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Cognitive Brain Research 25 (2005) 312 – 327
COGNITIVE BRAIN RESEARCH
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Research Report

Morphological processing in early bilinguals: An ERP study of regular and irregular verb processing

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Accepted 8 June 2005
Available online 14 July 2005

Abstract

Although the age of acquisition of a language has an effect when learning a second language, the similarity between languages may also have a crucial role. The aim of the present study is to understand the influence of this latter factor in the acquisition of morphosyntactic information. With this purpose, two groups of highly proficient early Catalan–Spanish bilinguals were presented with a repetition-priming paradigm with regular and irregular verbs of Spanish. Catalan and Spanish have a similar suffix (*-o*) for regular verbs and completely different alternations for irregular verbs. Two types of irregular verbs were studied (semi-regular verbs with a systematic diphthong alternation, *sentir–siento*, and verbs with idiosyncratic changes, *venir–vengo*). Regular verbs showed the same centro-parietal N400 priming effect in the second-language speakers (L2) as in primary-language (L1) speakers. However, differences between groups, in the ERP pattern and the topography of the N400 effect, were observed for irregular morphology. In L1 speakers, the N400 effect was attenuated only for semi-regular verbs. In contrast, L2 speakers showed a reduced N400 priming effect in both irregular contrasts. This pattern of results suggests that the similarity between languages may help for similar structures but may interfere for dissimilar structures, at least when the two languages have very similar morphological systems.

Theme: Neural basis of behavior
Topic: Neural plasticity

Keywords: Morphology; Event-related potential; Spanish; Bilingualism; Priming; N400

1. Introduction

It is frequently observed that, despite practice, late learners of a language retain a foreign accent and have greater difficulty in structuring sentences than in using the adequate words. Several studies have shown that this dissociation between grammatical and lexical achievement is modulated by the age of acquisition of the second language (L2). In the classical literature on the topic, it has been shown that while high proficiency is possible in the lexical domain, grammatical acquisition is harder and even impossible to reach at the first language (L1) level, if it has not been learned since early childhood [3,12,22,55]. It has been argued that the reason for this disadvantage in grammatical acquisition is closely linked to the fact that the two types of knowledge rely on different brain systems with different maturational constraints [32].

Nevertheless, maturational constraints do not influence the acquisition of all morphosyntactic structures in the same way [10,21]. In fact, some aspects of grammar are acquired at native or near-native level even in late learners, pointing

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doi:10.1016/j.cogbrainres.2005.06.003

to the crucial weight of other factors such as the explicit/implicit acquisition of the language [4], the salience of the element in the structure to be learned [10], or the similarity between the L1 and L2 systems [23,45,57]. The aim of the present study is to further our understanding of the influence of this latter factor in the acquisition of morphosyntactic information. One of the most commonly used approaches to the study of the differences in grammatical and lexical processing has been to confront second-language speakers with sentences where either semantic or syntactic information is altered [16,17,55]. The results from these studies have repeatedly shown that L2 processing differs from L1 mainly with respect to syntactic processing. Those differences appear not only in terms of behavioral performance (participants produce more errors detecting grammatical than lexical violations) but also in electrophysiological measures. From the syntax literature, it is known that reading syntactic violations can elicit two consecutive components: an early left anterior negativity (LAN) around 250–350 ms after the stimulus onset, more pronounced over the left anterior and temporal sites, followed by a positivity around 600 ms (P600) [13,25,31,34]. Lexical and semantic violations elicit a negative increase around 400 ms (N400) after the onset of the word presentation over the central–parietal sites [24,25]. In the bilingual studies, while lexical–semantic manipulations manifest the same modulation in L1 and L2 in the N400 component, the LAN effect does not appear in grammatical manipulations in the L2 groups [16,17].

Recently, an increasing amount of evidence has shown how grammatical and lexical processes can be mapped through the study of the representation and processing of regular and irregular morphology [38,54]. In this context, it has been proposed that regular verbs are stored as stems and produced in their inflected forms by applying a morphological rule. Irregular verbs, on the other hand, are stored and retrieved as whole forms in the lexicon. This claim has been supported by neuroimaging studies using PET [19] and fMRI [2,44]. In addition, event-related brain potential (ERP) studies have shown that violations involving the misapplication of a regular suffix elicit the same LAN and in some studies the P600 component, which has been related to grammatical processing—while the misapplication of an irregular morphological manipulation elicits N400 modulations classically related to lexical–semantic processing [18,36,41,56]. In the same vein, using the delayed repetition priming paradigm, regular non-inflected forms showed a reduction in the N400 component when they were preceded by their related inflected forms [1,30,56]. An inter-item lag of 5 to 9 stimuli was used between the presentation of the prime and the target in order to avoid formal and perceptual priming effects. This repetition priming effect was not observed for irregular inflected forms. Taken together, these data suggest that regular inflected forms are decomposed into stems and affixes and therefore, repeated access to the same-shared representation elicited the reduction in the N400 component. However, irregular inflected forms do not show this effect due to access of separate lexical representations [1,30,56].

Although morphological processing has been widely used in the field of first-language processing, few studies have focused on second-language acquisition in bilinguals [18,26,39]. Hahne et al. [18] explored how L2 learners processed inflected words by means of two offline tasks (acceptability judgement and elicited production) and ERP recordings during the processing of morphological violations. The participants in this study were L2 learners of German with Russian as their first language. The authors studied the processing of nominal (plurals) and verbal morphology (past participles). The behavioral results showed that the error ratings were higher in the L2 group in the acceptability judgement task. With regard to the ERP, the results showed that the violations of the regular suffixation elicited a P600 but no LAN, while both components were present in the native group. Although this result is consistent with the idea that late bilinguals do not process regular verbs in the same way as native speakers, a surprising and interesting result was obtained for past participle processing. In this case, the bilingual group was identical to the group of native speakers of German for the processing of regular and irregular violations in performance as well as in the ERP measures. Interestingly, Russian and German share a regular suffix (-t) and this similarity between languages may have a crucial influence, probably facilitating the learning of this inflectional rule in German. However, despite the similarities in the suffixes in both languages, participle formation in Russian is different from German. In Russian, the selection of the *-n* and *-en* participle suffixes is phonologically determined by certain stem endings, while in German, the *-n* suffix is determined by class membership and only applies to the subclass of strong verbs.

Another interesting study by Portin and Laine [39] reinforces the idea that the limitation in L2 grammatical (morphological) learning could actually depend on the similarity between the first and second language of the speaker with respect to this dimension. The participants of Portin and Laine [39] study were fluent early Swedish–Finnish bilinguals. Finnish has a very rich morphological system and, in fact, native Finnish monolinguals process words in a compositional manner (in combinations of stems and affixes). For its part, Swedish is a Germanic language and has a much more limited morphological system. In this study, Swedish monolinguals processed monomorphemic and inflected Swedish nouns at approximately equal speed. In contrast, Finnish–Swedish bilinguals processed inflected Swedish items significantly slower than monomorphemic ones. This pattern of results indicates that Finnish–Swedish bilinguals transferred the process of decomposing inflected words in their L1 (Finnish) into Swedish. These results, together with others [3,12], taking into account the L1–L2 pairings, suggest that L2 morphosyntactic acquisition may be shaped by the characteristics of the L1 morphosyntactic system.

In order to further explore this idea, we conducted an ERP study on Spanish morphology with two groups of highly proficient Catalan–Spanish early bilinguals with inverse profiles. One group (hereafter referred to as *L1-Spanish*) learned Spanish as their primary language and Catalan as their second language (L2). In contrast, the *L2-Spanish group* learned Catalan first. The interest of these languages is that, as in the German–Russian study, the regular suffix (*-o*) we studied is common to both languages[1] (e.g., menj-ar/menj-*o* [to eat/I eat]: Catalan, cant-ar/cant-*o* [to sing/I sing]: Spanish) while the irregular alternations are totally different (for a description of the languages, see Appendix A). Previous studies have investigated pairs of languages from different Language Families (Germanic–Slavic [18] and Finno Ugric–Germanic [39]), languages with some similarities but, generally speaking, huge differences between morphological systems. Spanish and Catalan have very similar morphological structures: they both have the same number of tenses and persons. Therefore, learners can easily exploit the structures already available in their L1 in the process of learning their morphological L2 system.

The influence of L2 proficiency in these studies should also be carefully considered. Sabourin [43] found clear P600 effects for gender agreement violations in L2 for a highly proficient German group learning Dutch, but this effect did not emerge in a non-fluent bilingual German group. The early acquisition of both languages and their common use in everyday life make our bilingual groups highly proficient in both their languages, and discounts the possible influence of unwanted variables such as proficiency and frequency of use of the L2. Despite this early acquisition, however, our subjects' first contact with L2 appeared after the age of three. At this age, children have already developed their L1 morphological system although it is still not fully consolidated [37,47,52]. Thus, the characteristics of the bilingual groups and the languages studied provide a unique context for the study of the influence of the similarities and discrepancies between languages in the acquisition of the morphological system of L2. If the similarity between languages is a critical factor affecting morphological acquisition, then differences should arise for irregular verb processing, and processing of regular verbs should be comparable for native and L2-Spanish speakers.

