/reactive control. Overall, these studies suggest that the ability to generate predictions, detect incongruences (i.e., monitoring comprehension), and update information to accommodate new information, is costlier in the L2 than in the L1.

Interestingly, research has also shown that encoding information in the L2 has effects that go beyond language processing in the purely linguistic sense (Bialystok, Dey, Sullivan & Sommers, 2020; Morales et al., 2015; Rosselli, Loewenstein, Curiel, Penate, Torres, Lang, Greig, Barker & Duara, 2019; Schroeder & Marian, 2014). For instance, it has been shown that decision making is modulated by the language in which people are reasoning (Costa, Foucart, Hayakawa, Aparici, Apesteguia, Heafner & Keysar, 2014; Costa, Corey, Hayakawa, Aparici, Vives & Keysar, 2019; Hayakawa, Costa, Foucart & Keysar, 2016; Hayakawa, Tannenbaum, Costa, Corey & Keysar, 2017). Explanations for these results include reductions in a) emotional responses (Costa et al., 2014), b) mental imagery or c) the access to episodic information when bilingual people work in a foreign language (Hayakawa & Keysar, 2018). Moreover, the impact of being bilingual has been reflected across other domains such as visual attention (Chabal & Marian, 2015), perception of multisensory emotions (Chen, Chung-Fat-Yim & Marian, 2022), and long-term memory (Marian, Bartolotti, van den Berg & Hayakawa, 2021). Consequently, given the implications of being bilingual on a high range of cognitive domains, we would expect that working in a L2 has an influence in a wide set of real-world phenomena. This idea is especially relevant if we think that people who speak more than one language constantly face different linguistic contexts that force them to use one language or the other (or even both at the same time) while they perform different tasks in day to day life. Therefore, it is relevant to explore how using a non-native language may modulate performance in different cognitive tasks that are also used in daily life.

In this regard, recalling future intentions plays an essential role in everyday experiences. Prospective memory (PM) allows us to create intentions and to execute them in the future. Many critical actions – such as taking medications at the proper time, getting to an appointment on time, doing the shopping when needed, or taking the cake out of the oven before it gets burned – depend on efficient PM functioning. In a PM task, participants are asked to carry out an ongoing activity (e.g., object naming) while maintaining the intention to perform a certain action (prospective intention) when they encounter a specific contextual cue (e.g., pressing a specific key on the keyboard when the object is of a specific colour). Thus, participants might receive instructions to name objects as they are presented on the screen (i.e., ONGOING TASK), and to remember to stop naming when the presented object is in a particular colour (e.g., the colour "red") in which case they have to press a specific key (i.e., PROSPECTIVE ACTION). Successfully remembering a prospective action involves monitoring the time or the context to perform the prospective task and switching from the ongoing task to the prospective task (Bisiacchi, Schiff, Ciccola & Kliegel, 2009; Scullin, Mullet, Einstein & McDaniel, 2015). Similarly, prediction, monitoring, and switching abilities are also engaged during language processing especially in bilingual situations (Beatty-Martínez, Navarro-Torres, Dussias, Bajo, Guzzardo Tamargo & Kroll, 2020; Martin, Thierry, Kuipers, Boutonnet, Foucart & Costa, 2013; Moreno, Bialystok, Wodniecka & Alain, 2010). Bilingual people must engage these abilities to choose the correct language in each situation (Declerck, Grainger, Koch & Philipp, 2017; Adamou & Shen, 2019). Thus, one might expect that the bilingual experience in monitoring and switching would modulate the cognitive processes that emerge during prospective remembering. In this line, López-Rojas, Rossi, Marful and Bajo (2022) found differences in prospective memory between bilinguals and monolinguals. Specifically, they explored how different bilingual experiences (i.e., age of acquisition and the linguistic context in which the bilingual was immersed) modulated the performance in a PM task and the neural correlates associated to prospective processing. Hence, participants with different linguistic history were asked to complete a PM task with prospective cues varying in distinctiveness (focal vs non-focal cues). Additionally, brain activity during the task was recorded to explore ERP components related to prospective recall (N300 and P3b). Differences in the wave amplitudes between ongoing and prospective trials in the N300 and P3b components have been associated to efficient monitoring and updating strategies (West, 2011). Results by López-Rojas et al. (2022) showed larger differences between the ongoing activity and the prospective intention in the N300 and P3b components for early bilinguals compared to late bilinguals or monolinguals, suggesting enhanced monitoring for early bilinguals. The fact that these differences were found in the more difficult PM conditions also suggest that early bilinguals adapted their monitoring processes to the requirements of the task. Similar ERP patterns – that is, ERP differences between ongoing activity and prospective intention depending on the monitoring capacities of the group – have also been found when comparing children, or older people with younger adults (Cejudo, López-Rojas, Gómez-Ariza & Bajo, 2022; Hering, Wild-Wall, Falkenstein, Gajewski, Zinke, Altgassen & Kliegel, 2020).

Hence, López-Rojas et al. (2022) showed how the bilingual experience influences prospective memory processes when bilinguals performed the PM task in their L1. However, they did not manipulate the language in which they completed the PM task, and therefore, they could not assess whether the differences were also modulated by whether the task was executed in the L1 or the L2. In the present study, we aimed to investigate possible differences between monolinguals and bilinguals when performing a PM task in different linguistic contexts. Our critical manipulation specifically assesses whether prospective remembering varies if it is performed in a L1 or L2 continuous task context. We argue that, given that L2 processing is costlier and more resource–consuming (Morishima, 2013; Pérez et al., 2019), when the PM task is carried out in the context of a L2 ongoing task, the bilingual capacity to dedicate executive control to monitor the environment for prospective cues and to switch from the ongoing task to the prospective intention might be compromised. At the moment, to the best of our knowledge, there are no studies exploring the influence of L2 processing during PM activities.

Therefore, the purpose of the current study is to explore how PM processes such as monitoring and switching are modulated when the ongoing task involves L1 or L2 processing. With this aim, we introduced an adapted version of the text comprehension task developed by Pérez, Cain, Castellanos, and Bajo (2015) as the ongoing task in the PM procedure. The aim of introducing this task was to manipulate the linguistic requirements of the ongoing activity. This task requires participants to read short narrative texts in which information can be congruent or incongruent with a previous generated inference. When incongruences are encountered, participants need to be able to monitor their comprehension by detecting the mismatch, and subsequently update the initial (but no longer plausible) interpretation, which can occur either early or late in the text, followed by comprehension questions about the texts. Previous experiments have shown that a late updating is more demanding than an early updating (Pérez et al., 2015, 2019), and therefore, this manipulation allows us to explore whether PM is affected by more difficult language conditions. Moreover, the purpose of using this comprehension task it is to resemble the rich and complex linguistic context in which bilinguals are immersed in their daily activities.

In addition, we manipulated the nature of the prospective memory task to vary its cognitive demands. Recent research suggests that the monitoring demands of the PM activity depend on the focality of the cue signaling the prospective task. Focal and non-focal cues differ in the extent to which processing of the cue engages the main features of the ongoing activity (Kliegel, Jäger & Phillips, 2008). For example, a focal condition may consist of participants receiving instruction to name the colour of objects as presented on the screen (ongoing task), and remember to stop naming when the presented object is in a particular colour

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(e.g., the colour "red") and instead, press a key. In this example, the item "heart" (that is red) is considered a focal cue because identifying the colour is involved in both the ongoing activity and processing of the prospective cue (colour red). In contrast, non-focal PM tasks refer to tasks where processing of the PM cues differ from the processing needed for the ongoing activity. In the previous example, if participants are asked to stop naming when the item on the screen belongs to a given category (e.g., parts of the human body), the category represents a non-focal cue, since the identification of a category differs from the ongoing activity (the colour naming task). This manipulation is theoretically important since it has been proposed that focal cues have higher probability of eliciting "spontaneous retrieval of the intention" without engagement of costly monitoring or retrieval processes (Einstein & McDaniel, 2005; McDaniel & Einstein, 2000; Scullin et al., 2015), whereas non-focal cues induce monitoring and costlier retrieval. In consequence, non-focal cues (compared to focal) require more attentional prospective resources resulting in more difficult and less accurate performance (Cona, Bisiacchi & Moscovitch, 2013; McDaniel, Umanath, Einstein & Waldum, 2015).

Similar to studies where the L2 modulated performance in linguistic and non-linguistic tasks (Costa et al., 2014; Foucart et al., 2016; Hayakawa & Keysar, 2018; Pérez et al., 2019), we expected that the language in which the prospective task is performed interacted with the focality of the PM task to modulate performance. Thus, we assumed that monitoring and switching would be more demanding in the L2 than in the L1.

In summary, the purpose of this experiment was to study possible changes in PM processes when the prospective task was performed in the context of an L1 or L2 ongoing task. To this end, monolinguals and bilinguals performed an event-based task in which the nature of the PM cue (focal vs. non-focal) and the linguistic requirements of the ongoing task (early updating vs. late updating) were manipulated. As mentioned, the manipulation of the cue focality (focal vs. non-focal) referred to the PM task, whereas manipulations of the language (L1 vs. L2) and updating conditions (early vs. late) referred to the ongoing task. We introduced additional baseline ongoing conditions in which the ongoing task was performed by itself (varying language and updating conditions) to be able to assess the cost associated with monitoring when the PM task has to be additionally performed. Thus, analyses of the task involve time and accuracy in the comprehension ongoing task as well as time and accuracy on the PM task. These analyses permit assessment of cue monitoring during the ongoing task, and cue detection and execution of the intention in PM trials. In addition, direct comparison between the ongoing trials (ON trial) and PM trials would allow us to assess switching processes. Note also that, by comparing monolinguals and bilinguals, and by having the bilingual participants perform the task in their L1 and L2, we were permitted: 1) to compare possible differences between monolinguals and bilinguals, and 2) to assess bilingual PM performance in L1 and L2 contexts. Also, since PM involves performance in the ongoing task (engaging context monitoring for cue detection), performance in the PM tasks (engaging cue detection, retrieval and implementation of the intention) and performance differences between ongoing and PM (engaging switching processes), we had specific predictions for each of these processes.

Regarding the ongoing comprehension task, we expected to observe better and faster performance when the ongoing task was performed by itself (baseline) compared to when participants performed the PM intention during the ongoing activity (focal and non-focal conditions). This effect would reflect the cost associated with cue monitoring, and we expected it to be larger for non-focal than focal condition. Additionally, we predicted this cost to also vary depending on the language and updating conditions. Specifically, we expected a greater comprehension cost when the updating requirements were introduced late in the text (Pérez et al., 2015, 2019), and more so when the task was performed in the L2. Overall, we anticipated that introducing cognitive demanding conditions, either in the ongoing comprehension tasks (late vs. early updating; and L2 vs. L1) or in the PM (focal and non-focal PM vs. baseline), would affect comprehension – with longer and less accurate performance in the more difficult conditions. Moreover, as long as bilinguals benefit by their context monitoring experience, we would expect better performance than their monolingual counterparts when they were both working in their L1 task.

With regard to the PM tasks, we expected better performance in the focal than in the non-focal trials due to the more demanding monitoring requirements of the non-focal cues (McDaniel & Einstein, 2000). We also predicted an interaction between cue focality and updating and language conditions, which should be reflected in slower and/or less accurate performance in the most difficult L2 non-focal-late updating condition. Regarding monolingual and bilingual comparisons in PM performance, we expected bilinguals to better adjust to the task demands and to reduce differences between the focal and non-focal conditions relative to the monolinguals (see Morales et al., 2013, 2015 for a similar conclusion in a different tasks).

Finally, regarding switching – that is, the comparison between the ongoing (ON) and PM trials – we expected an effect of cue focality, indicating that focal cues are more easily detected than non-focal cues (McDaniel et al., 2015), and an effect of language and updating, where the more demanding L2 language and late updating conditions would result in a costlier switching performance. Again, we expected differences between bilinguals and monolinguals if their language experience influences PM performance.

2. Methods

Participants

This study was approved by the Research Ethics Committee of the University of Granada (registration number, 2262/CEIH/2021). Sample size analysis (power = 90%, $\alpha = .05$) in G*power (Faul, Erdfelder, Lang & Buchner, 2007) revealed that a sample of 34 participants per group was enough to detect a large effect (Cohen's f effect = .40; Cohen, 1969) in an ANOVA with repeated measures and between/within interactions. In addition, similar studies on the field with a sample size of thirty (or fewer) participants per group (e.g., López-Rojas et al., 2022) have found medium to large effect sizes, which provides additional evidence for the selected sample size.

A total of 67 young adults from the University of Granada participated in this study and received course credits per participation (mean age = 22.87, SD = 3.59; mean years of education = 17.64, SD = 3.73). Of those, 35 were Spanish monolinguals and 32 Spanish-English bilinguals. Data from another 6 participants were also removed after data trimming (see analysis section). The study was disseminated by means of an institutional emailing list and the institutional online platform for experiments. All participants fulfilled the following criteria: 1) they were between 18-35 years old; 2) they had Spanish as a native language; 3) they reported normal or corrected-to-normal vision; 4) and they had no language disorders. Furthermore, monolinguals were explicitly required to have a very basic, almost null, level in any possible L2. Although they reported having enrolled in the mandatory English courses at school, they all reported being functionally monolinguals (Beatty-Martínez, Bruni, Bajo & Dussias, 2021; Perrotti, 2012), since they had not used English after high school (Granada is a very monolingual community where most people only speak/understand Spanish). In contrast, bilinguals were required to have at least a C1 level in English (corresponding to a proficient use of this language), and they reported to use English frequently in their daily life. Hence, both groups of participants differed extensively in their use of English (see Table 1). Whereas bilingual participants used English daily in different contexts, monolingual participants had a minimum exposure to it.

In addition, we verified participants' English self- informed proficiency by means of the Michigan English Language Institute College Entrance Test (MELICET). This test consisted of two exercises to assess English grammar through 50 cloze questions with three answer options. Higher scores in this test revealed an advanced knowledge of English grammar. For this reason, participants who obtained a direct score of 35≤ (out of 50) in this questionnaire were included in the bilingual group (32 participants). Those who scored 25 or less were classified as monolinguals (35 participants). Notice that this questionnaire was applied as a screening test – therefore, those potential participants with an intermediate level of English (scores between 26 to 34) did not qualify to participate in the study and were not invited to participate in the experiment. We also collected data from the LEAP-Q (Marian, Blumenfeld & Kaushanskaya, 2007) to obtain the history of language use of the bilinguals and monolinguals. The questionnaire consisted of a first section with questions related to the participant's linguistic history, such as listing the languages they know (even in a basic way), percentage of exposure to them, and preference for reading/speaking in each language. In a second section, questions regarding the use and exposure to their native language were presented. Both sections were completed by monolingual and bilingual participants in Spanish. Additionally, those participants who reported knowing a second language at an advanced level, and qualified as bilinguals in the MELICET test, were asked to complete the section about the use and exposure to their L2. That section was presented in English. Table 1 reports a summary of the average scores provided by bilinguals and monolinguals to relevant items from the questionnaire. Finally, a standard digit span task was used to ensure baseline working memory scores were comparable between groups (monolinguals: $M = 9.42$, $SD = 2.98$; bilinguals: $M = 10.82$; $SD = 2.54$; t $(59) = -1.95$; $p > .05$; $d = -0.51$). All participants gave written informed consent and filled out a sociodemographic questionnaire (e.g., age, illnesses, years of education, etc.). The two groups matched in their sociodemographic characteristics (all $p_s > .05$).

Design

We followed a factorial mixed design using Group (monolinguals vs. bilinguals) as a between subject factor and level of Prospective load (baseline vs. focal vs. non-focal), Updating (early vs. late), Focality (focal vs. non-focal) and Language (L1 vs. L2) as within subject factors. Since language was not completely crossed with all other variables (monolinguals could not perform the task in an unknown language), we performed analyses for monolinguals and bilinguals without considering language, and for L1 and L2 languages considering only the bilingual group.

Procedure and materials

The experimental procedure consisted of a first session of approximately 60 minutes where participants carried out first the MELICET and LEAP-Q (Marian et al., 2007). Later, they performed the PM task during text comprehension in the L1 and, finally, the digit span working memory task as a control measure. Additionally, in a second session, only for bilinguals, participants completed the PM task in the L2 text comprehension context. For these participants, the order of the two sessions was counterbalanced, to avoid undesirable order effects between the two language contexts. The study was programmed using Gorilla Experiment Builder (Anwyl-Irvine, Massonnié, Flitton, Kirkham & Evershed, 2020) and conducted online.

PM task during text comprehension

The text comprehension task was adapted from the situation model revision task used by Pérez et al. (2019; see Table 2). In each text, the first two sentences (Introduction) primed a specific inference (for example, the concept of "guitar"). Later, this inference was replaced with new information that required revising their initial interpretation and encoding an alternative inference (i.e., piano). This updating process might occur either in Sentence 3 (early updating) or in Sentence 4 (late updating). Results by Pérez et al. (2015, 2019) indicated that late updating produces slower and less accurate performance than early updating texts, and therefore, we used this manipulation to vary the linguistic difficulty of the ongoing task. For this task, we measured, first, the reading times for the complete text. Then, as each text was followed by a comprehension cloze question with three response options (participants were asked to respond by pressing the key corresponding to the correct option), we measured accuracy and response times to the question (see Figure 1). Hence, we assessed the following dependent variables for the ongoing text comprehension task: 1) text reading times; 2) accuracy and response times in the cloze question; 3) reading times in responding to the cloze question.

Across the short-texts, we manipulated the baseline and focal conditions. On the one hand, there was a baseline condition where the ongoing comprehension task was performed by itself, with no mention of PM instructions. Notice that this baseline condition permits us to assess performance in the ongoing task without the possible cost of PM instructions. On the other hand, there were two blocks where the PM task was introduced to the participants after explaining the ongoing comprehension task. The PM cue appeared exclusively at the end of six texts from the block (composed of a total of 30 texts) as part of the response options to the cloze comprehension questions (care was taken that across trials the PM appeared unpredictably in different points in the block). In the PM focal condition, participants were instructed to press a specific key whenever the words "necklace" or "bicycle" appeared among the three response options of the comprehension cloze question. These cues were considered focal because they were part of the features of the ongoing activity (identifying the correct word to answer the question) and thus, they were within the focus of attention of the participant. In the

Table 1. Mean score and standard deviations in questions about L1 and L2 from the LEAP-Q for the monolingual and bilingual group.

	L1 Monolinguals	L2 Monolinguals	L1 Bilinguals	L2 Bilinguals
Mean percentage of current exposure to the language	93%*	18%*	68%*	37%*
Mean percentage of preference to read in each language	94%*	14%*	58%*	40%*
Mean percentage of preference to speak in each language	93%*	13%*	67%*	29%*
Mean age of beginning acquisition (years)	0.78 (0.96)	-	0.50 (0.76)	5.76 (2.67)
Mean age of becoming fluent (years)	3.91 (1.40)	-	3.90 (1.95)	12.67 (4.27)
Mean level of self-competence (from 0–10)	9.61 (0.69)	-	9.80 (0.48)	8.50 (1.04)
Mean level of language exposure with family or friends (from 0–10)	9.83 (0.44)	-	9.27 (1.20)	2.14 (1.70)
Mean level of reading exposure (from 0–10)	9.15 (1.4)*	-	7.90 (2.12)*	7.92 (1.29)
Mean level of language exposure by TV or radio (from 0–10)	7.83 (2.95)*	-	5.80 (1.28)*	5.38 (3.61)
Mean level of language exposure by self-learning (from 0–10)	8.79 (1.82)*	-	5.90 (3.50)*	6.72 (2.97)

*Indicated significant differences ($p < .05$) between monolinguals and bilinguals group comparisons.

Table 2. Example of a text trial (late updating vs early updating). Each trial was composed of two introduction sentences, the third sentence with two types of sentences (congruent/incongruent) and the fourth sentence with two conditions of inference updating (non-updated/updated). Finally, a comprehension question with three answer options appeared.

	LATE UPDATING		EARLY UPDATING
SENTENCE 1 Introduction	Last year Bob started playing in a Jazz band.		
SENTENCE 2 Introduction	His musical instrument is golden and shiny, and it is played with the fingers.		
SENTENCE 3	Bob loves to practice along with the trumpeter while he plays his instrument.		Bob loves to practice playing the black and white keys of his instrument.
SENTENCE 4	This year Bob's band is giving a concert, so he must practice several hours a day playing the **piano**.		
QUESTION	Bob plays the _____.		
	saxophone	piano	clarinet

PM non-focal condition, participants were asked to press a specific key when a word belonging to the semantic category "profession" or "city" appeared among the response options. These cues were considered non-focal because the detection of the PM cues involved additional processing (semantic classification) that was not required for PM detection. It is important to remark that, for both focal and non-focal cues, participants were asked to interrupt the ongoing activity and execute the prospective intention by pressing a specific key which was different from the keys used to respond to the comprehension question. Performance in the PM task was assessed by accuracy scores and response times in the comprehension cloze questions were the prospective cues (i.e., the words necklace/bicycle or words belonging to "profession" or "city" categories) appeared among the response options; here they are termed "PM" because they correspond to the PM task. Trials in the comprehension cloze question that did not contain the prospective cues were termed ON trials (ongoing trials) and they were used for comparison with the PM trials to assess the cost of the disengaging from the ongoing linguistic task and switching to the PM task. Baseline, focal and non-focal block were counterbalanced across participants. Instructions were provided at the beginning of each block defining the PM conditions (baseline, focal and non-focal).

As stimulus materials, we used 150 experimental texts counterbalanced across the focality conditions and languages. Also, the texts rotated between updating conditions and type of trial (ongoing vs PM). Additionally, 3 practice trials were performed at the beginning of each condition.