We were also interested in the general effect of morphological results, as few studies have so far studied the processing of regular and irregular verbs in Spanish. Recently, Rodriguez–Fornells et al. [42] studied morphological priming of regular and irregular present tense inflections in this language using a delayed repetition-priming paradigm. However, they did not distinguish between different types of irregularities. Spanish has two groups of irregular verbs: (a) *semi-regular* verbs that have a frequent, non-systematic vowel to diphthong alternation in their stem: unstressed "-e-" and "-o-" become "ie" and "ue", respectively, in stressed position (i.e., "s*e*nt-ír/ s*ié*nt-o" to feel/I feel; "m*o*v-ér/ m*ué*v-o" to move/I move), and (b) *idiosyncratic* verbs that have a non-systematic phonological alternation in their stem (e.g., v*e*st-ir/v*i*st-o [to dress/I dress]; ca-er/caigo [to fall-I fall]). Recent neuropsychological data [8] in two aphasic patients with lesions involving Broca's area have shown a dissociation between their performance in regular versus idiosyncratic verb inflection, but the pattern of performance for semi-regular verbs awaits further exploration [7]. With regard to other languages, results from Hebrew and German [1,49] with verb forms with an alternation similar to that of *semi-regular* verbs in Spanish and retaining the regular suffixes showed the same amount of priming as regular verbs. Nevertheless, some findings do not support this idea. It seems that the diphthong alternation of Spanish is not productive in nonce verbs, as shown by Bybee and Pardo [5]. In that study, a nonce probe task administered to Spanish-speaking adults [5] revealed that participants rarely introduced an alternation into a nonce verb, indicating that these kinds of alternations have restricted productivity and do not easily extend to new lexical items. In addition, children show differences in the way they acquire these forms compared to regular verbs [6]. The importance of splitting between these different kinds of irregularities has also been noted in other morphologically complex languages [29,34]. Because of this, we distinguished between these two types of irregularities in our study.

2. Materials and methods

2.1. Participants

Thirty right-handed volunteers participated in the ERP experiment. All of them were born in Catalonia (most of them in Barcelona or its metropolitan area). Half were raised as Spanish monolinguals until the age of four, when schooling started. During the first years of their lives, their contact with Catalan was sporadic. The other half of the bilinguals had exactly the same characteristics, except that Catalan was their first language and Spanish their second language. All participants had received a bilingual Spanish–Catalan education and they were very fluent in the two languages, in both listening and reading. The characteristics of the groups are detailed in Table 1. Two subjects, one from each group, were rejected due to excessive ocular movements. All participants were students at the University of Barcelona and were paid for their participation in the experiment. They all gave written informed consent. The

[1] Although the so-called *Central* variant of Catalan pronounces the -o suffix as /u/, the remaining varieties pronounce it as /o/ and the written form is also -o.

Table 1
Language history and self-evaluated proficiency scores of the two bilingual groups

Language history	L1-Spanish	L2-Spanish		
Age	20 (1.2)	21 (4.6)		
Onset of the L2 acquisition	4.4 (1.9)	3.6 (1.4)		
Use of L2	5.5 (0.7)	2.0 (0.7)		
Proficiency	L1	L2	L1	L2
Production	4.0 (0)	3.9 (0.3)	4.0 (0)	4.0 (0)
Comprehension	4.0 (0)	3.8 (0.3)	4.0 (0)	4.0 (0)
Writing	4.0 (0)	3.1 (0.5)	4.0 (0)	3.6 (0.5)
Reading	3.9 (0.3)	3.5 (0.5)	3.9 (0.3)	3.9 (0.6)

Notes. Mean age and standard deviation (SD) are given in years. Onset of L2 acquisition refers to the mean age (in years) at which participants started their contact with the second language. "Use of L2" refers to the self-evaluation rates use in a 7-point scale ranging from 1 = Catalan only; 2 = Catalan frequently, Spanish rarely; 3 = Catalan majority with Spanish at least 1/4 of the time; 4 = Equal use of Spanish and Catalan; 5 = Spanish majority with Catalan at least 1/4 of the time; 6 = Spanish frequently; Catalan rarely; 7 = Spanish only. The proficiency scores refer to the self-evaluation rates in a 4-point scale raging from 4 = native speaker level to 1 = complete ignorance of the language. The self-evaluation scores were obtained through an adaptation of the Weber-Fox and Neville [55] questionnaire filled out by the participants before the experiment.

experiment was approved by the ethical committee of the University.

2.2. Task and stimulus materials

In order to avoid unwanted semantic effects from morphological priming, we adopted the paradigm developed in the word-reading domain by Stolz and Besner [50,51]. This priming paradigm uses prime–target word pairs that are semantically (*nurse–doctor*), morphologically (*marked–mark*), or formally related (orthographic and phonological overlap with no semantic relation, *market–mark*). The critical aspect is that participants are engaged in an orthographic search task during the presentation of the prime and a lexical decision has to be performed on the target, presented immediately afterwards. As the semantic condition shows no priming with this paradigm, the priming observed in the morphological condition cannot be explained by the semantic relationship between morphologically related words. The authors reasoned that the letter search task on the prime involves an attentional manipulation that blocks semantic access to the prime but maintains morphological priming.

As in the Stolz and Besner paradigm, in our experiment, each trial required the performance of a dual task from the participants. Subjects were instructed to make a letter search in the prime word and afterwards a lexical decision task in the target word. During the letter search task, in half of the trials, the letter to be searched for was present in the prime word. Before the experimental trials, subjects were presented with 40 training trials in which feedback on their responses was provided. No feedback was given afterwards. The complete sequence in a trial was the following: a fixation point (an asterisk) was presented for 1000 ms and the prime screen set followed. The letter to be searched for in the prime was presented as a repeated upper case letter string (e.g., PPPPPP) with as many letters as the prime word presented above. The prime screen set was presented until the subject gave a response, or for a maximum of 1500 ms. As soon as the screen set disappeared, the target was presented until the subject gave a response or for a maximum of 1500 ms. Targets were presented in lower case to avoid pure perceptual priming effects. Subjects responded by means of two accessory key buttons, one for each hand. Response hand assignments were counterbalanced across subjects.

Three Spanish morphological verb conditions were used: regular, semi-regular, and idiosyncratic. Sixty prime–target pairs of words in each condition and respective nonwords were selected. Approximately half of the verbs in each condition were cognates (33 regular, 39 semi-regular, 30 idiosyncratic) and half were non-cognates.[2] Targets across conditions and related and unrelated control primes were matched ($t < 1$ in all cases) in frequency and length (Table 2). Frequency values were obtained from LEXESP [46]. In order to be able to observe the effects of the pure formal (orthographic) overlap, nonwords were constructed mimicking the three different types of morphological relatedness, by using existing real verb suffixes and nonce stems which were only one segment different from real words. In total, 180 word–word pairs and 180 nonword–nonword pairs were obtained in this way. A condition with 60 pairs of semantically related words, with no formal or morphological relation, was also created, in order to assess the effectiveness of the semantic blocking with this paradigm. We chose to use semantically related items such as synonyms in order to have a condition that resembled morphological relations as closely as possible. In addition, 240 filler pairs (120 nonword–word pairs and 120 word–nonword) were included. Both nouns and verbs were used as fillers. Two lists of 30 related and 30 unrelated experimental word pairs of each condition were created (the list of stimuli can be seen in Appendix B). Stimuli appearing with their related primes in one list appeared with their control primes in the other. Subjects participated in two experimental sessions. In the first session, half of the subjects saw the first list and the other half the second one. In the second session, the lists were counterbalanced and therefore, subjects saw each stimulus only once per session. An example of one of the lists used is illustrated in Table 3.

If the paradigm is able to block semantic priming, then a clear difference in the priming effects should be detected in the ERP and behavioral data between the semantic and morphological conditions. Then, if the similarity between

[2] Despite the cognate status, most of the verbs had different suffixes in the languages. A verb that has the same stem in both languages may have a different thematic vowel and may use different regular suffixes or different irregular patterns in the two languages. See Appendix A for details.

Table 2
Mean letter length and mean frequency (per million) in the different experimental conditions

Experimental conditions	Length			Frequency		
	Target	Related	Unrelated	Target	Related	Unrelated
Verbs						
Regular	6.52	5.52	5.60	32.17	11.14	8.81
Semi-regular	6.65	6.65	6.37	25.18	14.65	15.21
Idiosyncratic	6.60	6.15	5.92	35.81	16.40	15.83
Semantic relation	5.85	6.13	6.00	51.74	42.14	41.86

the morphological systems of a bilingual has a crucial effect on the way L2 is processed, we should observe differences in the behavioral and/or ERP patterns for regular and irregular verbs between groups, with regular verbs showing a closer pattern to the L1 Spanish speakers than irregular ones. In addition, based on previous results on Spanish, we would not expect differences in the amount of priming in either type of verb for the L1 group in the behavioral data. In contrast, differences between regular and irregular verbs should arise in the ERPs although no specific hypothesis is expected a priori for the two irregular contrasts.

2.3. Electrophysiological recording

The ERPs were recorded from the scalp using tin electrodes mounted in an electrocap (Electro-Cap International) and located at 29 standard locations (Fp1/2, Fz, F7/8, F3/4, Fc1/2 Fc5/6, Cz, C3/4, T3/4, Cp1/2, Cp5/6, Pz, P3/4, T5/6, Po1/2, O1/2). Biosignals were rereferenced off-line to the mean of the activity at the two mastoid processes. Vertical eye movements were monitored with an electrode at the infraorbital ridge of the right eye. Electrode impedances were kept below 5 kΩ.