Each trial started with a fixation point ('+') that remained on the screen until the participant pressed the space bar to see the first sentence. Sentences 1–4 were presented one sentence at a time, and participants were instructed to read each sentence at their own pace, pressing the space bar to display the next sentence. The positions of the correct answer or the prospective cue in the questions were randomized. Texts were printed in black and appeared centred on the screen in a white background. Both groups of participants performed the task in Spanish. In addition, the bilingual group performed the task in English. The order in which the bilingual participants performed the task was counterbalanced across sessions. The order in which bilingual participants carried out the task (first Spanish or first English) did not have an effect either in RTs or accuracy (all $p_s > .05$), so this variable was not considered in the following analyses. Finally, in order to control overall language abilities in the L1, we compared reading times to the first and second sentence (introduction) in the ongoing baseline block for both groups. Results indicated no significant differences between monolinguals and bilinguals (all $p_s > .05$).

Data analysis

Our results are organised into two broad sections: 1) comparison between monolinguals and bilinguals in the shared L1, and 2) comparison between the L1 and L2 contexts, only for the bilingual group. Within each of these sections, subsections referred to whether the comprehension ongoing task, the PM task, or an index for ON-PM switching, were considered.

Ongoing text comprehension

This was assessed by calculating reading times for each text and averaging them for updating (early and late) and PM (baseline,

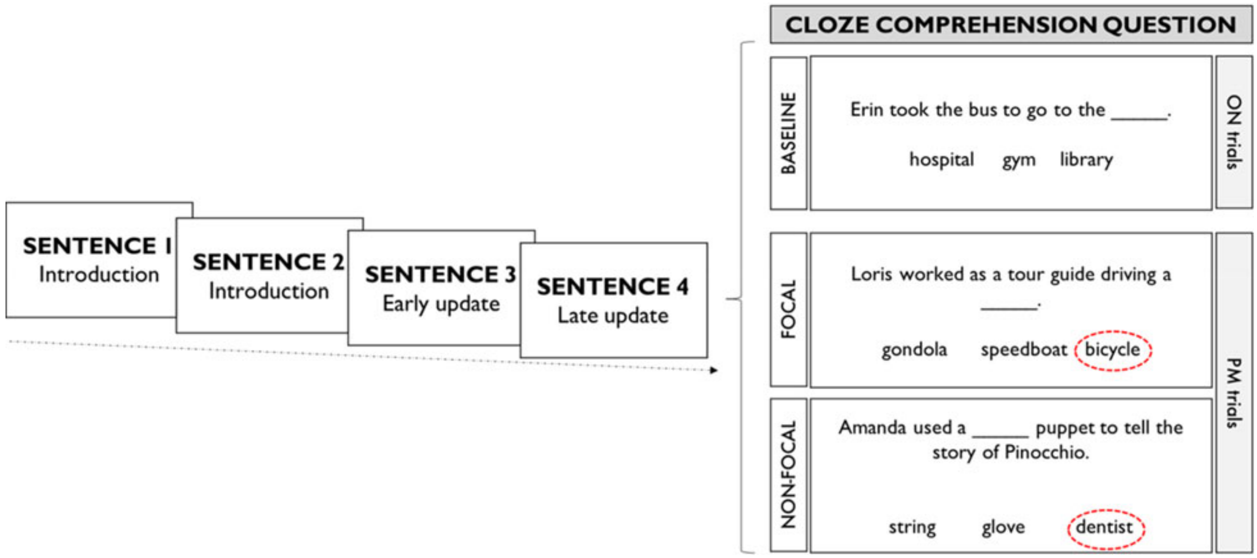

Fig. 1. Example of a cloze comprehension question (comprehension question and three response options) for each block: baseline, focal, and non-focal blocks. The baseline condition served as an ON trial. Whereas, the focal and the non-focal conditions were the PM trials in which a focal PM and a non-focal cue respectively, appeared between the response options (marked in red).

focal and non-focal condition). In addition, we calculated mean accuracy in and response times to the comprehension questions for ongoing trials as a function of conditions. Thus, for these measures, we averaged across trials defining the updating (early and late) and PM conditions (baseline, focal and non-focal) for each group in ON trials. Note that ON trials were cloze questions where the PM cue was not presented among the response options. In order to equate the number of PM and ON trials, we selected the ON trials that preceded PM trials. Thus, for each PM trial in the focality conditions (a total of 6), the previous ON trials (6) were considered for comparison (see Cejudo, Gómez-Ariza & Bajo, 2019, for a similar procedure).

PM performance

This was assessed by analysing response times and accuracy for PM trials in L1 for each focality condition and group (or L1/L2 language in bilinguals). For these analyses, averaging was done for PM trials (trials where the cloze questions contained the PM cue) and considering the updating (early vs late) and focality conditions (focal vs non-focal) for each group (monolingual vs bilingual) or language (L1 vs L1 condition in bilinguals).

ON-PM switching

This was assessed by the subtraction between ON and PM trials. In this third analysis, we aimed to explore the processes of monitoring and switching that take place during the implementation of the prospective intention. As mentioned, in order to equate the number of trials in the ON and PM condition, for these analyses we also selected the responses to the questions of the ON trials that appeared before the PM trials.

For all the analyses, data trimming was performed by removing participants with accuracy or response times greater than three times the interquartile range in the ON task for at least two levels of prospective load conditions. This resulted in the removal of two monolinguals and four bilinguals.

For simplicity, in the results section, we only included significant effects and interactions. In Appendix A, we detail all the statistics for significant and non-significant effects and interactions.

3. Results

Monolinguals vs Bilinguals in L1

Online text comprehension: Text reading times in ON trials

We averaged total reading times in the text per participants and condition and submitted them to a 3 × 2 × 2 mixed factorial ANOVA with Group (monolingual vs bilingual), Prospective load (baseline vs focal vs non-focal) and Updating (early vs late) as factors (for means and standard deviations per condition see Table 3A). The results of this analysis indicated that the main effect of group was marginally significant, $F(1,59) = 3.631$; $p = .062$; η_p^2 0.058, indicating that, in general and independently of the prospective load and updating condition, reading times in the bilingual group were faster ($M = 3159$, $SD = 968$) than in the monolingual group ($M = 3682$, $SD = 1474$).

Off-line text comprehension: Accuracy to the comprehension question

Averaged ON responses to the cloze questions in ongoing trials were submitted to a 3x2x2 mixed ANOVA with Group (monolingual vs bilingual), Prospective load (baseline vs focal vs and non-focal), and Updating (early vs late) as factors (see Table 3B). Results showed that the main effect of group was significant, $F(1,59) = 4.465$; $p < .05$; $\eta_p^2 = 0.070$, with greater accuracy in bilinguals ($M = .88$, $SD = .15$) than in monolinguals ($M = .82$, $SD = .19$). Moreover, the main effect of prospective load, $F(1,59) = 4.944$; $p < .05$; $\eta_p^2 = 0.077$ was significant, indicating that text comprehension in the baseline block led to more accurate responses ($M = .87$, $SD = .18$) than comprehension during the focal ($M = .82$, $SD = .18$) and the non-focal blocks ($M = .84$, $SD = .18$); and the main effect of updating, $F(1,59) = 22.719$; $p < .0001$; $\eta_p^2 = 0.278$, where early updating led to better performance ($M = .89$, $SD = .15$) than the late updating condition ($M = .82$, $SD = 0.20$). Overall, these results showed that PM instructions had a cost in text comprehension as suggested by the higher accuracy in the baseline condition. More importantly, however, the pattern of data demonstrates better performance of bilinguals over monolinguals independently of the prospective

Table 3. Mean score and standard deviations in behavioural data for the monolingual and bilingual group in L1 as a function of the experimental conditions.

A. Mean score and standard deviations in online text comprehension (Reading Times).

	L1 Monolinguals			L1 Bilinguals		
	Reading Times			Reading Times		
	Early	Late	**Total**	Early	Late	**Total**
Baseline	3575 (1342)	3735 (1978)	3655 (1660)	3124 (843)	3197 (769)	3161 (806)
Focal	3569 (1296)	3531 (1217)	3550 (1257)	3237 (866)	3085 (894)	3161 (880)
Non-focal	3816 (1522)	3863 (1489)	3840 (1506)	3189 (977)	3122 (859)	3156 (877)
Total	3653 (1387)	3710 (1561)		3183 (895)	3135 (841)	

B. Mean score and standard deviations in off-line text comprehension (ACC and RT).

	L1 Monolinguals						L1 Bilinguals					
	ACC		RT				ACC		RT			
	Early	Late	Early	Late	**Total**		Early	Late	Early	Late	**Total**	
					ACC	RT					ACC	RT
Baseline	.87 (.18)	.83 (.21)	3187 (1380)	3118 (1617)	.85 (.20)	3153 (1499)	.95 (.09)	.84 (.19)	2757 (1005)	3025 (1330)	.90 (.14)	2891 (1168)
Focal	.81 (.15)	.72 (.20)	3660 (1255)	3697 (1525)	.77 (.18)	3679 (1390)	.87 (.17)	.87 (.14)	3308 (1169)	3443 (1720)	.87 (.16)	3376 (1445)
Non-focal	.86 (.17)	.81 (.20)	4206 (1954)	4136 (1848)	.84 (.19)	4171 (1901)	.93 (.11)	.85 (.20)	3365 (1320)	3152 (1239)	.90 (.16)	3258 (1280)
Total	.85 (.17)	.79 (.20)	3684 (1530)	3650 (1663)			.92 (.12)	.85 (.18)	3143 (1165)	3207 (1430)		

C. Mean score and standard deviations in accuracy (ACC) and response times (RT) in the PM trials.

	L1 Monolinguals						L1 Bilinguals					
	ACC		RT				ACC		RT			
	Early	Late	Early	Late	**Total**		Early	Late	Early	Late	**Total**	
					ACC	RT					ACC	RT
Focal	.60 (.37)	.64 (.36)	3393 (1443)	3496 (1433)	.62 (.37)	3445 (1438)	.81 (.29)	.68 (.33)	2959 (1660)	2649 (996)	.75 (.27)	2804 (1328)
Non-focal	.38 (.42)	.40 (.44)	4179 (2490)	3821 (1666)	.40 (.43)	4000 (2078)	.80 (.29)	.81 (.28)	2822 (957)	2957 (1235)	.81 (.23)	2890 (1096)
Total	.49 (.40)	.52 (.40)	3786 (1967)	3658 (1550)			.81 (.29)	.75 (.31)	2891 (1309)	2803 (1116)		

D. Mean score and standard deviations in accuracy (ACC) and response times (RT) in the switching cost index.

	L1 Monolinguals						L1 Bilinguals					
	ACC		RT				ACC		RT			
	Early	Late	Early	Late	**Total**		Early	Late	Early	Late	**Total**	
					ACC	RT					ACC	RT
Focal	.18 (.44)	.03 (.44)	733 (811)	747 (2149)	.11 (.44)	740 (1480)	.20 (.36)	.07 (.41)	904 (1495)	797 (1608)	.14 (.39)	851 (1552)
Non-focal	.46 (.50)	.39 (.46)	346 (3201)	356 (1693)	.43 (.48)	351 (2447)	.14 (.36)	-.02 (.43)	643 (1288)	532 (1877)	.06 (.40)	582 (1583)
Total	.32 (.47)	.21 (.45)	540 (2006)	552 (1921)			.17 (.36)	.03 (.42)	774 (1392)	665 (1743)		

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Table 4. Mean score and standard deviations in behavioural data for the bilingual group in L1 and L2 as a function of the experimental conditions.

A. Mean score and standard deviations in **online text comprehension** (Reading Times).

	L1 Bilinguals			L2 Bilinguals		
	Reading Times			Reading Times		
	Early	Late	**Total**	Early	Late	**Total**
Baseline	3124 (843)	3197 (769)	3161 (806)	4299 (928)	4264 (862)	4282 (895)
Focal	3237 (866)	3085 (894)	3161 (880)	4274 (741)	4200 (821)	4237 (781)
Non-focal	3189 (977)	3122 (859)	3156 (877)	4373 (1224)	4538 (1931)	4455 (660)
Total	3183 (895)	3135 (841)		4315 (964)	4334 (1205)	

B. Mean score and standard deviations in **off-line text comprehension** (ACC and RT).

	L1 Bilinguals						L2 Bilinguals					
	ACC		RT				ACC		RT			
	Early	Late	Early	Late	**Total**		Early	Late	Early	Late	**Total**	
					ACC	RT					ACC	RT
Baseline	.95 (.09)	.84 (.19)	2656 (969)	2788 (1228)	.90 (.14)	2722 (1099)	.89 (.14)	.69 (.32)	3947 (1557)	3602 (1042)	.79 (.23)	3775 (1300)
Focal	.87 (.17)	.87 (.14)	3068 (1096)	3207 (1482)	.87 (.16)	3138 (1289)	.90 (.16)	.68 (.28)	3647 (1012)	3975 (1260)	.79 (.22)	3811 (1136)
Non-focal	.93 (.11)	.85 (.20)	2993 (1228)	2990 (1566)	.90 (.16)	2992 (1397)	.83 (.18)	.70 (.31)	4083 (1247)	3939 (1228)	.77 (.25)	4011 (1238)
Total	.92 (.12)	.85 (.18)	2906 (1098)	2995 (1425)			.87 (.16)	.69 (.31)	3893 (1272)	3839 (1177)		

C. Mean score and standard deviations in accuracy (ACC) and response times (RT) in the **PM trials**.

	L1 Bilinguals						L2 Bilinguals					
	ACC		RT				ACC		RT			
	Early	Late	Early	Late	**Total**		Early	Late	Early	Late	**Total**	
					ACC	RT					ACC	RT
Focal	.81 (.29)	.68 (.33)	2959 (1660)	2649 (996)	.75 (.27)	2804 (1328)	.78 (.28)	.87 (.24)	3695 (2906)	3805 (1954)	.83 (.21)	3750 (2430)
Non-focal	.80 (.29)	.81 (.28)	2822 (957)	2957 (1235)	.81 (.23)	2890 (1096)	.75 (.34)	.70 (.32)	3825 (1923)	4603 (3789)	.73 (.29)	4214 (2856)
Total	.81 (.29)	.75 (.31)	2891 (1309)	2803 (1116)			.77 (.31)	.79 (.28)	3760 (2415)	4204 (2872)		

D. Mean score and standard deviations in accuracy (ACC) and response times (RT) in the **switching cost index**.

	L1 Bilinguals						L2 Bilinguals					
	ACC		RT				ACC		RT			
	Early	Late	Early	Late	**Total**		Early	Late	Early	Late	**Total**	
					ACC	RT					ACC	RT
Focal	.20 (.36)	.07 (.41)	904 (1495)	797 (1608)	.14 (.39)	851 (1552)	.12 (.34)	-.23 (.43)	567 (1883)	1170 (2204)	-.11 (.39)	869 (2044)
Non-focal	.14 (.36)	-.02 (.43)	643 (1288)	532 (1877)	.06 (.40)	582 (1583)	.04 (.38)	.01 (.56)	2394 (4294)	259 (2198)	.03 (.47)	1327 (2346)
Total	.17 (.36)	.03 (.42)	774 (1392)	665 (1743)			.08 (.36)	-.22 (.50)	1481 (3089)	715 (2201)		

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load or difficulty of the updating process. This pattern suggests that bilinguals compared to monolinguals might monitor more efficiently the context for appropriate cues independently of the difficulty of the prospective task.

Off-line text comprehension: Response times to the comprehension question

We averaged the response times (for correct responses) per participants and condition and submitted them to a 3x2x2 mixed factorial ANOVA with Group (monolingual vs bilingual), Prospective load (baseline vs focal vs and non-focal), and Updating (early vs late) as independent variables (see Table 3B). A main effect of prospective load, $F(1,59) = 15.972$; $p < .0001$; $\eta_p^2 = 0.213$) showed faster response times in the baseline ($M = 3033$, $SD = 1357$) when compared to focal ($M = 3540$, $SD = 1414$) and non-focal ($M = 3752$, $SD = 1726$) conditions. Interestingly, the interaction prospective load by group was also significant, $F(1,59) = 4.129$; $p < .05$; $\eta_p^2 = 0.065$, indicating that the difference between monolinguals and bilinguals was significant in the non-focal condition (monolinguals: $M = 4171$, $SD = 1901$; bilinguals: $M = 3258$, $SD = 1280$; $t(59) = 1.952$; $p < .05$; $d = 0.51$). This suggests that, in general, bilinguals were faster answering to the comprehension question. However, these differences between groups did not appear in the focal (monolinguals: $M = 3679$, $SD = 1390$; bilinguals: $M = 3376$, $SD = 1445$; $t(59) = 0.883$; $p = .381$; $d = 0.23$) and baseline (monolinguals: $M = 3153$, $SD = 1499$; bilinguals: $M = 2891$, $SD = 1168$; $t(59) = 0.787$; $p = .434$; $d = 0.26$) conditions. Thus, these results indicated greater efficiency of bilingual people adapting their monitoring abilities to perform the more resource-demanding PM activity. Nevertheless, in the blocks where monitoring was not required (i.e., focal and baseline) both groups performed in a similar way.

Prospective performance accuracy.

Average PM responses to the cloze questions containing the prospective cue were submitted to a 3x2x2 mixed ANOVA with Group (monolingual vs bilingual), Focality (focal vs non-focal), and Updating (early vs late) as factors (see Table 3C). These results showed a significant main effect of group, $F(1,59) = 15.129$; $p < .0001$; $\eta_p^2 = 0.240$, with greater accuracy in bilinguals ($M = .78$, $SD = .30$) than in monolinguals ($M = .51$, $SD = .40$). Interestingly, the interaction between focality and group was also significant, $F(1,59) = 9.539$; $p < .05$; $\eta_p^2 = 0.139$, indicating that bilinguals were equally accurate in the focal than in the non-focal condition, $t(27) = -1.106$; $p = .396$; $d = -4.32$, while monolinguals showed greater accuracy for focal cues than for non-focal cues, $t(32) = 3.136$; $p < .05$; $d = 1.63$.

Prospective performance response times.

We averaged response times per participants and condition for prospective cloze trials and submitted them to a 3x2x2 mixed factorial ANOVA with Group (monolingual vs bilingual), Prospective load (focal vs non-focal), and Updating (early vs late) factors (see Table 3C). The results of this analysis indicated that group was the only significant effect, $F(1,59) = 7.618$; $p < .05$; $\eta_p^2 = 0.114$, indicating that, in general, bilinguals were faster responding to the PM cues ($M = 2847$, $SD = 1212$) compared to monolinguals ($M = 3722$, $SD = 1758$).

In sum, the analyses of the prospective task indicate that bilingual participants were not affected by the difficulty of detecting the prospective cues given their high performance in both the focal and non-focal conditions. However, overall, monolinguals showed less accuracy. These results could indicate that bilingual participants may have a better ability to involve cue detection than their monolingual counterparts. This was also reflected in their overall faster response times to the PM.

Switching between ON and PM tasks accuracy.

The switching cost index was submitted to a 2x2x2 mixed ANOVA with Group (monolingual vs bilingual), Focality (focal vs non-focal), and Updating (early and late) as factors (see Table 3D). The main effect of group was marginally significant, $F(1,59) = 3.802$; $p = .056$; $\eta_p^2 = 0.061$, with less cost in bilinguals ($M = .10$, $SD = .39$) than in monolinguals ($M = .26$, $SD = .46$). The other two main effects were significant: focality, $F(1,59) = 7.628$; $p < .05$; $\eta_p^2 = 0.114$, indicating greater cost in the non-focal ($M = .25$, $SD = .44$) than in the focal block ($M = .13$, $SD = .42$); and updating, $F(1,59) = 15.198$; $p < .001$; $\eta_p^2 = 0.205$, with greater cost for early updating ($M = .26$, $SD = .44$) than for late updating ($M = .13$, $SD = .44$). More importantly, the focality by group interaction was significant, $F(1,59) = 19.177$; $p < .0001$; $\eta_p^2 = 0.245$, indicating that monolinguals showed greater cost for non-focal than for focal cues, $t(32) = -4.368$; $p < .001$; $d = -2.15$, whereas this effect was not significant for bilinguals, $t(27) = 1.030$; $p = .276$; $d = 7.96$ (see Table 3C).

Switching between ON and PM response times.

We averaged response times per participants and condition and submitted them to a 3x2x2 mixed factorial ANOVAs with Group (monolingual and bilingual), Focality (focal, and non-focal), and Updating (early and late) (see Table 3D). The main effects and interactions did not reach significance.

Overall, when considering switching from the ON task to the PM tasks bilinguals seem to overcome the cost of task switching more efficiently than the monolinguals, and they did so in both focal and non-focal conditions (no difference between conditions), whereas monolinguals evidenced greater cost in the more difficult non-focal condition. This pattern, however, was only evident when looking at the accuracy data and not to the response times.

Bilinguals L1 vs L2

With the aim of exploring the language effect in monitoring cost, prospective performance and switching processes, we ran the same analyses on bilinguals and compared their performance when the task was done in the L1 and the L2.

Online text comprehension: Text reading times in ON trials

We averaged reading times per participants and condition and submitted them to a $3 \times 2 \times 2$ within participants ANOVA with Language (L1 vs. L2), Prospective load (baseline vs. focal vs. and non-focal), and Updating (early vs. late) as factors (see Table 4A). The main effect of language was significant, $F(1,27) = 32.366$; $p < .0001$; $\eta_p^2 = 0.545$, indicating faster reading times in the L1 ($M = 3159$; $SD = 868$) than in the L2 ($M = 4324$; $SD = 1085$).

Overall, the language in which the task was executed modulated online text comprehension. Thus, when participants were reading texts in their L1 they were faster independently of the prospective load and updating conditions.

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Off-line text comprehension: Accuracy to comprehension questions.

The number of correct responses to the ON task in the cloze questions were averaged per subject and condition and submitted to a 3x2x2 within ANOVA with Language (L1 vs. L2), Prospective load (baseline vs. focal vs. non-focal), and Updating (early vs. late) as factors (see Table 4B). The main effects of language, $F(1,27) = 6.532$; $p < .05$; $\eta_p^2 = 0.195$, and updating, $F(1,27) = 35.781$; $p < .0001$; $\eta_p^2 = 0.570$, were significant. Importantly, there was a significant interaction of language by updating, $F(1,27) = 7.692$; $p < .05$; $\eta_p^2 = 0.222$, indicating that although the updating effect (i.e., higher accuracy in the early than late conditions) was significant in both the L1,($t(27) = -3.070$, $p < .05$, $d = -1.70$), and the L2 ($t(27) = -4.957$, $p < .0001$, $d = -4.38$), the effects differed in size – that is, there was larger effect size in the L2 than in the L1.