The electrophysiological signals were filtered with a bandpass of 0.01–50 Hz (half-amplitude cutoffs) and digitized at a rate of 250 Hz. Trials with base-to-peak electro-oculogram (EOG) amplitude of more than 50 μV, amplifier saturation, or a baseline shift exceeding 200 μV/s were automatically rejected off-line. No significant differences were observed for the percentage of rejected trials in both groups [$t(28) < 1$; in the L1-Spanish 10.3% and 11.7% in the L2-Spanish group].

2.4. Data analysis

Stimulus-locked ERPs were averaged for epochs of 1024 ms starting 100 ms prior to the stimulus. In order to encompass the N400 repetition priming effect, the waveforms were quantified by mean-amplitude measures in two time windows: 200–400 ms and 400–600 ms post-target onset. Several three- and four-factor repeated measures ANOVAs were conducted on the mean amplitude of the N400 component (200–400 and 400–600 time windows) for the evaluation of stimulus-locked ERPs (specified in each case in the Results section) including *relatedness* (related, unrelated prime), *verb type* (regular, semi-regular and idiosyncratic forms), *hemisphere* (right, left), and *anterior/posterior* position as within-subject factors. This analysis was performed on the real verb conditions and in the nonce conditions separately. The ANOVAs were carried out for the critical time windows at parasagittal (PS) (5 levels for the anterior/posterior factor: Fp1/Fp2, F3/F4, C3/C4, P3/P4, O1/O2), temporal (TE) (3 levels for the anterior/posterior, F7/F8, T3/T4, T5/T6) and midline (MD) (Fz, Cz, Pz) electrode locations. The bilingual *group* (L1-Spanish, L2-Spanish) was introduced in all the ANOVAS as a between-subjects factor. For the resulting interactions including group, relatedness, or verb type, additional ANOVAs were carried out, being restricted to specific electrode sites as determined by the corresponding interactions with hemisphere or anterior/posterior factors in the different locations (PS, TE, and MD).

For all statistical effects involving two or more degrees of freedom in the numerator, the Huynh–Feldt epsilon was used to correct for non-sphericity [20]. The exact P value after the correction will be reported. Moreover, tests involving electrode × condition interactions were carried

Table 3
An example of the experimental conditions used in the ERP experiment

Experimental conditions	List 1		List 2	
	Related	Unrelated	Related	Unrelated
Verbs				
Regular	gano–ganar	fundo–temer	temo–temer	espio–ganar
Semi-regular	cuento–contar	bailo–moler	muelo–moler	resisto–contar
Idiosyncratic	mido–medir	guardo–pedir	pido–pedir	ordeno–medir
Nonce verbs				
Regular	gazo–gazar	lundo–teper	tepo–teper	esbío–gazar
Semi-regular	cuengo–congar	baino–moder	Muedo–moder	registo–congar
Idiosyncratic	bedo–bedir	Vazgo–vacer	allaso–vacer	cuardo–bedir
Semantic relation	maestro–profesor	lechuga–cuchillo	tenedor–cuchillo	capricho–profesor
Fillers		avión–zaja		avión–zaja
		alcofol–cierto		alcofol–cierto

out on data corrected using the vector normalization procedure [28].

3. Results

3.1. Behavioral performance

3.1.1. Morphological priming in L1 and L2

An ANOVA with factors group, relatedness, and verb type was performed for the analysis of reaction times in the lexical decision task performed on the targets. In the analyses concerning real verbs, no differences between groups were encountered [$F(1,28) = 1.3$; $P > 0.2$; mean reaction time and standard deviation for the L1 group, 664 ± 127 ms; L2 group, 708 ± 83]. As expected, significant main effects were found for relatedness [$F(1,28) = 111$, $P < 0.0001$; related 659 ± 105, unrelated 713 ± 108] and verb type [$F(2,56) = 34.6$, $P < 0.0001$; regular 669 ± 104 ms, semi-regular 687 ± 110, idiosyncratic 703 ± 114]. However, no interactions were significant. The same analyses were also performed for nonce verbs. In this case, the only significant main effect was relatedness [$F(1,28) = 6.9$; $P < 0.01$]. The direction of the effect was the inverse as in the real verb conditions (related 805 ± 95 ms, unrelated 789 ± 95). No interactions were significant.

The percentage of erroneous responses observed in both real and nonce verbs mirrored the reaction time pattern (see Fig. 1). For real verbs, no differences were observed between groups ($F < 1$; L1: 10% ± 7; L2: 12% ± 8). The main effects observed were relatedness [$F(1,28) = 84.5$, $P < 0.0001$, related: 9% ± 7, unrelated: 13% ± 8] and verb type [$F(2,56) = 50.1$, $P < 0.0001$; regular forms: 8% ± 5, semi-regulars 10% ± 7, idiosyncratic 15% ± 8]. For the nonce verbs, the only significant effect was relatedness [$F(1,28) = 6.9$, $P < 0.01$, related 17% ± 9, unrelated 15% ± 10].

3.1.2. Source of the morphological priming

In order to compare the semantic control condition with the other conditions (morphological verb priming and formal priming in nonwords), an ANOVA was computed with the following within-subject factors: condition (regular-verb, regular-nonce-verb, semantic condition) and relatedness (related vs. unrelated). Main effects of relatedness and condition were significant [$F(1,28) = 69$ and $F(2,56) = 230$, respectively]. A significant interaction between condition and relatedness [$F(2,56) = 11.6$, $P < 0.001$] showed crucial differences in the amount of priming: reaction time (unrelated minus related) difference for morphological priming was ~55 ms; formal priming ~−22 and semantic priming ~19. A pairwise comparison applied only in the semantic condition between related and unrelated targets showed that the priming effect was significant [$F(1,28) = 18.6$, $P < 0.001$]. For the percentage of errors, relatedness was not significant [$F(1,28) = 2.5$, $P > 0.13$] but condition and its interaction reached a significant value [$F(2,56) = 32.8$, $P < 0.001$; $F(2,56) = 7.1$, $P < 0.01$, respectively]. This interaction reflected the reduction of errors in the related morphological targets (~2%) and the increase in the nonce and semantic conditions (~3.3% and ~1.5%, respectively).

3.2. ERPs

The grand average ERPs for both L1-Spanish and L2-Spanish groups are shown in Figs. 2 and 3, respectively, for the three morphological priming conditions (related and unrelated targets) and the control semantic condition. It can be observed that the target ERP waveforms began with a widespread central N1 component (peaking around 90–110 ms), followed by a standard P200 component. The N1 component was unusually large compared to that normally observed in word reading or lexical decision tasks. This is due to the fact that the target word was presented immediately after the letter search task performed on the

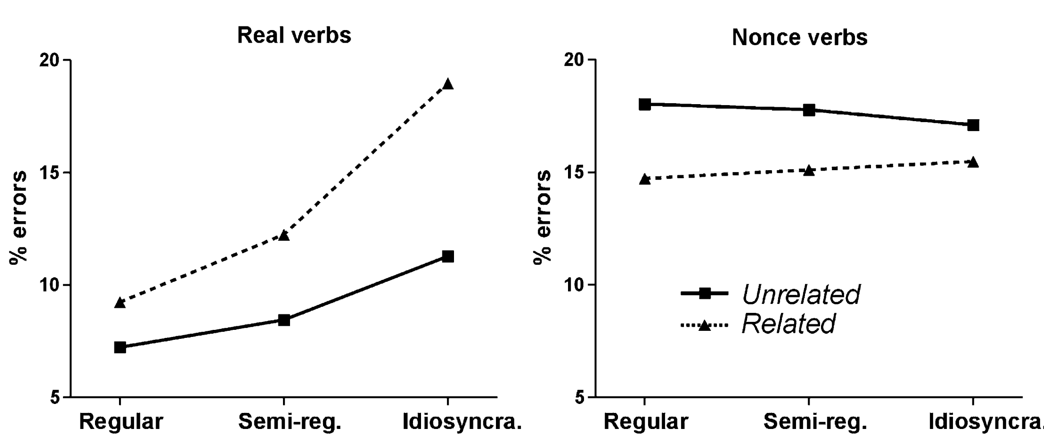

Fig. 1. Percentage of erroneous responses for the regular, semi-regular, and idiosyncratic conditions comparing the effect of priming (related and unrelated targets). In the real verb conditions (left site), the effect of priming reduces the percentage of errors, especially in the idiosyncratic forms. In nonce conditions (right site), related forms showed a larger percentage of erroneous responses equally distributed in the three types of forms.