Off-line text comprehension: Response times to the comprehension question

Response times (for correct responses) were averaged per participant and condition and submitted to a 3x2x2 mixed factorial ANOVA with Language (L1 vs. L2), Prospective load (baseline vs. focal vs. non-focal), and Updating (early vs. late) as factors (see Table 4B). The result of this analysis showed a significant main effect of language, $F(1,27) = 19.728$; $p < .0001$; $\eta_p^2 = 0.473$, indicating that response times were faster in the L1 ($M = 2950$, $SD = 1261$) than in the L2 ($M = 3865$, $SD = 1224$).

Altogether, these results indicate that language modulated accuracy and response times to the comprehension questions. Comprehension was faster in the L1 than in the L2. In addition, processing in the L2 led to a larger updating effect – this is to say, L2 comprehension seems to be especially impaired in the most linguistically complex late updating condition.

Prospective performance accuracy

Average PM responses to the cloze questions with prospective cues were submitted to a 2x2x2 within ANOVA with Language (L1 vs. L2), Focality (focal vs. non-focal), and Updating (early vs. late) as factors (see Table 4C). The interaction of language by focality was significant, $F(1,27) = 4.278$; $p < .05$; $\eta_p^2 = 0.137$, showing that in L1 there was no difference between focal and non-focal cues ($t(27) = -1.106$; $p = .278$; $d = -0.24$), whereas in L2 the difference was marginally significant ($t(27) = 1.966$; $p = .060$; $d = 8.00$), indicating greater accuracy in focal cues than in non-focal cues (see Table 4C).

Prospective performance response times

We averaged response times per participants and condition and submitted them to a 2x2x2 within factorial ANOVA with Language (L1 vs. L2), Focality (focal vs. non-focal), and Updating (early vs. late) as factors (see Table 4C). There was a significant main effect of language, $F(1,27) = 7.125$; $p < .05$; $\eta_p^2 = 0.209$, indicating that, in general, L1 responses to the PM cues were faster ($M = 2847$, $SD = 1212$) compared to L2 ($M = 3982$, $SD = 2643$). The main effect of language was modulated by the language by updating interaction, $F(1,27) = 4.509$; $p < .05$; $\eta_p^2 = 0.143$. This interaction indicated that there was no difference between the late and early updating conditions in the L1 ($t(27) = -0.618$; $p = .541$; $d = -11.60$), while in the L2 this difference was significant ($t(27) = 2.103$; $p < 0.05$; $d = 5.46$), with slower response times in the late than in the early updating condition (see Table 4C).

In sum, in the L1, bilinguals seemed to be able to overcome the difficulties associated with the focality of the cue and the updating requirements of the text. However, when they performed the task in their L2, the cost associated with processing in their less dominant language produced focality effects in accuracy and updating effects in response times.

Switching between ON and PM tasks accuracy

The switching cost index calculated from the PM and ON questions were submitted to a 3x2x2 within ANOVA with Language (L1 vs. L2), Focality (focal vs. non-focal), and Updating (early vs. late) as factors (see Table 4D). The main effect of updating was significant, $F(1,27) = 22.409$; $p < 0.001$; $\eta_p^2 = 0.454$, reflecting that the difference between ON and PM trials was smaller in the late updating ($M = -.01$; $SD = .46$) compared to the early updating condition ($M = .12$; $SD = .36$).

Switching between ON and PM tasks response times

We averaged response times per participants and conditions and submitted them to a 2x2x2 within ANOVA with Language (L1 vs. L2), Focality (focal vs. non-focal), and Updating (early vs. late) (see Table 4D). The main effects and interactions did not reach significance.

All in all, our results showed smaller differences in accuracy between ON and PM trials in the more demanding late updating condition. This effect was however not evident in response times. Interestingly, the effect of updating in accuracy was independent of the language in which the ON task was performed (and language did not yield significant effects), suggesting that switching was not influenced by the language in which the task was performed.

4. Discussion

In the present study we examined the influence of bilingualism on prospective memory. First, we explored possible differences between monolinguals and bilinguals in a PM task, which varied in monitoring demands (baseline –without PM instructions-, focal PM or non-focal PM tasks) and the linguistic requirements (early updating vs. late updating). Second, we compared bilingual PM performance when the task was carried out in the first (L1) and second (L2) language. To this end, monolinguals and bilinguals performed an event-based task in which the nature of the PM cue (focal vs. non-focal) and the linguistic requirements of the ongoing task (early updating vs. late updating) were manipulated. Additionally, bilingual participants performed the PM task in both their L1 and L2. Below, we discuss the findings of our study in the same order of presentation used in the Results section.

Monolinguals vs Bilinguals in L1

Bilinguals showed better performance in text comprehension during the ongoing task with faster reading times (online text comprehension), higher response accuracy and faster response times (off-line text comprehension) to the comprehension questions. In general, this advantage was independent of the monitoring requirements of the prospective task and the linguistic difficulty of the ongoing activity, suggesting that overall bilinguals were more efficient L1 comprehenders than monolinguals when they faced inferential revision during text comprehension. However, regarding response times to the comprehension question, we

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found that bilinguals were faster compared to monolinguals only in the more resource-demanding PM activity. This suggested a higher ability of the bilingual participants facing activities where monitoring is required. Notice that, this does not necessarily suggest that each of the underlying reading comprehension processes are affected by bilingualism, but that higher-levels processes such as inferencing, monitoring and revision, involved in our text comprehension task were modulated by language use.

Studies comparing differences in text comprehension between monolinguals and bilinguals, Teubner-Rhodes, Mishler, Corbett, Andreu, Sanz-Torrent, Trueswell, and Novick (2016) have also found that bilingual readers show better performance than monolinguals in their offline comprehension of syntactically ambiguous sentences, also suggesting that their previous language experience may enhance general performance in language comprehension. Similarly, Afsharrad and Sadeghi Benis (2017) also showed that successful L2 learners outperformed unsuccessful L2 learners classified as monolinguals, in a reading comprehension task, and they attributed this reading comprehension advantage to bilinguals' better use of metacognitive strategies. Moreover, Filippi, Leech, Thomas, Green, and Dick (2012) studied the effect of interference in an auditory sentence comprehension task finding that bilingual speakers outperformed their monolingual peers in the more interfering condition, suggesting that better cognitive control abilities in bilinguals might allow them to control the interference. Hence, our results add to the evidence suggesting that the bilingual experience modulates high-level comprehension processes, leading to better performance than the monolinguals.

Interestingly, inferential revision in text comprehension has been linked with different executive functions. For example, a recent study (Pérez, Schmidt, Kourtzi & Tsimpli, 2020) showed differences in text comprehension performance due to inhibitory control mechanisms. Specifically, they found that higher compared to lower inhibitory control comprehenders had better performance in a comprehension question when conflicting information was presented in the text. Similarly, inferential text revision requires successful monitoring processes to detect incongruences and to update the mental representation of the text to ensure coherence (Kintsch, 1998; Perfetti, Stafura & Adlof, 2013). Despite the fact that different underlying abilities have been proposed for reading comprehension (Li, Koh, Geva, Joshi & Chen, 2020), we suggest that differences in monitoring abilities are the main factor that explain our findings, given the critical role of monitoring in tracking text coherence during the inferential revision (Pérez et al., 2015) and during the PM task (Hunter Ball & Bugg, 2018). Thereby, we interpret that the higher performance found in bilinguals during the execution of the PM trials is explained by greater monitoring abilities. Consequently, it is possible that our bilingual participants engaged the monitoring processes required for high-level text comprehension more efficiently, and therefore, they outperformed monolinguals. This assumption is in line with previous studies in the field of bilingualism and cognitive functions which have shown better monitoring capacity in bilinguals than monolinguals, not only at the behavioral level, but also at the neural level (Abutalebi, Della Rosa, Green, Hernández, Scifo, Keim, Kappa & Costa, 2012; Costa, Hernández, Costa-Faidella & Sebastián-Gallés, 2009; Hilchey & Klein, 2011; Morales et al., 2013, 2015; Kousaie & Phillips, 2012, 2017).

As we previously mentioned, this idea is also supported by the findings regarding the prospective task, where bilinguals showed overall faster response times and higher accuracy than the monolinguals. Thus, the bilingual group seemed to overcome the difficulties in prospective performance associated with the monitoring demands of the task, showing similar performance in the more demanding (non-focal) conditions compared with the less demanding (focal) conditions. These findings suggest that bilinguals can adapt their capacities to the demands of the task and engage in prospective processing strategies, enabling them to successfully perform the PM task even in the more challenging conditions. These results support previous studies, similarly suggesting that bilinguals may have better cognitive strategy adjustment than monolinguals (Morales et al., 2013, 2015). This pattern of results also resembles previous data on PM and bilingualism that observed how bilingual experience modulates the cognitive processes involved in updating and cue detection to adapt them to the PM task's demands (López-Rojas et al., 2022). There is also the possibility that the better PM performance in bilinguals (compared to monolinguals) could be explained by a general higher linguistic capacity in the bilingual group and not by their knowledge of a second language. However, given that reading times to the first and second sentence in the ongoing baseline trials did not differ between monolinguals and bilinguals, we consider that L2 learning (and not a general language capacity) is the responsible for their better PM performance.

Similarly, bilinguals also seemed more efficient when switching between activities (ON-PM tasks), as we found smaller switching cost for bilinguals than monolinguals in accuracy. The smaller cost for bilinguals was similar for the focal and non-focal conditions, whereas monolinguals' cost was affected by the difficulty of the PM task, with greater cost in non-focal than in focal conditions.

The pattern of focality effects observed in monolinguals in their prospective performance and in their switching cost can be easily explained by the Multiprocess framework proposed by McDaniel and Einstein (2000). According to this framework, focal cues elicit "spontaneous retrieval" of the intention in contrast to non-focal cues that require more costly monitoring processes which in turn results in longer response times and poorer accuracy. However, the lack of focality effects in bilinguals suggested that they overcame the processing difficulties associated with the focality of the cue. These findings support the idea that bilingualism modulates the processes engaged in PM processing.

In sum, when focusing on differences between bilinguals and monolinguals in L1, the general pattern of results showed between-group differences in performance with faster and more accurate responses in bilinguals. More importantly, bilingual participants seemed to be able to overcome the monitoring demands imposed by the nature of the PM cue as compared to monolinguals, who show the usual impairment with increments in monitoring demands.

L1 vs L2 in Bilinguals

Language comparisons in online (short-text readings times) and offline (accuracy and response times in cloze-questions) indicated faster and more accurate reading in the L1 compared to L2 comprehension. This is in line with previous studies in the field of reading comprehension in foreign language (Melby-Lervåg & Lervåg, 2014). In our data we found an impairment in text comprehension when working in a less dominant language. Although this effect was independent of inference updating and prospective load when focusing on reading times during online text comprehension and response times to the comprehension questions, accuracy during offline comprehension was modulated by the updating condition. Specifically, between-language differences in accuracy increased for the more demanding late updating condition, indicating that L2 comprehension is selectively impaired in difficult conditions. This pattern of results supports the findings by Pérez et al. (2019), who suggested that the efficiency of predictive processes and inferential revision (a highly demanding updating process) is reduced in the L2, compared to the L1. Pérez et al. (2019) argued that the differences between languages might be because during L2 comprehension, cognitive resources might mainly engage in lower-level features processing and, consequently, less resources might be available to process conceptual features (Horiba & Fukaya, 2015; Segalowitz, Watson & Segalowitz, 1995; Yang, 2002).

Regarding performance in the prospective memory task, we found that when the task was performed in the L2, bilinguals showed a focality effect with better accuracy for the focal than for the non-focal condition. However, when bilinguals performed the task in L1, cue-focality did not have an effect and there were no differences in PM performance between the focal and non-focal conditions. These effects suggest that bilinguals, when working in their L1, seem to be able to adjust their performance to the monitoring demands of the task to overcome the difficulty of non-focal monitoring. However, when the task is performed in the more demanding L2 language, bilinguals may have fewer resources for strategic processing and adjustment; we see this in the standard focality effect, i.e. lower performance in the non-focal when compared to the focal condition. These results are in agreement with previous studies on the role of working memory (WM) in highly demanding inferential reading tasks. For instance, Alptekin and Erçetin (2010) reported differences in WM processing depending on the language. Concretely, participants were more accurate in L1 than in L2, and they argued that reading complex texts in L2 comprehension poses higher demands on WM decreasing their performance in this task. Similarly, and due to the fact that our bilinguals were relatively less proficient in their L2 than in their L1, our results are consistent with previous studies reporting differences between poor and good comprehenders in meta-comprehension monitoring when presented with texts that varied in difficulty (Maki, Shields, Wheeler & Zacchilli, 2005). Thus, Maki et al. (2005) found that good comprehenders were more precise than poor comprehenders when making prospective judgments to difficult texts, where more monitoring was required. However, in the easier texts, there were no differences between the two groups. These results suggest that poor comprehenders' monitoring capacity was reduced when reading difficult texts. In line with this hypothesis, Han (2012) observed worse comprehension monitoring for low-proficiency foreign language readers compared to highly proficient foreign language readers (but see Silawi, Shalhoub-Awwad & Prior (2020), that failed to find correlations between monitoring in reading comprehension and language proficiency). Altogether, we suggest that the impairment in PM when bilinguals performed the task in their less dominant language was due to reduced cognitive resources and the need to re-allocate attention to the main task.

Finally, analyses comparing the cost of switching between the ongoing and the prospective tasks when working in L1 and L2 indicated that there were no differences between the two languages. Surprisingly, the only observed effect in this analysis involved smaller cost in accuracy in the late updating condition, indicating that while switching was affected by the conditions of the ongoing task, participants were able to disengage from the ongoing task and switch to the prospective task.

Thereby, the overall pattern of results seems to indicate that L2 processing has a cost in ongoing performance and prospective memory, especially in the more demanding L2 processing conditions and when the PM cue requires effortful monitoring processing. However, once that monitoring results in cue detection, L2 processing does not affect switching to the PM and implementing the action intention.

In sum, our study adds to a wide range of literature suggesting that bilinguals are able to better adjust their cognitive strategies to task demands in comparison to monolinguals (Costa, Hernández & Sebastián-Gallés, 2008; Morales et al., 2013, 2015; Prior & MacWhinney, 2010; see Antoniou, 2019, for a review). More importantly, our results support and extend previous studies (López-Rojas et al., 2022) indicating the influence of bilingualism in PM, and the influence of L2 processing on PM performance. Thus, our findings showed an impairment in PM associated with L2 processing. This cost was especially evident in the more demanding conditions suggesting that increments in attentional load due to L2 processing may have impaired the monitoring processes required for prospective remembering.

Prospective memory plays a fundamental role in daily activities. In fact, PM failures (i.e., forgetting to turn off the oven) can result in dramatic consequences when they occur in real life context. Understanding whether and how its underlying cognitive mechanisms can be modulated by bilingualism allows us to accurately address the challenges of today's world. In this line, studies focused on exploring the interaction between different individual characteristics, such us bilingualism and prospective memory, are of especial interest to address different questions. First, these studies add to studies in other domains suggesting that learning a second language (or being immersed in a L1 or L2 context) can impact perception, attention and memory and in turn many real-world phenomenon such as the recall of future intentions (e.g., send a pending email or attending a scheduled meeting). Second, bilingualism can serve as a tool to study in depth the different cognitive mechanisms involved in the prospective recall (e.g., strategic monitoring).

Overall, our findings suggest that some memory processes might vary depending on the linguistic context. Therefore, this research provides a base for future studies about the impact of bilingualism on prospective memory. Further studies are needed to fully understand the dynamic interaction between L1 and L2 processing during recall of future intentions, as well as possible differences of this interaction by comparing different bilingual experiences.

5. Conclusion

In conclusion, the observed results support our hypothesis that differences in prospective processes might be due to bilingualism and the linguistic context in which bilinguals perform a prospective memory task. We observed that in L1 contexts, bilingualism modulates the cognitive processes involved in updating and cue detection to adapt them to the task demands. Bilinguals were able to engage executive control mechanisms to a greater extent than monolinguals, in order to detect and respond to the PM cue. By contrast, recalling future intentions in an L2 context resulted in an impairment of the performance, especially in the more challenging cognitive conditions. These findings suggest

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the importance of studying how linguistic context modulates certain memory processes.

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References

Abutalebi J, Della Rosa PA, Green DW, Hernandez M, Scifo P, Keim R, Kappa SF and Costa A (2012). Bilingualism tunes the anterior cingulate cortex for conflict monitoring. *Cerebral cortex* **22**, 2076–2086. https://doi.org/10.1093/cercor/bhr287

Adamou E and Shen XR (2019). There are no language switching costs when codeswitching is frequent. *International Journal of Bilingualism* **23**, 53–70. https://doi.org/10.1177/1367006917709094

Afsharrad M and Sadeghi Benis AR (2017). Differences between monolinguals and bilinguals/males and females in English reading comprehension and reading strategy use. *International Journal of Bilingual Education and Bilingualism* **20**, 34–51. https://doi.org/10.1080/13670050.2015.1037238

Alptekin C and Erçetin G (2010). The role of L1 and L2 working memory in literal and inferential comprehension in L2 reading. *Journal of Research in Reading* **33**, 206–219. https://doi.org/10.1111/j.1467-9817.2009.01412.x

Antoniou M (2019). The advantages of bilingualism debate. *Annual Review of Linguistics* **5**, 395–415. https://doi.org/10.1146/annurev-linguistics-011718-011820

Anwyl-Irvine AL, Massonnié J, Flitton A, Kirkham N and Evershed JK (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior research methods* **52**, 388–407. https://doi.org/10.3758/s13428-019-01237-x

Beatty-Martínez AL, Bruni MR, Bajo MT and Dussias PE (2021). Brain potentials reveal differential processing of masculine and feminine grammatical gender in native Spanish speakers. *Psychophysiology* **58**, e13737. https://doi.org/10.1111/psyp.13737

Beatty-Martínez AL, Navarro-Torres CA, Dussias PE, Bajo MT, Guzzardo Tamargo RE and Kroll JF (2020). Interactional context mediates the consequences of bilingualism for language and cognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition* **46**, 1022. https://psycnet.apa.org/doi/10.1037/xlm0000770

Bialystok E, Dey A, Sullivan MD and Sommers MS (2020). Using the DRM paradigm to assess language processing in monolinguals and bilinguals. *Memory & Cognition* **48**, 870–883. https://doi.org/10.3758/s13421-020-01016-6

Bisiacchi PS, Schiff S, Ciccola A and Kliegel M (2009). The role of dual-task and task-switch in prospective memory: Behavioural data and neural correlates. *Neuropsychologia* **47**, 1362–1373. https://doi.org/10.1016/j.neuropsychologia.2009.01.034

Blumenfeld HK and Marian V (2007). Constraints on parallel activation in bilingual spoken language processing: Examining proficiency and lexical status using eye-tracking. *Language and cognitive processes* **22**, 633–660. https://doi.org/10.1080/01690960601000746

Cejudo AB, Gómez-Ariza CJ and Bajo MT (2019). The cost of prospective memory in children: The role of cue focality. *Frontiers in psychology* **9**, 2738. https://doi.org/10.3389/fpsyg.2018.02738

Cejudo AB, López-Rojas C, Gómez-Ariza CJ and Bajo MT (2022). ERP Correlates of Prospective Memory and Cue Focality in Children. *Brain Sciences* **12**, 533. https://doi.org/10.3390/brainsci12050533

Chabal S and Marian V (2015). Speakers of different languages process the visual world differently. *Journal of Experimental Psychology: General* **144**, 539–550. https://doi.org/10.1037/xge0000075

Chen P, Chung-Fat-Yim A and Marian V (2022). Cultural Experience Influences Multisensory Emotion Perception in Bilinguals. *Languages* **7**, 12. https://doi.org/10.3390/languages7010012

Cohen J (1969). *Statistical power analysis for the behavioral sciences*. Academic press.

Cona G, Bisiacchi PS and Moscovitch M (2013). The effects of focal and nonfocal cues on the neural correlates of prospective memory: Insights from ERPs. *Cerebral Cortex* **24**, 2630–2646. https://doi.org/10.1093/cercor/bht116

Costa A, Corey JD, Hayakawa S, Aparici M, Vives ML and Keysar B (2019). The role of intentions and outcomes in the foreign language effect on moral judgements. *Quarterly Journal of Experimental Psychology* **72**, 8–17. https://doi.org/10.1177/1747021817738409

Costa A, Foucart A, Hayakawa S, Aparici M, Apesteguia J, Heafner J and Keysar B (2014). Your morals depend on language. *PloS one* **9**, e94842. https://doi.org/10.1371/journal.pone.0094842

Costa A, Hernández M and Sebastián-Gallés N (2008). Bilingualism aids conflict resolution: Evidence from the ANT task. *Cognition* **106**, 59–86. https://doi.org/10.1016/j.cognition.2006.12.013

Costa A, Hernández M, Costa-Faidella J and Sebastián-Gallés N (2009). On the bilingual advantage in conflict processing: Now you see it, now you don't. *Cognition* **113**, 135–149. https://doi.org/10.1016/j.cognition.2009.08.001

Declerck M, Grainger J, Koch I and Philipp AM (2017). Is language control just a form of executive control? Evidence for overlapping processes in language switching and task switching. *Journal of Memory and Language* **95**, 138–145. https://doi.org/10.1016/j.jml.2017.03.005

Dijkstra T and Kroll JF (2005). Bilingual visual word recognition and lexical access. *Handbook of bilingualism: Psycholinguistic approaches* **178**, 201. Oxford University Press.