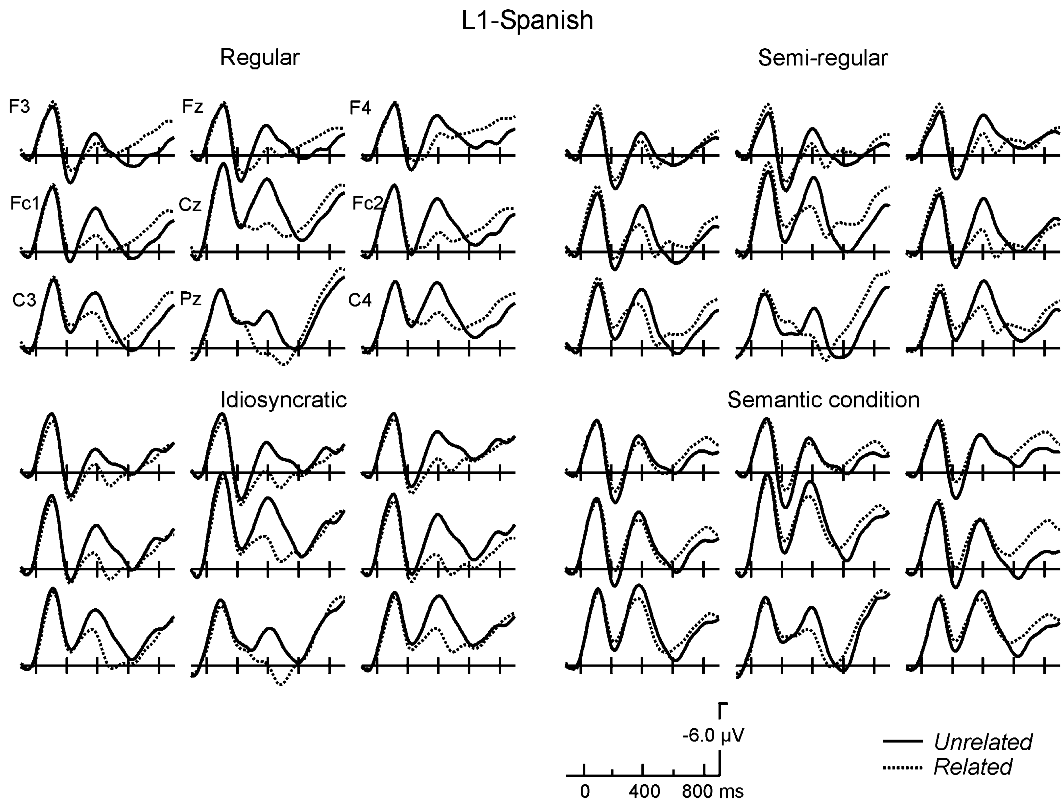

Fig. 2. Grand average ERPs for the Spanish group (n = 15) for frontal, frontocentral, central, and parietal electrode locations elicited on the three morphological priming conditions using real verbs and the control semantic one. Both related and non-related targets are depicted. Notice the decreased N400 component elicited (between 200 and 600 ms) in all the morphological priming conditions. In the semantic condition, an only slightly reduced N400 is observed in the related targets.

prime. Thus, the N1 component overlapped with previous ERP components related to the processing of the prime and the first task. After the N1 component, notable differences were observed between related and unrelated targets and for the morphological conditions (see Figs. 2 and 3). A clear decrease in the N400 component was observable in related targets compared to the unrelated ones. This priming effect appeared just after 200 ms and lasted until 600 ms, being observable at frontocentral and posterior locations. We will first comment on the overall semantic, formal, and morphological effects taking the two groups of subjects together to clearly isolate the contribution of morphological priming, and then we will present the results for each group of subjects in order to observe the effect of their language dominance.

3.2.1. Source of the morphological priming

The overall results confirm that the letter search paradigm was able to reduce considerably the contribution of semantic priming and that the morphological priming differs from semantic and formal priming with respect to the topographical distribution of the N400 effect.

3.2.1.1. Semantic priming. The analysis of the semantic condition showed that, overall, the paradigm successfully minimized semantic priming by doing the letter search, although some priming showed up in left parietal electrodes (see Figs. 2 and 3). An ANOVA with relatedness factor alone was carried out in this condition and showed that this factor was not significant at 200–400 ms in any of the locations ML, PS, or TE [in all cases, $F(1,28) < 2.1$ and $P >$ 0.16]. However, a significant interaction between relatedness and hemisphere [$F(2,56) = 5.6$, $P < 0.05$] was observed at parasagittal locations showing a larger priming effect in the left hemisphere (mean amplitude for related targets, left hemisphere -0.52 ± 3.9 µV, right -0.29 ± 3.9; unrelated right, -1.1 ± 3.8 and left -0.5 ± 3.6). In the 400- to 600-ms time window, a significant reduction in the N400 was observed [ML, $F(1,28) = 5.1$, $P < 0.05$; PS, $F = 7.4$, $P < 0.05$; TE, $F = 10.9$, $P < 0.01$]. The other interactions did not show any significant value.

3.2.1.2. Formal priming. To rule out the contribution of formal priming, the effect on nonce verbs was also compared for the three different conditions evaluated (see Fig. 4). Because no effects were observed in performance for the different forms in the nonce verbs, the ANOVAs were conducted for all conditions pooled together. No effect of relatedness appeared for the first time window 200–400 ms [ML: $F(1,28) = 3.9$, $P < 0.06$; PS, $F = 1.2$; TE, $F < 1$). However, during this time window, a significant interaction was present between relatedness and anterior–posterior

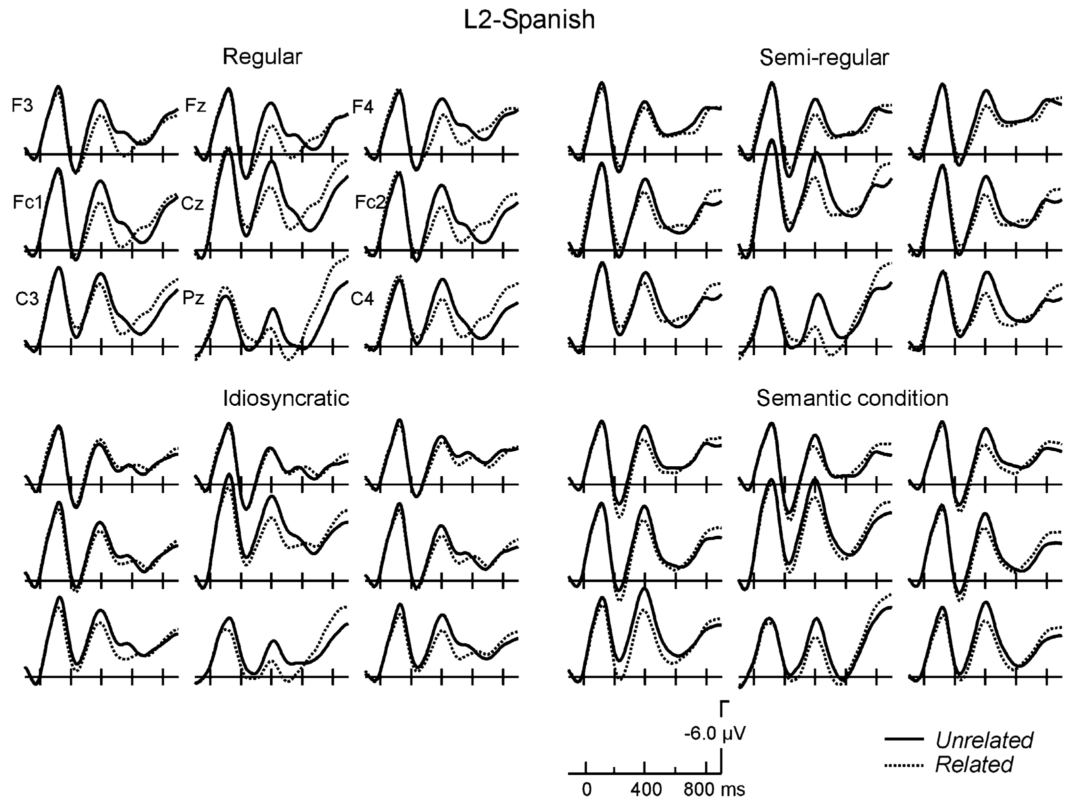

Fig. 3. ERPs for the Catalan group (n = 15) which depicts the same conditions as in Fig. 2. In the idiosyncratic verb condition, the N400 priming effect is not observable in the frontal central electrodes when compared to the L1-Spanish group.

topographical factor at PS and TE locations [$F(4,112) = 4.6$, $P < 0.01$; $F(2,56) = 4.6$, $P < 0.05$]. Besides, an interaction between relatedness × anterior–posterior × hemisphere was present at PS locations [$F(4,112) = 2.8$, $P < 0.05$]. In the 400- to 600-ms time window, a clear priming effect appeared in all locations [$F(1,28) > 6.4$, $P < 0.02$, for all]. The interaction with anterior–posterior locations remained significant in the three locations (in all cases $F > 3.8$, and $P < 0.02$). This interaction reflects the larger reduction of the N400 component in the related targets at posterior electrode locations. Significantly, no interactions with the variable group were obtained, either for the formal or for the semantic priming effects.

3.2.1.3. Morphological priming. Focusing now on the results in the three morphological conditions (Figs. 2 and 3), Table 4 presents a summary of the overall ANOVAs conducted with factors group, relatedness, verb type, and topography. It is evident that the priming effect was significant at both time windows (200–400 and 400–600 ms) for the ML and PS locations and at 400–600 ms for the temporal electrode locations. However, the effect was modulated by topography. The N400 priming effect was larger during the first time window over the right hemisphere. This was reflected by the interaction between relatedness and hemisphere (mean amplitude at temporal locations for the related targets, right hemisphere −0.6 ± 2.1 μV, left −0.02 ± 2.2; unrelated ones, right −0.5 ± 2.3 and left −0.5 ± 2.4). Further, the reduction of the N400 in the related targets was larger in the central and posterior sites compared to the anterior ones during the second time window (see Table 4). This effect is also clearly observable in the

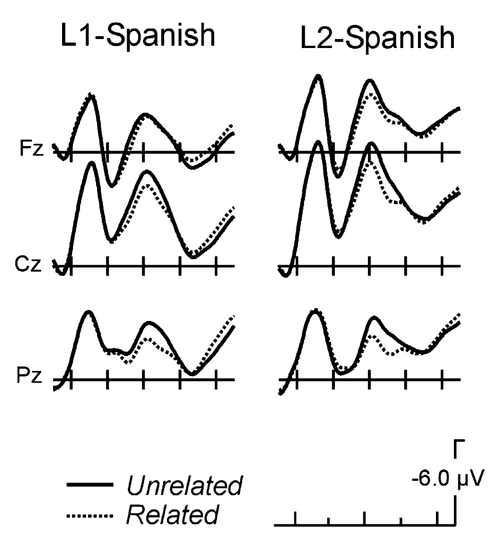

Fig. 4. ERPs for the Spanish and Catalan L1 groups elicited for the targets of the nonce verbs that appeared after nonce primes. All the conditions have been pooled together. No differences between groups were noticeable in this condition.

Table 4
Summary of overall ANOVAs for the verb conditions

	Midline (ML)		Parasagittal (PS)		Temporal (TE)	
	200–400 *F*=, *P*<	400–600 *F*=, *P*<	200–400 *F*=, *P*<	400–600 *F*=, *P*<	200–400 *F*=, *P*<	400–600 *F*=, *P*<
R[a]	11.9, 0.002	20.7, 0.001	6.9, 0.014	20.2, 0.001		23.5, 0.001
RxH[a]	n.a.	n.a.	5.2, 0.030		11.4, 0.002	
RxAP[b]		7.44, 0.001		9.29, 0.004		13.3, 0.001
RxHxAP[b]	n.a.	n.a.	2.8, 0.043		6.03, 0.018	7.73, 0.001
VxHxAP[c]	n.a.	n.a.				3.94, 0.011
GxRxV[d]		3.32, 0.043		3.09, 0.053		4.14, 0.021
GxRxVxAP[e]		2.74, 0.072	6.0, 0.032	2.24, 0.089	3.74, 0.014	3.25, 0.046

Notes. 'G' = group effect (L1-Spanish; L2-Spanish), 'R' = relatedness (related or unrelated prime-target relations), 'V' = verb type (regular, semi-regular, idiosyncratic), 'AP' = anterior–posterior line of electrode locations and 'H' = hemisphere. Main effects for 'H' and 'AP' factors and its interaction have been omitted, as have factors or interactions with no significant intervals. Two time windows were selected in order to encompass the early and late priming effects observed in the N400 component. Huynh–Feldt epsilon was applied when necessary. Blank cells in the table were not significant ($P > 0.05$); n.a. = non-applicable in the corresponding ANOVA. Degrees of freedom of the F values: [a]1,28; [b]2,56 for ML/TE and 4,112 for PS; [c]4,112 for TE; [d]2,56; [e]4,112 for ML/TE and 8,224 for PS.

difference waveforms (unrelated minus related targets) depicted in Fig. 5.

3.2.2. Morphological priming in L1 and L2

If we further split the data into the two groups of interest (L1-Spanish and L2-Spanish), Figs. 2 and 3 show that the groups mainly differed in the idiosyncratic condition. While the L1-Spanish group showed a robust priming effect in the different frontal, central, and posterior locations depicted, the L2-Spanish group did not show a similar effect for this condition. This was confirmed with the significant interaction between group × relatedness × verb type and the four-way interaction between group × relatedness × verb type and anterior–posterior locations, which was significant at parasagittal and temporal clusters in the 200- to 400-ms time window (see Table 4). In order to decompose this interaction, the effect of relatedness was assessed independently for each group in each verb condition. An ANOVA (relatedness, hemisphere, anterior–posterior) was carried out in each bilingual group (see Table 5). As shown in this table, the L2- and L1-Spanish groups differed clearly in the priming effects observed in the N400 component time-range.

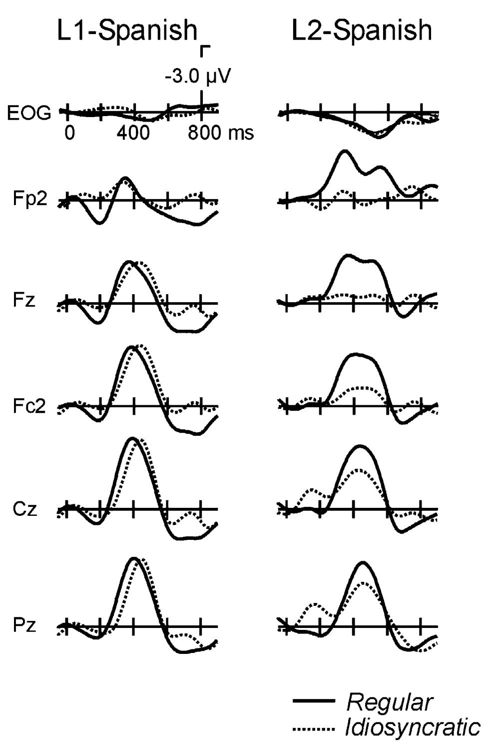

Fig. 5. Unrelated minus related difference waveforms depicted for regular and idiosyncratic verb conditions that correspond to the frontal/central/parietal electrode locations at the midline and right hemisphere. The difference waveforms were plotted after being bandpass filtered (0.5–4 Hz half-amplitude cutoff).

3.2.2.1. Morphological priming in L1.

A clear effect of priming (reduction in the N400 for related targets) was found in the L1 group for the regular and idiosyncratic

Table 5
Summary of the ANOVAs applied in each group and for each experimental verb condition

	Regular						Semi-regular						Idiosyncratic					
	ML		PS		TE		ML		PS		TE		ML		PS		TE	
	t1	t2	t1	t2	t1	t2	t1	t2	t1	t2	t1	t2	t1	t2	t1	t2	t1	t2
L1-Spanish																		
R	+	+										+	+	+++	+	+++		+++
RxH	n.a.	n.a.	+	+	++													
RxAP				+		+												
RxHxAP	n.a.	n.a.																
L2-Spanish																		
R		+		+		++		+		+		+						
RxH	n.a.	n.a.				+												
RxAP			+		+			+		+						++		++
RxHxAP	n.a.	n.a.													+	+		+++

Notes. 'R' = relatedness (related or unrelated targets), 'AP' = anterior–posterior line of electrode locations and 'H' = hemisphere. Time windows evaluated: 't1' = 200–400 ms and t2 = 400–600 ms. Main effects for 'H' and 'AP' factors and its interaction have been omitted. Huynh–Feldt epsilon was applied when necessary. Blank cells in the table were not significant ($P > 0.05$); Probability of the F tests: $^{+}P < 0.05$; $^{++}P < 0.01$; $^{+++}P < 0.001$. n.a. = non-applicable in the corresponding ANOVA.

conditions. However, no significant priming or interactions were found in the semi-regular condition in this group (with the exception of the temporal locations at the 400–600 ms). In the L2 group, a clear priming pattern for the regular and semi-regular conditions was evident. In contrast, no significant priming effects were found for the idiosyncratic condition, but the interactions between relatedness and anterior–posterior and between relatedness, hemisphere, and anterior–posterior indicated that the reduction of the N400 for related targets was not observed at anterior sites, though it was present in the posterior electrodes. Figs. 5 and 6 illustrate clearly the priming effects (unrelated minus related amplitude difference) for each verb condition at frontal and posterior sites (mean amplitude of three frontal and parietal electrodes in Fig. 6).

3.2.2.2. Morphological priming in L2. In the L2 group, a clear reduction in the priming effect was observed for the idiosyncratic condition at frontal sites and in both time windows evaluated. This pattern contrasts with the clear priming effect in idiosyncratic forms for the L1 group. Another earlier time window, at 100–250 ms, emerges as a clear indicator of differences between the morphological priming effects in the L1 and L2 groups (Fig. 5). An obvious differentiation at this interval appeared between the regular and idiosyncratic conditions selectively for the L2 group in the posterior electrodes as proved by the regularity × relatedness × anterior–posterior interaction in this group of subjects [PS: $F(8,112) = 3.6$, $P < 0.02$]. Higher negativity was found in idiosyncratic verbs than in regular verbs. These differences did not appear in the L1 group ($F < 1$).