Droop M and Verhoeven L (2003). Language proficiency and reading ability in first-and second-language learners. *Reading research quarterly* **38**, 78–103. https://doi.org/10.1598/RRQ.38.1.4

Einstein GO and McDaniel MA (2005). Prospective memory: Multiple retrieval processes. *Current Directions in Psychological Science* **14**, 286–290. https://doi.org/10.1111/j.0963-7214.2005.00382.x

Faul F, Erdfelder E, Lang AG and Buchner A (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods* **39**, 175–191. https://doi.org/10.3758/BF0319314

Filippi R, Leech R, Thomas MS, Green DW and Dick F (2012). A bilingual advantage in controlling language interference during sentence comprehension. *Bilingualism: language and cognition* **15**, 858–872. doi:10.1017/S1366728911000708

Foucart A, Romero-Rivas C, Gort BL and Costa A (2016). Discourse comprehension in L2: Making sense of what is not explicitly said. *Brain and language* **163**, 32–41. https://doi.org/10.1016/j.bandl.2016.09.001

Geva E and Siegel LS (2000). Orthographic and cognitive factors in the concurrent development of basic reading skills in two languages. *Reading and writing* **12**, 1–30.

Green DW and Abutalebi J (2013). Language control in bilinguals: The adaptive control hypothesis. *Journal of cognitive psychology* **25**, 515–530. https://doi.org/10.1080/20445911.2013.796377

Han F (2012). Comprehension monitoring in reading English as a foreign language. *New Zealand Studies in Applied Linguistics* **18**, 38–51.

Hayakawa S, Costa A, Foucart A and Keysar B (2016). Using a foreign language changes our choices. *Trends in cognitive sciences* **20**, 791–793 https://doi.org/10.1016/j.tics.2016.08.004

Hayakawa S and Keysar B (2018). Using a foreign language reduces mental imagery. *Cognition* **173**, 8–15. https://doi.org/10.1016/j.cognition.2017.12.010

Hayakawa S, Tannenbaum D, Costa A, Corey JD and Keysar B (2017). Thinking more or feeling less? Explaining the foreign-language effect on moral judgment. *Psychological science* **28**, 1387–1397. https://doi.org/10.1177/0956797617720944

Hering A, Wild-Wall N, Falkenstein M, Gajewski PD, Zinke K, Altgassen M and Kliegel M (2020). Beyond prospective memory retrieval: Encoding and

remembering of intentions across the lifespan. *International Journal of Psychophysiology* **147**, 44–59. https://doi.org/10.1016/j.ijpsycho.2019.11.003
Hilchey MD and Klein RM (2011). Are there bilingual advantages on nonlinguistic interference tasks? Implications for the plasticity of executive control processes. *Psychonomic bulletin & review* **18**, 625–658. https://doi.org/10.3758/s13423-011-0116-7
Horiba Y and Fukaya K (2015). Reading and learning from L2 text: Effects of reading goal, topic familiarity, and language proficiency. *Reading in a Foreign Language* **27**, 22–46. doi: 10125/66699
Hoshino N and Thierry G (2011). Language selection in bilingual word production: Electrophysiological evidence for cross-language competition. *Brain research* **1371**, 100–109. https://doi.org/10.1016/j.brainres.2010.11.053
Hunter Ball B and Bugg JM (2018). Context cue focality influences strategic prospective memory monitoring. *Psychonomic Bulletin and Review* **25**, 1405–1415. https://doi.org/10.3758/s13423-018-1442-9
Kintsch W (1998). *Comprehension: A paradigm for cognition*. New York: Cambridge University Press.
Kliegel M, Jäger T and Phillips LH (2008). Adult age differences in event-based prospective memory: A meta-analysis on the role of focal versus non-focal cues. *Psychology and Aging* **23**, 203. https://doi.org/10.1037/0882-7974.23.1.203
Kousaie S and Phillips NA (2012). Conflict monitoring and resolution: Are two languages better than one? Evidence from reaction time and event-related brain potentials. *Brain research* **1446**, 71–90. https://doi.org/10.1016/j.brainres.2012.01.052
Kousaie S and Phillips NA (2017). A behavioural and electrophysiological investigation of the effect of bilingualism on aging and cognitive control. *Neuropsychologia* **94**, 23–35. https://doi.org/10.1016/j.neuropsychologia.2016.11.013
Kroll JF and Stewart E (1994). Category interference in translation and picture naming: Evidence for asymmetric connections between bilingual memory representations. *Journal of memory and language* **33**, 149–174. https://doi.org/10.1006/jmla.1994.1008
Kroll JF, Dussias PE, Bice K and Perrotti L (2015). Bilingualism, mind, and brain. *Annu. Rev. Linguist.*, **1**, 377–394. https://doi.org/10.1146/annurev-linguist-030514-124937
Lesaux N, Koda K, Siegel L and Shanahan T (2006). Development of literacy. Developing literacy in second-language learners. *Report of the National Literacy Panel on Language-Minority Children and Youth*. Mahwah: Lawrence Erlbaum Associates, Publishers.
Li M, Koh PW, Geva E, Joshi R and Chen X (2020). The componential model of reading in bilingual learners. *Journal of Educational Psychology* **112**, 1532. https://doi.org/10.1037/edu0000459
López-Rojas C, Rossi E, Marful A and Bajo MT (2022). Prospective memory in bilinguals and monolinguals: ERP and behavioural correlates of prospective processing in bilinguals. *Brain and Language* **225**, 105059. https://doi.org/10.1016/j.bandl.2021.105059
Ma F, Li S and Guo T (2016). Reactive and proactive control in bilingual word production: An investigation of influential factors. *Journal of memory and language* **86**, 35–59. https://doi.org/10.1016/j.jml.2015.08.004
Macizo P, Bajo T and Martín MC (2010). Inhibitory processes in bilingual language comprehension: Evidence from Spanish–English interlexical homographs. *Journal of Memory and Language* **63**, 232–244. https://doi.org/10.1016/j.jml.2010.04.002
Maki RH, Shields M, Wheeler AE and Zacchilli TL (2005). Individual Differences in Absolute and Relative Metacomprehension Accuracy. *Journal of Educational psychology* **97**, 723.
Marian V, Bartolotti J, van den Berg A and Hayakawa S (2021). Costs and Benefits of Native Language Similarity for Non-native Word Learning. *Frontiers in psychology*, 1906. https://doi.org/10.3389/fpsyg.2021.651506
Marian V, Blumenfeld HK and Kaushanskaya M (2007). The Language Experience and Proficiency Questionnaire (LEAP-Q): Assessing Language Profiles in Bilinguals and Multilinguals. *Journal of Speech, Language, and Hearing Research* **50**, 940–967. https://doi.org/10.1044/1092-4388(2007/067)
Martin CD, Thierry G, Kuipers JR, Boutonnet B, Foucart A and Costa A (2013). Bilinguals reading in their second language do not predict upcoming words as native readers do. *Journal of memory and language* **69**, 574–588. https://doi.org/10.1016/j.jml.2013.08.001
McDaniel MA and Einstein GO (2000). Strategic and automatic processes in prospective memory retrieval: a multiprocess framework. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition* **14**, S127–S144. https://doi.org/10.1002/acp.775
McDaniel MA, Umanath S, Einstein GO and Waldum ER (2015). Dual pathways to prospective remembering. *Frontiers in human neuroscience* **9**, 392. https://doi.org/10.3389/fnhum.2015.00392
Melby-Lervåg M and Lervåg A (2014). Reading comprehension and its underlying components in second-language learners: A meta-analysis of studies comparing first- and second-language learners. *Psychological Bulletin* **140**, 409–433. https://doi.org/10.1037/a0033890
Morales J, Gómez-Ariza CJ and Bajo MT (2013). Dual mechanisms of cognitive control in bilinguals and monolinguals. *Journal of Cognitive Psychology* **25**, 531–546. https://doi.org/10.1080/20445911.2013.807812
Morales J, Yudes C, Gómez-Ariza CJ and Bajo MT (2015). Bilingualism modulates dual mechanisms of cognitive control: Evidence from ERPs. *Neuropsychologia* **66**, 157–169. https://doi.org/10.1016/j.neuropsychologia.2014.11.014
Moreno S, Bialystok E, Wodniecka Z and Alain C (2010). Conflict resolution in sentence processing by bilinguals. *Journal of Neurolinguistics* **23**, 564–579. https://doi.org/10.1016/j.jneuroling.2010.05.002
Morishima Y (2013). Allocation of limited cognitive resources during text comprehension in a second language. *Discourse Processes* **50**, 577–597. https://doi.org/10.1080/0163853X.2013.846964
Pérez A, Cain K, Castellanos MC and Bajo T (2015). Inferential revision in narrative texts: An ERP study. *Memory & Cognition* **43**, 1105–1135. https://doi.org/10.3758/s13421-015-0528-0
Pérez A, Hansen L and Bajo T (2019). The nature of first and second language processing: The role of cognitive control and L2 proficiency during text-level comprehension. *Bilingualism: Language and Cognition* **22**, 930–948. https://doi.org/10.1017/S1366728918000846
Pérez A, Schmidt E, Kourtzi Z and Tsimpli I (2020). Multimodal semantic revision during inferential processing: The role of inhibitory control in text and picture comprehension. *Neuropsychologia* **138**, 107313. https://doi.org/10.1016/j.neuropsychologia.2019.107313
Perfetti CA, Stafura JZ and Adlof SM (2013). Reading comprehension and reading comprehension problems: A word-to-text integration perspective. *Unravelling reading comprehension: Behavioral, neurobiological, and genetic components*, 22–32. Baltimore, MD: Paul Brookes Publishing Co.
Perrotti L (2012). *Grammatical gender processing in L2 speakers of Spanish: Does cognate status help?*. Diss. Pennsylvania State University.
Prior A and MacWhinney B (2010). A bilingual advantage in task switching. *Bilingualism: Language and cognition* **13**, 253–262. doi:10.1017/S1366728909990526
Roessel J, Schoel C, Zimmermann R and Stahlberg D (2019). Shedding new light on the evaluation of accented speakers: Basic mechanisms behind nonnative listeners' evaluations of nonnative accented job candidates. *Journal of Language and Social Psychology* **38**, 3–32. https://doi.org/10.1177/0261927X17747904
Rosselli M, Loewenstein DA, Curiel RE, Penate A, Torres VL, Lang M, Greig MT, Barker WW and Duara R (2019). Effects of bilingualism on verbal and nonverbal memory measures in mild cognitive impairment. *Journal of the International Neuropsychological Society* **25**, 15–28. doi:10.1017/S135561771800070X
Schroeder SR and Marian V (2014). Bilingual episodic memory: How speaking two languages influences remembering. *In Foundations of bilingual memory*. Springer, New York, NY, pp. 111–132. https://doi.org/10.1007/978-1-4614-9218-4_6
Scullin MK, Mullet HG, Einstein GO and McDaniel MA (2015). *Prospective Memory,* I*nternational Encyclopedia of the Social & Behavioral Sciences* (2nd ed.). Elsevier. doi:10.1016/B978-0-08-097086-8.51055-1
Segalowitz N, Watson V and Segalowitz S (1995). Vocabulary skill: Single-case assessment of automaticity of word recognition in a timed lexical decision task. *Second Language Research* **11**, 121–136. https://doi.org/10.1177/026765839501100204
Silawi R, Shalhoub-Awwad Y and Prior A (2020). Monitoring of Reading Comprehension Across the First, Second, and Third Language:

Domain-General or Language-Specific?. *Language Learning* **70**, 886–922. https://doi.org/10.1111/lang.12410

Teubner-Rhodes SE, Mishler A, Corbett R, Andreu L, Sanz-Torrent M, Trueswell JC and Novick JM (2016). The effects of bilingualism on conflict monitoring, cognitive control, and garden-path recovery. *Cognition* **150**, 213–231. https://doi.org/10.1016/j.cognition.2016.02.011

West R (2011). The temporal dynamics of prospective memory: A review of the ERP and prospective memory literature. *Neuropsychologia* **49**, 2233–2245. https://doi.org/10.1016/j.neuropsychologia.2010.12.028

Yang YF (2002). Reassessing readers' comprehension monitoring. *Reading in a Foreign Language* **14**, 18–42. doi: 10125/66584

Appendix A

Table 1. Statistical effects from data analysis in monolinguals vs bilinguals.