4. Discussion

In this study, we tested how the similarity between the two morphological systems of a bilingual influences the processing of an L2. With this aim, morphological processing for regular and irregular verbs was studied in first- and

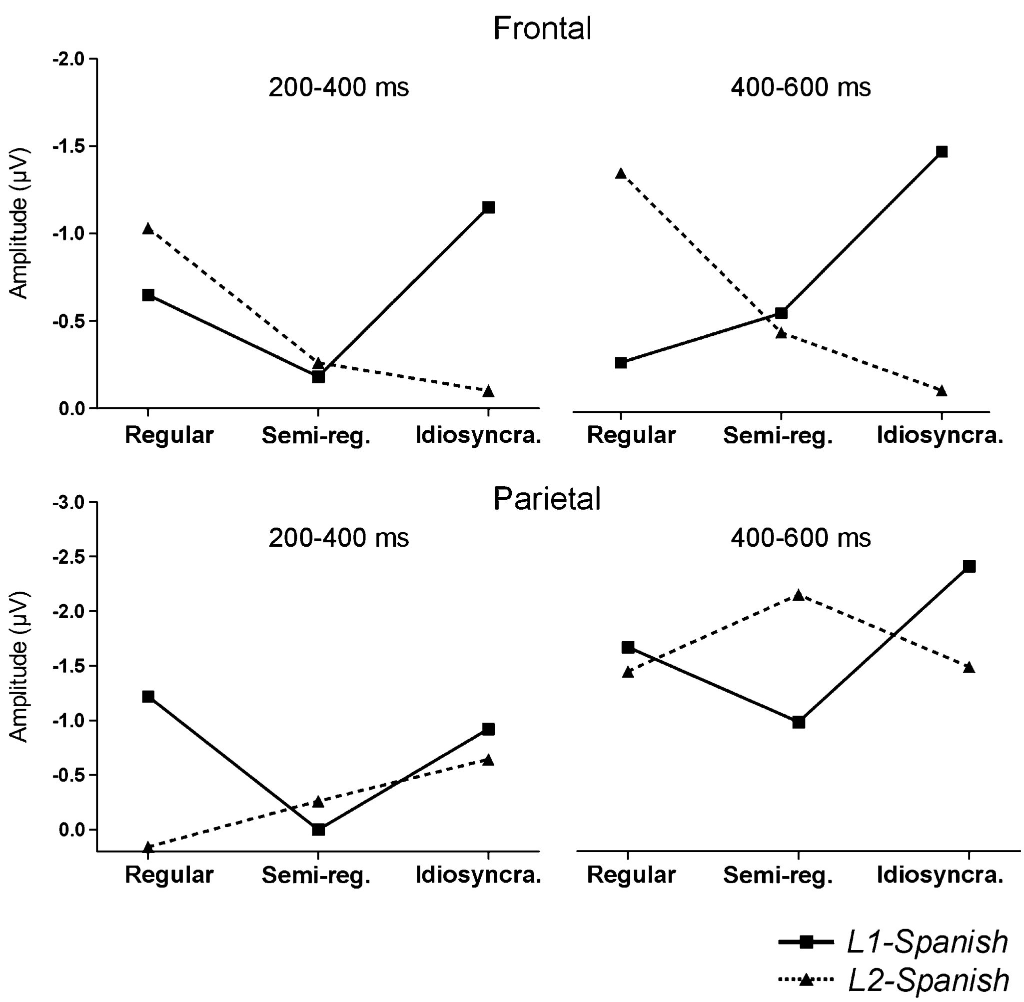

Fig. 6. Mean differences in amplitude (unrelated minus related target forms) between 200–400 and 400–600 ms time windows averaged for three *frontal* electrodes (F3, Fz, F4) and three *parietal* locations (P3, Pz, P4). The difference amplitudes are depicted separately for the regular, semi-regular, and idiosyncratic verb forms, in each time window and comparing both L1/L2 groups.

second-language speakers of Spanish. The regular/irregular contrast is particularly relevant because Catalan and Spanish share similar regular suffixes but have different irregular patterns. The behavioral results were contrasted with those of the event-related potential recordings within each group and between the L1 and L2 groups.

Overall, reaction times showed the same priming effect for all morphological conditions irrespective of regularity. However, this morphological priming effect was different to that of semantic priming. In this condition, a partial blocking of the effect was observed, as predicted in the experiments reported in Stolz and Besner [50,51]. The morphological effect was also clearly different from the formal priming effect observed in the nonce conditions. In the latter, the relatedness effect was the reverse of that observed in the real verb conditions: the nonce-related targets showed slower reaction times than unrelated ones. Crucially, the fact that the same pattern was observed for both groups reflects the high proficiency and near-native performance of the L2 group in their second language.

However, interesting differences arose in the ERPs, both within and between groups. The results suggest that, despite the proficiency level of L2 speakers, the way they process their L2 morphology differs from native speakers. The first important result of this study concerns regular verbs. As we pointed out in the Introduction, Catalan and Spanish use the same *-o* suffix to produce the first person singular in the present indicative. In both languages, this suffix could have a full default value as it applies to verbs of all conjugation classes. We were thus testing the possibility that the two groups of bilinguals (L1 and L2) may process regular verbs in the same way, due to the similarity between the languages. The ERP recordings showed that regular verbs displayed a clear N400 priming effect, showing a significant reduction of the N400 component in related targets compared to the unrelated ones. The magnitude of this effect was equal in both L1- and L2-Spanish speakers, supporting the idea that bilinguals with similar morphological systems may benefit from their knowledge of their L1 in the acquisition of the morphological system of their L2.

A sharp contrast appeared in the processing of irregular verbs between the two groups of bilinguals. The results for the verbs with a more systematic pattern, semi-regular verbs, replicated those of the previous repetition priming study in Spanish [42] where no significant priming was observed for these verbs in the ERPs despite the significant level of priming comparable to regular verbs in the reaction times. In that earlier study, as we noted in the Introduction, irregular verbs included semi-regular verbs almost exclusively. In our case, however, the scalp distribution of the N400 priming effect was different in the L1 and L2 groups: whereas the effect appeared exclusively in temporal locations for the L1 group, for the L2 group the pattern was quite different, with the effect reaching significance throughout the scalp. Interestingly enough, this dissociation also emerged for the more idiosyncratic irregular condition, but in the opposite direction. While L1-Spanish participants showed a clear N400 priming effect for idiosyncratic irregular verbs at all locations, L2-Spanish subjects showed clear priming effects at posterior electrodes but the priming was reduced at frontal electrodes.

The dissociations that appeared between the two types of irregularities in the L2- and the L1-bilinguals and the topographical differences between groups of subjects point to different neural generators for the effects in each group. Importantly, these disparities across groups cannot be explained by a difference in proficiency as no behavioral disparities were detected either in the morphological or in the semantic and formal conditions. In addition, the topographical differences of the effects were not present for regular verbs.

It remains to be explored whether the transfer observed here only occurs when the system under study is identical or if it also applies in similar but not identical instances [15,33,40]. By *transfer*, we mean the use of the characteristics of the first language for the acquisition, representation, and processing of the second language.

Relevant to this issue is a very interesting ERP experiment in which a miniature artificial language was used [14] to evaluate the effects of syntactic transfer between languages. Participants in this experiment had to learn different grammatical rules, some of them already existing in their L1 (German) and some completely new in which L1–L2 transfer was not possible. The results showed that, in both cases, the syntactic violations in the new language elicited the same LAN/P600 pattern for both types of grammatical rules. This result is partly in disagreement with other studies [16,17,55], in which ERP differences were obtained in L2 processing. The disparity of the results may have been due to the degree of fluency of bilinguals in L2. In the Friederici et al. [14] experiment, participants were very well trained in the new language, and therefore, the interesting interplay between learning and the effect of transfer was not directly tested.

A direct evaluation of the effect of progressive learning on the acquisition of similar and distinct syntactic rules between languages has recently been reported [35]. In this longitudinal study, a sample of English students who were enrolled on a formal French course was evaluated after 1, 4, and 8 months of training. The effect of semantic anomalies in the N400 component was already present after the first month of learning. Two syntactic violations were also evaluated: (i) subject–verb agreement, which is present in English as well as in French and (ii) number agreement between the article and the noun, rarely present in English. While the P600 component was elicited at the fourth month of training for the subject–verb agreement violation, no P600 effect was elicited for the second type of grammatical violations even at the last evaluation point. These results also support the hypothesis that common grammatical rules shared by the L1 and L2 are qualitatively different from the ones that are not common to the two languages.

The effect of the degree of similarity between languages in the acquisition of the L2 system is a point that may also be critical to determining whether the differences observed for irregular verbs between L1 and L2 groups could arise precisely due to the interference of a dissimilar irregular system within two otherwise very similar morphological systems. Indeed, this idea gains support from another interesting result observed for our L2 subjects at an early time window (100–250 ms). At this interval, differences between the priming in the regular and idiosyncratic conditions were present at posterior sites. Although the topography of this effect does not fully correspond to a LAN syntactic effect [17,36,56], it is possible to speculate that this increase in negativity for idiosyncratic verbs may be an indicator of the interference of the L1 system in the processing of the L2 idiosyncratic irregular verbs that are totally different in the two languages. It would be interesting to explore this possibility further in future research.

Concerning the morphological processing in Spanish native speakers, as previously reported in the Rodriguez-Fornells et al. [42] study, differences in the N400 effect were observed between regular and semi-regular verbs indicating that the latter has a different lexical representation and not a single access representation, as do regular verbs. We extended these results by including an idiosyncratic irregular condition that led to the same N400 effect as regular verbs. Surprising as they are, these results are nevertheless in agreement with a recent study with idiosyncratic verbs that showed decomposition in those verbs with an ERP violation paradigm [27]. Nonetheless, the topographical differences in the effects between regular and idiosyncratic verbs may indicate different neural generators of the effects. Recent neuroimaging data point to the confirmation of this in Spanish [7,9]. In fact, priming appears in all types of verbs in the ERP results although more or less widely distributed throughout the scalp or with a different topographical distribution (e.g., semi-regular priming was only restricted to temporal locations). This may mean that decomposition actually occurs in all cases, but in addition, other processes underlie the processing of the irregular verbs. Adopting Clahsen's proposal of a distinction between stem formation (lexical retrieval) and suffixation, the latter might be common to all verbs in Romance languages, while stem retrieval may only apply to irregular verbs (idiosyncratic and semi-regular). The N400 effect may be related to the compositional component, and stem retrieval to another process that modulates the effect to a different scalp distribution: one common and one distinct neural substrate. This explanation is in agreement with our recent neuroimaging results in Spanish [9] and with recent neuropsychological studies (in Greek [53]; in English [11,48]). In a recent event-related fMRI study in Spanish [9], we observed that the left inferior frontal gyrus is responsible for the retrieval of grammatical features necessary for the processing of all verbs irrespective of their regularity status. In contrast, the left dorsolateral prefrontal cortex and more superior frontal areas were selectively involved in the control of lexical retrieval for irregular verbs. In addition, in accordance also with the behavioral priming results in the Rodriguez-Fornells et al. [42] study, we obtained significant priming comparable for all types of verbs in the reaction times. These results are in agreement with those obtained in French [29] and Italian [34] and provide a tentative explanation for the disparity of results between Romance and Germanic languages.