Statistical effects	MONOLINGUALS VS BILINGUALS Online text comprehension (Reading Times)	
Group	$F(1,59) = 3.631$; $p = .062$; $\eta_p^2 = 0.058$	
Prospective load	$F(1,59) = 0.403$; $p = .528$; $\eta_p^2 = 0.007$	
Updating	$F(1,59) = 0.006$; $p = .939$; $\eta_p^2 = 0.00$	
Group by prospective load	$F(1,59) = 0.454$; $p = .503$; $\eta_p^2 = 0.008$	
Group by updating	$F(1,59) = 1.077$; $p = .304$; $\eta_p^2 = 0.018$	
Prospective load by updating	$F(1,59) = 0.705$; $p = .405$; $\eta_p^2 = 0.012$	
Group by prospective load by updating	$F(1,59) = 0.007$; $p = .934$; $\eta_p^2 = 0.000$	
Statistical effects	Off-line text comprehension ACC	Off-line text comprehension RT
Group	$F(1,59) = 4.465$; $p < .05$; $\eta_p^2 = 0.070$	$F(1,59) = 2.283$; $p = .136$; $\eta_p^2 = 0.037$
Prospective load	$F(1,59) = 4.944$; $p < .05$; $\eta_p^2 = 0.077$	$F(1,59) = 15.972$; $p < .0001$; $\eta_p^2 = 0.213$
Updating	$F(1,59) = 22.719$; $p < .0001$; $\eta_p^2 = 0.278$	$F(1,59) = 0.025$; $p = .876$; $\eta_p^2 = 0.000$
Group by prospective load	$F(1,59) = 1.315$; $p = .272$; $\eta_p^2 = 0.022$	$F(1,59) = 4.129$; $p < .05$; $\eta_p^2 = 0.065$
Group by updating	$F(1,59) = 0.002$; $p = .\ 968$; $\eta_p^2 = 0.000$	$F(1,59) = 0.277$; $p = .601$; $\eta_p^2 = 0.005$
Prospective load by updating	$F(1,59) = 0.488$; $p = .615$; $\eta_p^2 = 0.008$	$F(1,59) = 1.055$; $p = .351$; $\eta_p^2 = 0.018$
Group by prospective load by updating	$F(1,59) = 2.891$; $p = .059$; $\eta_p^2 = 0.047$	$F(1,59) = 0.829$; $p = .439$; $\eta_p^2 = 0.014$
Statistical effects	PM ACC	PM RT
Group	$F(1,59) = 15.129$; $\mathrm{p} < .0001$; $\eta_p^2 = 0.240$	$F(1,59) = 7.618$; $p < .05$; $\eta_p^2 = 0.114$
Focality	$F(1,59) = 3.356$; $\mathrm{p} = .072$; $\eta_p^2 = 0.054$	$F(1,59) = 3.490$; $p = .067$; $\eta_p^2 = 0.056$
Updating	$F(1,59) = 2.450$; $\mathrm{p} = .123$; $\eta_p^2 = 0.040$	$F(1,59) = 0.793$; $p = .377$; $\eta_p^2 = 0.013$
Group by focality	$F(1,59) = 9.539$; $\mathrm{p} < .05$; $\eta_p^2 = 0.139$	$F(1,59) = 1.875$; $p = .176$; $\eta_p^2 = 0.031$
Group by updating	$F(1,59) = 1.834$; $p = .181$; $\eta_p^2 = 0.030$	$F(1,59) = 0.028$; $p = .867$; $\eta_p^2 = 0.000$
Focality by updating	$F(1,59) = 2.028$; $p = .160$; $\eta_p^2 = 0.033$	$F(1,59) = 0.001$; $p = .978$; $\eta_p^2 = 0.000$
Group by focality by updating	$F(1,59) = 0.220$; $p = .641$; $\eta_p^2 = 0.004$	$F(1,59) = 2.637$; $p = .110$; $\eta_p^2 = 0.043$
Statistical effects	Switching ON-PM ACC	Switching ON-PM RT
Group	$F(1,59) = 3.802$; $p = .056$; $\eta_p^2 = 0.061$	$F(1,59) = 0.379$; $p = .540$; $\eta_p^2 = 0.006$
Focality	$F(1,59) = 7.628$; $p < .05$; $\eta_p^2 = 0.114$	$F(1,59) = 1.240$; $p = .270$; $\eta_p^2 = 0.056$
Updating	$\mathrm{F}(1,59) = 15.198$; $p < .001$; $\eta_p^2 = 0.205$	$F(1,59) = 0.069$; $p = .793$; $\eta_p^2 = 0.001$
Group by focality	$F(1,59) = 19.177$; $p < .0001$; $\eta_p^2 = 0.245$	$F(1,59) = 0.047$; $p = .830$; $\eta_p^2 = 0.001$
Group by updating	$F(1,59) = 0.367$; $p = .547$; $\eta_p^2 = 0.006$	$F(1,59) = 0.111$; $p = .740$; $\eta_p^2 = 0.002$
Focality by updating	$F(1,59) = 0.064$; $p = .801$; $\eta_p^2 = 0.001$	$F(1,59) = 0.000$; $p = .994$; $\eta_p^2 = 0.000$
Group by focality by updating	$F(1,59) = 0.438$; $p = .510$; $\eta_p^2 = 0.007$	$F(1,59) = 0.000$; $p = .999$; $\eta_p^2 = 0.000$

Table 2. Statistical effects from data analysis in bilinguals L1 vs L2.

	BILINGUALS L1 VS L2	
Statistical effects	Online text comprehension (Reading Times)	
Language	$F(1,27) = 32.366$; $p < .0001$; $\eta_p^2 = 0.545$	
Prospective load	$F(1,54) = 0.898$; $p = .352$; $\eta_p^2 = 0.032$	
Updating	$F(1,27) = 0.080$; $p = .779$; $\eta_p^2 = 0.003$	
Language by prospective load	$F(1,27) = 1.343$; $p = .257$; $\eta_p^2 = 0.047$	
Language by updating	$F(1,27) = 0.368$; $p = .549$; $\eta_p^2 = 0.013$	
Prospective load by updating	$F(1,27) = 0.016$; $p = .901$; $\eta_p^2 = 0.001$	
Language by prospective load by updating	$F(1,27) = 0.460$; $p = .503$; $\eta_p^2 = 0.017$	
Statistical effects	**Off-line text comprehension ACC**	**Off-line text comprehension RT**
Language	$F(1,27) = 6.532$; $p < .05$; $\eta_p^2 = 0.195$	$F(1,27) = 19.728$; $< .0001$; $\eta_p^2 = 0.473$
Prospective load	$F(2,54) = 0.506$; $p = .606$; $\eta_p^2 = 0.018$	$F(2,54) = 2.550$; $p = .125$; $\eta_p^2 = 0.104$
Updating	$F(1,27) = 35.781$; $p < .0001$; $\eta_p^2 = 0.570$	$F(1,27) = 0.034$; $p = .856$; $\eta_p^2 = 0.002$
Language by prospective load	$F(2,54) = 0.894$; $p = .415$; $\eta_p^2 = 0.032$	$F(2,54) = 0.025$; $p = .875$; $\eta_p^2 = 0.001$
Language by updating	$F(1,27) = 7.692$; $p < .05$; $\eta_p^2 = 0.222$	$F(1,27) = 0.567$; $p = .459$; $\eta_p^2 = 0.025$
Prospective load by updating	$F(2,54) = 1.863$; $p = .165$; $\eta_p^2 = 0.065$	$F(2,54) = 0.031$; $p = .862$; $\eta_p^2 = 0.001$
Language by prospective load by updating	$F(2,54) = 2.594$; $p = .084$; $\eta_p^2 = 0.088$	$F(2,54) = 1.040$; $p = .319$; $\eta_p^2 = 0.045$
Statistical effects	**PM ACC**	**PM RT**
Language	$F(1,27) = 0.001$; $p = .973$; $\eta_p^2 = 0.000$	$F(1,27) = 7.125$; $p < .05$; $\eta_p^2 = 0.209$
Focality	$F(1,27) = 0.315$; $p = .579$; $\eta_p^2 = 0.012$	$F(1,27) = 2.083$; $p = .160$; $\eta_p^2 = 0.072$
Updating	$F(1,27) = 2.933$; $p = .098$; $\eta_p^2 = 0.098$	$F(1,27) = 1.944$; $p = .175$; $\eta_p^2 = 0.067$
Language by focality	$F(1,27) = 4.278$; $p < .05$; $\eta_p^2 = 0.137$	$F(1,27) = 1.472$; $p = .235$; $\eta_p^2 = 0.052$
Language by updating	$F(1,27) = 0.921$; $p = .346$; $\eta_p^2 = 0.033$	$F(1,27) = 4.509$; $p < .05$; $\eta_p^2 = 0.143$
Statistical effects	**Switching ON-PM ACC**	**Switching ON-PM RT**
Language	$F(1,27) = 3.090$; $p = .090$; $\eta_p^2 = 0.103$	$F(1,27) = 1.371$; $p = .252$; $\eta_p^2 = 0.048$
Focality	$F(1,27) = 0.001$; $p = .976$; $\eta_p^2 = 0.000$	$F(1,27) = 0.120$; $p = .731$; $\eta_p^2 = 9.004$
Updating	$F(1,27) = 22.409$; $p < 0.001$; $\eta_p^2 = 0.000$	$F(1,27) = 2.199$; $p = .150$; $\eta_p^2 = 0.075$
Language by focality	$F(1,59) = 4.126$; $p = 0.052$; $\eta_p^2 = 0.133$	$F(1,27) = 1.949$; $p = .174$; $\eta_p^2 = 0.067$
Language by updating	$F(1,27) = 0.172$; $p = .682$; $\eta_p^2 = 0.006$	$F(1,27) = 1.343$; $p = .257$; $\eta_p^2 = 0.047$
Focality by updating	$F(1,27) = 3..449$; $p = .074$; $\eta_p^2 = 0.113$	$F(1,27) = 4.113$; $p = .053$; $\eta_p^2 = 0.132$
Language by focality by updating	$F(1,27) = 3.388$; $p = .077$; $\eta_p^2 = 0.112$	$F(1,27) = 3.615$; $p = .068$; $\eta_p^2 = 0.118$

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