In summary, our data replicate the results by Rodriguez-Fornells et al. [42] for the semi-regular versus regular distinction with a different paradigm, and also show that irregular idiosyncratic verbs have a different pattern of results. Idiosyncratic and regular verbs both exhibit significant N400 priming effects although with a different topography, pointing to different neural generators. This pattern of results emphasizes the importance of splitting between the two irregular conditions when studying the regular–irregular distinction. With respect to L2 processing, the results point to an influence of the similarity of the morphological systems of a bilingual in the way the L2 system is processed. Differences in processing between L1 and L2 speakers are observed even in highly proficient early bilinguals when languages have very similar systems but differ in particular structures: the similarity between languages may help for similar suffixations, but may interfere for dissimilar structures. Considering that our sample of subjects learned their L2 very early in the acquisition process and in a natural context, possibly these processing differences observed in adulthood come from the transfer of L1 to L2 during the acquisition period. This transfer may occur at least when a morphological paradigm is identical. Further research is needed in order to identify the differences underlying the two types of irregular verbs that cause the dissociations within L1 and L2 but also across groups of bilinguals.

Acknowledgments

We thank Elena Azañón for her help in running the experiment and Matti Laine and A.C. Bachoud-Lévi for their helpful revisions and comments on an earlier version of this paper. RDB was supported by a pre-doctoral Grant (2000FI 00069) from the Catalan government. ARF was supported by the Ramon y Cajal research program. The study was also supported by the MCYT Grant (BSO 2002-01211) to ARF and HFSP (RGP682002)/MCYT Grants to NSG (with EC Fondos, SEJ 2004-07680-C02-01/PSIC).

Appendix A. Description of the Spanish and Catalan morphological systems

Both Spanish and Catalan are Romance languages with verbal inflectional systems organized into three morphological classes, called "conjugations". To simplify the following explanations, the examples will be given only in Spanish and the explanations are applicable to both languages, unless otherwise specified. Each conjugation has its characteristic thematic vowel, e.g., first conjugation: -a- ("estudi-a-r" [to study]), second conjugation: -e- ("com-e-r" [to eat][3]), and third conjugation: -i- ("viv-i-r" [to live]). This thematic vowel determines the suffixes that have to be used to inflect the verb for tense and person. Thus, while a verb of the first conjugation like "soñ-a-r" (to dream) is inflected as "soñ-*aba*" (I dreamt), a second or third conjugation verb, such as "viv-i-r", is inflected as "viv-*ía*" (I lived), for the imperfect tense, first person singular. Exceptionally, the 1st person singular of the present tense applies the same suffix "-o" to conjugation classes. This and the other regular suffixes, apply also to most of the stems even when they undergo irregular changes in their stems.

With respect to the similarities and differences between languages, at the lexical level, Spanish and Catalan languages have a high number of cognate stems, as a consequence of their common Romance root and their contact through time. Some stems are exactly the same in their written form but vary in their phonological execution (i.e., to sing: /kan'tar/, /kən'ta/) and some others share a number of phonemes although they are not identical even in their written form (i.e., to offend /ofender/, /ufɜndrə/). A few suffixes are also the same between languages. That is the case, for example, for suffixes /-aba/, /-ia/ of the past tense (1st and 3rd person sing.) and the suffix /-o/ for the present tense (1st person sing.) studied here. Nevertheless, the cognate status of a word does not determine systematically that the same suffix is applied in both languages. Thus, there are verbs such as "cant-a-r" which have the same form in both languages ("cant-o"), but also verbs such as "part-i-r" (to break), with the same written infinitive form in both languages, but becoming "part-o" in Spanish and "part-eix-o" in Catalan. Some cognate stems may also have different thematic vowels (i.e., to ascend: "ascender" in Spanish, "ascendir" in Catalan) or may undergo completely different morphophonological irregularities between languages. This is the case for verbs such as to come, "venir", becoming "vengo" in Spanish and "vinc" in Catalan. In the same way, non-cognate verbs may use exactly the same suffix between languages (i.e., to eat: "com-e-r/com-o" [Spanish]; "menj-a-r"/"menj-o" [Catalan]) or may not (i.e., to remove: "sac-a-r/sac-o" [Spanish]; "true-re/tre-c" [Catalan].

Concerning irregularities, a large group of Spanish verbs deviate from the regular pattern of verb formation due to changes in the stem or root form. Vowel phonological alternations affecting the stem/root of the verb are common in the present tense. In such alternations, front or back vowels change to diphthongs when stressed ("e"/ "i" _ "ie" and "o"/ "u" _ "ue")," as in "quer-ér" [to want]–"quiéro" [I want] or "volv-ér" [to return]–"vuélv-o" [I return]. The inflectional suffix for the first singular present tense is "-o," irrespective of whether or not the stem to which "-o" is attached has an alternated vowel. This group of verbs is the one called *semi-regular* in our study. It is relevant to mention that this diphthongisation process does not exist in Catalan. Aside from this widely extended irregularity, other more idiosyncratic variations exist in Spanish (i.e., "caer–caigo"; "estar–estoy"; "caber–quepo"; "pedir–pido") with no systematic similarity between languages. Those verbs are called *idiosyncratic* in the present study.

[3] This conjugation also includes verbs in -re for Catalan (i.e., to remove: "treu-re").

Appendix B. Experimental stimuli used in the present study (infinitive/related/unrelated items)

Regular verbs: ganar/gano/espío, temer/temo/fundo, acabar/acabo/juzgo, sucumbir/sucumbo/nado, ejercer/ejerzo/dedico, construir/construyo/permito, formar/formo/utilizo, llevar/llevo/indico, tocar/toco/ando, creer/creo/detesto, dejar/dejo/percibo, beber/bebo/admiro, actuar/actúo/tacho, instalar/instalo/ignoro, asumir/asumo/llamo, añadir/añado/pregunto, meter/meto/brillo, poseer/poseo/leo, escribir/escribo/recibo, dudar/dudo/sudo, correr/corro/remito, insistir/insisto/sello, decidir/decido/rezo, aprender/aprendo/saneo, romper/rompo/aprecio, vivir/vivo/silbo, tejer/tejo/sorbo, proteger/protejo/disparo, rascar/rasco/desprecio, soplar/soplo/suscito, resumir/resumo/taladro, subastar/subasto/tapo, resistir/resisto/tirito, asistir/asisto/discuto, consumir/consumo/tuerzo, corromper/corrompo/valoro, sobrar/sobro/aguanto, resbalar/resbalo/compro, avalar/avalo/vende, declarar/declaro/aclaro, ceder/cedo/cumplo, acceder/accedo/busco, deber/debo/camino, consistir/consisto/suplo, presumir/presumo/remo, apartar/aparto/limo, partir/parto/ventilo, compartir/comparto/coso, esperar/espero/rimo, mirar/miro/calibro, llegar/llego/ingreso, subir/subo/fijo, sufrir/sufro/derramo, repartir/reparto/hundo, impartir/imparto/cocino, asar/aso/atrevo, llorar/lloro/animo, salvar/salvo/ato, fumar/fumo/canto, cruzar/cruzo/froto.

Semi-regular verbs: contar/cuento/resisto, moler/muelo/bailo, tostar/tuesto/navego, acertar/acierto/ocupo, soltar/suelto/sacudo, querer/quiero/detengo, resolver/resuelvo/concluyo, requerir/requiero/cuido, apretar/aprieto/nombro, mover/muevo/invito, perder/pierdo/pinto, rodar/ruedo/vendo, temblar/tiemblo/opino, tender/tiendo/asomo, confesar/confieso/gusto, volver/vuelvo/enseño, cocer/cuezo/imagino, morder/muerdo/tengo, dormir/duermo/estudio, rogar/ruego/dibujo, hervir/hiervo/exijo, renovar/renuevo/firmo, mentir/miento/inflo, cerrar/cierro/junto, morir/muero/logro, preferir/prefiero/consiento, atender/atiendo/luzco, serrar/sierro/machaco, acostar/acuesto/marcho, pensar/pienso/meriendo, acordar/acuerdo/nazco, convertir/convierto/opero, conmover/conmuevo/barnizo, aprobar/apruebo/planto, entender/entiendo/protejo, reprobar/repruebo/quemo, inferir/infiero/quiebro, referir/refiero/susurro, encender/enciendo/cometo, ascender/asciendo/bostezo, conferir/confiero/vuelo, comprobar/compruebo/arrastro, revertir/revierto/arrebato, advertir/advierto/trasplanto, divertir/divierto/favorezco, invertir/invierto/confundo, manifestar/manifiesto/dimito, diferir/difiero/cancelo, sugerir/sugiero/fabrico, negar/niego/sueño, sentir/siento/libro, oler/huelo/arrimo, probar/pruebo/afloro, colgar/cuelgo/acostumbro, sembrar/siembro/atribuyo, volcar/vuelco/protejo, colar/cuelo/suplico, poder/puedo/reduzco, regar/riego/facilito, costar/cuesto/alegro.

Idiosyncratic verbs: convenir/convengo/levanto, sofreír/sofrío/critico, deshacer/deshago/presto, sustraer/sustraigo/ronco, medir/mido/ordeno, caber/quepo/subrayo, dar/doy/termino, pedir/pido/guardo, concebir/concibo/reclamo, yacer/yazgo/entro, ceñir/ciño/escucho, valer/valgo/amaso, disponer/dispongo/hablo, salir/salgo/necesito, elegir/elijo/prometo, maldecir/maldigo/emito, corregir/corrijo/envio, despedir/despido/veo, derretir/derrito/bombeo, distraer/distraigo/imito, embestir/embisto/chillo, estar/estoy/circulo, gemir/gimo/rasgo, ir/voy/suprimo, oír/oigo/excedo, detener/detengo/digiero, vestir/visto/diluyo, oponer/opongo/toso, caer/caigo/sucedo, contener/contengo/divido, decaer/decaigo/edito, devenir/devengo/lucho, atener/atengo/destaco, bendecir/bendigo/escalo, componer/compongo/escondo, impedir/impido/escupo, contraer/contraigo/atropello, venir/vengo/vacío, conseguir/consigo/cambio, suponer/supongo/vibro, estreñir/estriño/calculo, sostener/sostengo/freno, exponer/expongo/barro, atraer/atraigo/adhiero, abstener/abstengo/trituro, herejir/herijo/camino, intervenir/intervengo/rebato, decir/digo/alquilo, rendir/rindo/buceo, servir/sirvo/derrumbo, regir/rijo/elimino, seguir/sigo/falto, repetir/repito/formulo, expedir/expido/pego, teñir/tiño/publico, perseguir/persigo/recojo, reñir/riño/sé, sonreír/sonrio/señalo, competir/compito/tiro, constreñir/constriño/tomo.

Regular nonce verbs: gazar/gazo/esbío, teper/tepo/lundo, atabar/atabo/jurto, sudumbir/sudumbo/nazo, edencer/edenzo/defido, conspruir/conspruyo/perbito, fortar/forto/budo, lledar/lledo/incico, tecar/teco/ango, craer/crao/deresto, derar/dero/pertibo, geber/gebo/admino, acluar/aclúo/tado, inspalar/inspalo/ignodo, apumir/apumo/llapo, acadir/acado/prefunto, mefer/mefo/prillo, poteer/poteo/ceo, espribir/espribo/renibo, fudar/fudo/silizo, coper/copo/retibo, insirtir/insirto/tello, defidir/defido/reco, acrender/acrendo/saleo, rolper/rolpo/apregio, vidir/vido/silpo, teler/telo/sorpo, decrarar/decraro/discaro, nascar/nasco/desprenio, socrar/socro/sascito, redumir/redumo/talagro, sunastar/sunasto/tano, refistir/refisto/tirifo, afistir/afisto/disfuto, condumir/condumo/tuerco, collomper/collompo/vacoro, sotrar/sotro/aguanso, resnalar/resnalo/combra, analar/analo/vempe, proteler/protelo/aclapo, cener/ceno/cumblo, accener/acceno/busmo, deter/deto/catino, confistir/confisto/suflo, predumir/predumo/repo, abartar/abarto/liro, bartir/barto/ventijo, combartir/combarto/cogo, espezar/espezo/ripo, migar/migo/calino, degar/dego/indreso, supir/supo/fibo, sugrir/sugro/derraco, rebartir/rebarto/hunso, imbartir/imbarto/cocimo, acar/aco/atrepo, llofar/llofo/anico, salcar/salco/aco, futar/futo/canco, truzar/truzo/fropo.

Semi-regular nonce verbs: congar/cuengo/registo, moder/muedo/baino, toscar/tuesco/navedo, acerpar/acierpo/ocuro, solfar/suelfo/sacuro, quener/quieno/desengo, resolmer/resuelmo/contruyo, requenir/requieno/cueco, afretar/afrieto/mombro, moder/muedo/indito, permer/piermo/pinco, rojar/ruejo/venfo, tamblar/tienglo/opiro, tenger/tienjo/asogo, condesar/condieso/fusto, volder/vueldo/ensebo, coder/cuedo/inagino, morrer/muerro/tenro, dorcir/duerzo/estucio, ronar/rueno/dibupo, herdir/hierdo/exino, renonar/renueno/firso, mencir/mienzo/infro, cellar/ciello/jundo, modir/muedo/lopro, prefebir/prefiebo/conciento, atencer/atienzo/lurco, sechar/siecho/machano, adostar/aduesto/marpo, pengar/piengo/megiendo, acondar/acuendo/nazo, condentir/condiento/oredo, conmoder/conmuedo/barmizo, acrobar/acruedo/plando, entencer/entienzo/protelo, recrobar/recruebo/quero, infebir/infiebo/quiefo, refebir/refiebo/susullo, entenger/entienjo/comero, astenger/astienjo/postezo, confebir/confiebo/juelo, concrobar/concruebo/anastro, redertir/redierto/allebato, adertir/adierto/traspranto, didertir/didierto/famorezco, indertir/indierto/conprundo, manigestar/manigiesto/domito, difebir/difiebo/canzalo, superir/supiero/fadrico, nerar/niero/cueño, sensir/sienso/ligro, oder/huedo/allimo, crobar/cruebo/afroro, dolgar/duelgo/apostumbro, semprar/siempro/adribuyo, voldar/vueldo/crotejo, conar/cueno/sutrico, pomer/puemo/reduco, gegar/giego/fadilito, cosbar/cuesbo/abegro.

Irregular nonce verbs: condenir/condengo/ledanto, sodreir/sodrío/dritico, desdacer/desdago/presco, suscraer/suscraigo/ponco, merrir/mirro/orreno, daber/depo/sucrayo, gar/goy/ternino, bedir/bido/cuardo, conteder/contido/reclaco, yecer/yezgo/endro, celir/cilo/estucho, vacer/vazgo/allaso, disboner/disbongo/haplo, nalir/nalgo/nedesito, edegir/edijo/propeto, malnecir/malnigo/enito, collegir/collijo/enfío, desbedir/desbido/deo, delletir/dellito/rombeo, discraer/discraigo/imeto, emestir/emisto/gillo, escar/escoy/cirbulo, genir/gino/rasno, fir/foy/sucrimo, eir/eigo/exledo, derener/derengo/diliero, gestir/gisto/dimuyo, oboner/obongo/tozo, saer/saigo/subedo, conrener/conrengo/dimido, desaer/desaigo/erito, decenir/decengo/lullo, arener/arrener/despaco, benecir/benigo/esdalo, comboner/combongo/espondo, imbedir/imbido/esdudo, concraer/concraigo/acropello, renir/rengo/dacío, conreguir/conrigo/carbio, suboner/subongo/vicro, escreñir/escriño/caltulo, sospener/sospengo/creno, exboner/exbongo/bamo, acraer/acraigo/adhielo, abrener/abrengo/tricuro, herenir/herino/tamino, interrenir/interrengo/resato, necir/nigo/anquilo, señir/siño/bublico, combetir/combito/ciro, exbedir/exbido/dego, pervir/pirvo/dellumbo, rebetir/rebito/dormulo, pendir/pindo/duceo, begir/bijo/elidino, reguir/rigo/falbo, leñir/liño/pé, perreguir/perrigo/rebojo, conscreñir/conscriño/romo, sondeír/sondío/semalo.

Semantic: pronto/temprano/lejos, nariz/ojos/broche, coche/moto/gallo, botas/zapatos/veloz, profesor/maestro/capricho, abogado/fiscal/alumno, mermelada/tostada/rana, pera/manzana/atleta, primavera/verano/buzón, amor/cariño/armario, enfermera/médico/carpeta, cielo/nube/vértigo, arriba/encima/hormiga, sumar/restar/farola, sal/pimienta/tecla, caliente/quemado/betún, autopista/carretera/amigo, mesa/silla/puente, árbol/bosque/flor, muchos/pocos/pantalla, pájaro/águila/vaso, plato/cuenco/piedra, padre/hijo/cuadro, cuchillo/tenedor/lechuga, luna/estrella/espejo, reloj/hora/cometa, revólver/pistola/barco, camisa/blusa/embudo, almohada/cojín/letra, ácido/limón/orégano, vela/antorcha/serpiente, basura/papelera/puerta, iglesia/convento/marco, pastel/tarta/flecha, pan/bollo/bolsillo, potaje/sopa/abrazo, rosa/violeta/guitarra, papel/hoja/voz, atún/salmón/hoja, botón/ojal/billete, pelo/cabello/grito, océano/mar/botella, tigre/león/barril, chorizo/longaniza/tren, folio/hoja/sonrisa, postal/carta/montaña, felicidad/alegría/melón, risa/carcajada/lámpara, gramo/quilo/cama, órgano/piano/beso, cumbre/cima/escalera, paliza/golpe/pared, palmada/aplauso/vino, ordenador/computadora/semáforo, ducha/bañera/barriga, nevera/frigorífico/conde, lumbre/fuego/tabaco, queja/lamento/semilla, abrigo/chaqueta/habitación, barniz/esmalte/corazón.

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